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U.S. Coast Guard/U.S. Maritime Administration Cooperative Research on Marine Engine Exhaust Emissions

MARINE EXHAUST EMISSIONS MEASUREMENT OF THE M/V KINGS POINTER

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16. Abstract

This report presents the results of emissions testing conducted on board the M/V KINGS POINTER in May 1995. The objective of this testing was to conduct baseline instrumentation, monitoring, and evaluation of the engine exhaust emissions as part of joint U.S. Coast Guard/Maritime Administration cooperative research on controlling air pollution from ships. The U.S. Coast Guard's interest in emissions testing arises from both its desire to meet all federal and state air quality regulations and the fact that in the future it may be called upon to enforce regulations in the marine environment. The U.S. Maritime Administration's interest in this and related research is based on its efforts to assure that its vessels and those of the privately-owned U.S. Flag Merchant Marine can comply with future air pollution control requirements.

Underway tests were conducted of the 224-foot M/V KINGS POINTER in which two of its four diesel-electric generators were sampled for NO, NO_2, CO, and SO_2 in the exhaust. Additional data on fuel flow and power output were collected at five speeds over the full range of vessel operating ranges. NOx values were calculated and compared with standards proposed by the Environmental Protection Agency (EPA) and the International Maritime Organization (IMO).

Results showed that average NOx values were 9.4 g/kWh which is slightly below the 10.9 g/kWh upper limit or cap that is being proposed by the IMO for a diesel engine with a rated speed of 1200 RPM.

Additional conclusions and recommendations on the technique of portable emissions monitoring instrumentation are made.

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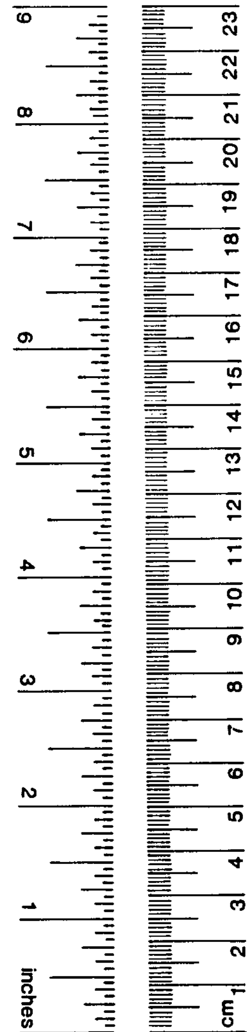
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (WEIGHT)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (EXACT)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly).



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (WEIGHT)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (EXACT)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

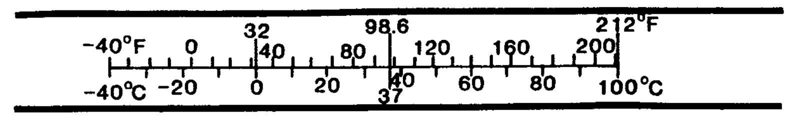


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TABLE OF CONTENTS

ACKNOWLEDGMENTS

1.0 BACKGROUND 1

1.1 Purpose of Test 1

1.2 Review of Regulatory Actions 1

1.3 Prior Work on Portable Emissions Measurements 4

2.0 OBJECTIVE 6

3.0 METHODOLOGY 7

3.1 M/V KINGS POINTER Description 7

3.2 Area of Operations 7

3.3 Testing Period 12

3.4 Data Collected 12

3.5 Experimental Design 19

4.0 RESULTS 20

4.1 April 12, 1995 20

4.2 May 10 and 11, 1995 21

4.3 Summary Data 21

4.4 Calculation Procedure 22

4.5 Calculated Emissions 29

4.6 Discussion 29

5.0 CONCLUSIONS 37

5.1 ISO 8178 Emission Factor 37

5.2 Portable Emission Testing Procedures 38

REFERENCES 40

APPENDIX A – CALCULATIONS for EMISSIONS A–1

APPENDIX B – DATA SHEETS – May 10 and 11, 1995 .... B–1

APPENDIX C – FUEL MEASUREMENT – May 10 and 11, 1995 .... C–1

LIST OF FIGURES

Figure		Page
1	IMO NOx Emissions	3
2	M/V KINGS POINTER	9
3	Engine Room, M/V KINGS POINTER	10
4	Area of Operations	11
5	Exhaust Sampling Schematic, Caterpillar D398	18
6	Laboratory Fuel Analysis Report	28
7	NOx Emissions vs. Shaft RPM	30
8	NOx Emissions vs. Propulsion Shaft Torque	32
9	CO Emissions vs. Shaft RPM	33
10	NOx (kg/tonne) of Fuel Consumed vs. Shaft RPM	34

LIST OF TABLES

Table		Page
1	Principal Characteristics – M/V KINGS POINTER	8
2	Ship Test Data Collected	13
3	Summary Air Flow Data – Engine 2	23
4	Summary Air Temperature Data Engine 2	23
5	Summary Fuel Flow Data – Engine 2	24
6	Summary Fuel Flow Data – Engine 4	24
7	Summary Horsepower Data – Starboard Propeller Shaft	25
8	Summary Pollutant Levels (ppm) – Engine 2	26
9	Summary Pollutant Levels (ppm) – Engine 4	26
10	Power Output – Engine 2	27
11	Power Output – Engine 4	27
12	ISO 8178 Engine 2 NOx Factors	31
13	ISO 8178 Engine 4 NOx Factors	31
14	Comparison of Gas Analyzer Readings	36

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1.0 BACKGROUND

1.1 Purpose of Tests

The U.S. Maritime Administration (MARAD) requested [1]* that the U.S. Coast Guard (USCG) conduct emission testing of the MARAD training ship M/V KINGS POINTER. Funding was provided to the Coast Guard's Research and Development Center (RDC) in Groton, Connecticut, to conduct "baseline instrumentation, monitoring, and evaluation of the engine exhaust emissions as part of joint USCG/MARAD Cooperative Research on Controlling Air Pollution from Ships." The requested research is intended to continue interagency research on the development of portable emissions testing protocols for consideration by the International Maritime Organization (IMO). This research has been conducted within the present Exhaust Emissions Project, 3310, sponsored by the Naval Engineering Projects Division within USCG Headquarters.

1.2 Review of Regulatory Actions

The U.S. Coast Guard's interest in emissions testing arises from both its desire to meet all federal and state air quality regulations and the fact that it may be called upon in the future to enforce regulations in the marine environment. MARAD's interest in this and related research is based on its efforts to assure that its vessels and those of the privately owned U.S.–flag merchant marine can comply with future air pollution control requirements. In the U.S., the Clean Air Act Amendments of 1990, Section 213(a)(3), have charged the U.S. Environmental Protection Agency (EPA) with defining and controlling the emission inputs from non–road sources, including marine sources. In November 1994, the EPA issued a proposed rule regulating emissions of non–road internal combustion engines. The EPA proposed to include marine

*Brackets refer to references on pages 23 and 24.

diesel compression–ignition engines under the same regulatory framework as land–based, non–road compression–ignition engines at or above 37 kW [2]. Specific emissions limits for new marine diesel engines were proposed.

These proposed regulations, which are expected to be finalized in 1996, are identical to regulations for non–road diesel engines. The EPA proposes that marine engines rated at less than 560 kW power be required to meet the above–proposed emission levels by January 1, 1999. Engines with power rated over 560 kW will be required to meet the above emission levels by January 1, 2000.

The proposed emissions levels address pollutants including nitrogen oxides (NOx), carbon monoxide (CO), particulate matter (PM), and unburned hydrocarbon (UHC). The levels are as follows:

NOx:	9.2 g/kWh
PM:	0.54 g/kWh
UHC:	1.3 g/kWh
CO:	11.4 g/kWh

On the international level, the International Maritime Organization (IMO) has developed proposed guidelines for controlling air pollution from ships. In these guidelines, maximum NOx emissions at different rated engine speeds are recommended. For example, a maximum value of 10.9 g/kWh of NOx is recommended for a 1200 RPM engine. These are shown in Figure 1. The testing procedures used to develop engine NOx values are contained in International Organization for Standardization (ISO) 8178, parts 1, 4, and 5. Typically these tests are done in the engine manufacturer's laboratory on test beds.

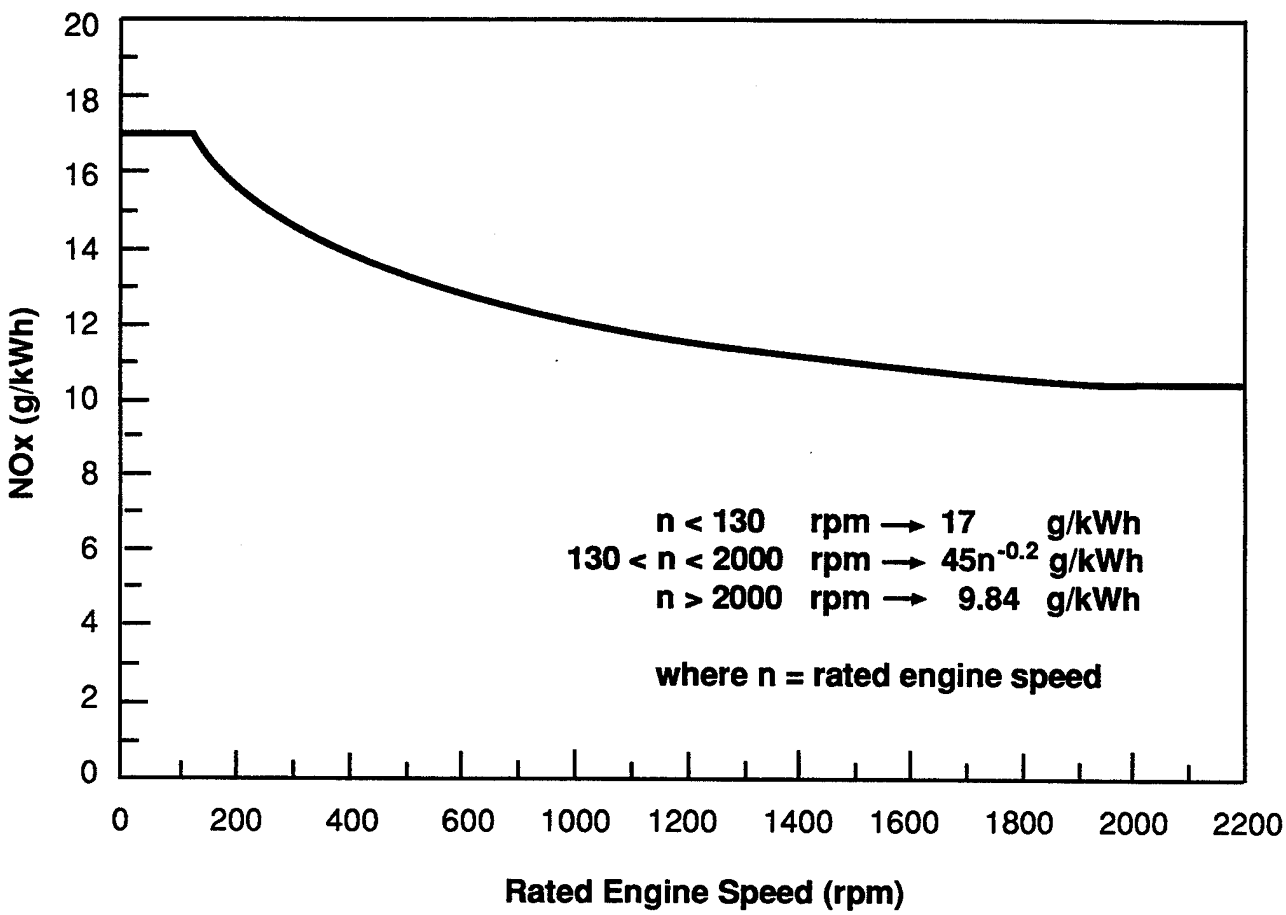

FIGURE 1

MAXIMUM PROPOSED NOx EMISSIONS LIMITS
FOR MARINE DIESEL ENGINES

In February 1996, the EPA issued a supplemental notice of proposed rulemaking [2] which refines its November 1994 proposed rule. Specifically, the EPA sought input on how to harmonize its proposed regulations with the IMO. The "EPA proposed an average NOx emission standard of 9.2 g/kWh, while the IMO NOx emission standard varies from 9.8 g/kWh to 17.0 g/kWh depending on engine speed. EPA's proposed NOx emission standard is an average in which the engine can be either below or above, so long as the emissions above the standard are compensated with emissions below the standard. On the other hand, the IMO NOx emission standard is a cap type standard that all engines must be less than."

One difficulty with the IMO test procedure is that it requires that all "NOx be reported as NO_2." However, NO is usually the largest component of NO_x making up approximately 90% of the NO_x reported. The molecular weight of NO at 30 is considerably lower than the molecular weight of NO_2 (46). As a consequence, reporting NO as NO_2 increases the apparent NOx value by a factor of 47.7%. Thus an actual NOx reading of 6.8 g/kWh would be reported by the IMO procedure as exceeding the 9.84 g/kWh limit for a high–speed engine, if it is interpreted literally.

The California Air Resources Board (CARD) proposes that new engines' NOx emissions comply with EPA regulations. The implementation of a compliance system which may involve fines has not yet been approved, but demonstrates that individual states may adopt their own standards, especially in areas of poor air quality.

1.3 Prior Work on Portable Emissions Measurements

Because of concern that laboratory bench testing does not duplicate the actual in–service load cycles on marine engines, and that performance of in–service engines degrades in time and their emissions increase, it is desired to measure at–sea emissions. There usually may be several modes of operation for vessels called duty cycles with defined speed, torque and time. ISO lists several duty cycles [3]. The EPA recommends cycle E2 at four different torque values (as a percentage of full torque), giving emissions as a weighted average of the four values.

In an attempt to characterize the emissions from its own vessels, as well as develop correlations between shipboard and bench test results, the Coast Guard undertook a series of tests involving three of its "Point" class 82–foot weapons patrol boats (WPBs). These tests developed a statistically based experimental design and test procedure based upon the ISO 8178, Part [2a]. Data were collected at five different shaft RPMs which represent the ship's operating profile better than the E2 values. A weighted average of emissions was then taken to represent the emissions of each cutter. The results of these tests are documented in [4].

In early 1995, as part of her M.S. thesis, Lieutenant A. Mayeaux, USN, undertook at–sea emissions testing on a large naval vessel of the LSD–41 class. Using a test protocol similar to that used by Goodwin [4], Mayeaux used a duty cycle developed earlier by Markle [5]. Actual emissions in the exhaust stream were measured in ppm and then converted to units of g/kWh based upon a mass flow calculation using the molecular density of the pollutant, its volume concentrations, and the mass flow rate of the exhaust stream. The results from her tests are contained in [6] and indicate that the LSD–41 vessel exceeded recommended EPA guidelines for NOx.

The most recent effort to conduct at–sea emissions testing of naval vessels was completed by a contractor, Environmental Transportation Consultants (ETC), for the Volpe National Transportation Systems Center in late 1995 [7]. Several Coast Guard cutters and patrol boats were tested for emissions. The purpose of these tests was to survey vessel emissions to provide the Coast Guard with a database for air quality compliance planning, update the emission inventory for select USCG vessel classes operating under the jurisdiction of CARB, and reevaluate emission control options for the propulsion engines.

2.0 OBJECTIVE

The objective of testing emissions on M/V KINGS POINTER was twofold: first, to quantify levels of pollutant emissions during actual underway operation over its entire operating speed range and, second, to continue to evaluate and develop the portable emissions testing technology used in prior tests.

There is a growing body of data on marine diesel emission levels from a variety of vessels ranging from the Coast Guard's 41-foot Motor Life Boat to the U.S. Navy ship USS ASHLAND, LSD-48. The M/V KINGS POINTER provided an important data point in that its diesel-electric drive configuration requires that the diesel engines run at a constant 1200 RPM, unlike other ships with diesel engines coupled directly to the propulsion shafts. Logistic and operational support was provided by the U.S. Merchant Marine Academy which operates the M/V KINGS POINTER as its training vessel. Underway testing was greatly facilitated since the primary mission of the M/V KINGS POINTER is midshipman training. During testing, midshipmen actively collected data and contributed significantly to the successful completion of test objectives.

Another reason for the selection of the M/V KINGS POINTER was the possibility of it or a sister ship being used as the fuel cell propulsion prototype vessel. Because of its diesel-electric propulsion, and the fact that several federal agencies, including the Coast Guard , operate sister ships, it is an ideal platform to develop, test and evaluate a fuel cell technology as a viable pollutant-free propulsion system. Currently a federal consortium is assembling to conduct the research leading to the year 2000 demonstration of marine fuel cell propulsion. The T-AGOS class to which the M/V KINGS POINTER belongs, is proposed as the future platform.

With regard to the second objective, i.e., to continue to evaluate and develop portable emission testing technology, the M/V KINGS POINTER tests enabled the RDC personnel to try out newly developed sampling instrumentation. Further refinements in sampling techniques were evaluated. Results from emission analyzers manufactured by two vendors provided comparative emissions data, and are summarized in the RESULTS section.

3.0 METHODOLOGY

3.1 M/V KINGS POINTER Description

The M/V KINGS POINTER is designated as a T–AGOS–2 acoustic ocean surveillance vessel. Originally commissioned for the U.S. Navy, it was designed to tow a slow–speed acoustic hydrophone array in support of anti–submarine warfare. The principal characteristics of the M/V KINGS POINTER (formerly USNS CONTENDER) are listed in reference [8] and outlined in Table 1. Figure 2 shows a line drawing of the M/V KINGS POINTER. Figure 3 shows a schematic of the engine room. Engines were numbered from port to starboard as follows: Engine 4 port, engine 2 port center, engine 1 starboard center, engine 3 starboard. A ship check was performed by RDC personnel in December 1994 to verify access within the engine room for emissions measurement and supporting instrumentation. In addition, ship's personnel were briefed on proposed test plans. These discussions led to development of test plans for Spring 1995 underway testing in the immediate area of western Long Island Sound.

3.2 Area of Operations

Figure 4 is a copy of NOAA chart #12363 showing the area just outside Great Neck, New York, with the operations areas depicted in rectangular blocks. Water depths generally were around 40–50 feet in the region northeast of Execution Rocks. Light seas were expected due to location within the Sound. One day of equipment installation and two days of underway testing were planned.

TABLE 1

PRINCIPAL CHARACTERISTICS

M/V KINGS POINTER

Official Number	CG002248
Builder	Tacoma Boatbuilding Co.
Commissioned	29 July 1984
Length Overall	224'–00"
Beam	15'–01"
Deadweight	2,250 tons
Displacement @ design draft	2,285 tons
Gross tonnage	1,914 tons
Net tonnage	574 tons
Propulsion	Diesel–Electric
Cruising Speed	10 knots
Complement	30
Main Engines (4)	Caterpillar D398TA, 970 Hp
Main Generators (4)	Kato, 600 kW, 600 VAC, 3 phase
Main Propulsion	General Electric 800 Hp,
Motors (2)	750 VDC
Rudders (2)	Spade, semi–balanced
Propellers (2)	4 blades, 8' dia., 8.5' pitch

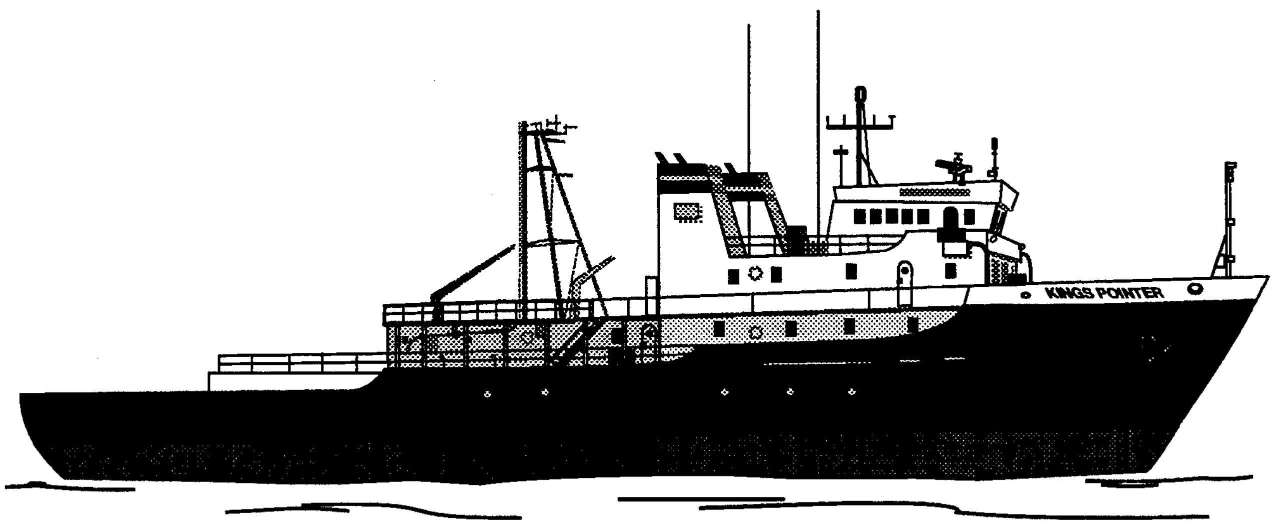

FIGURE 2
KINGS POINTER

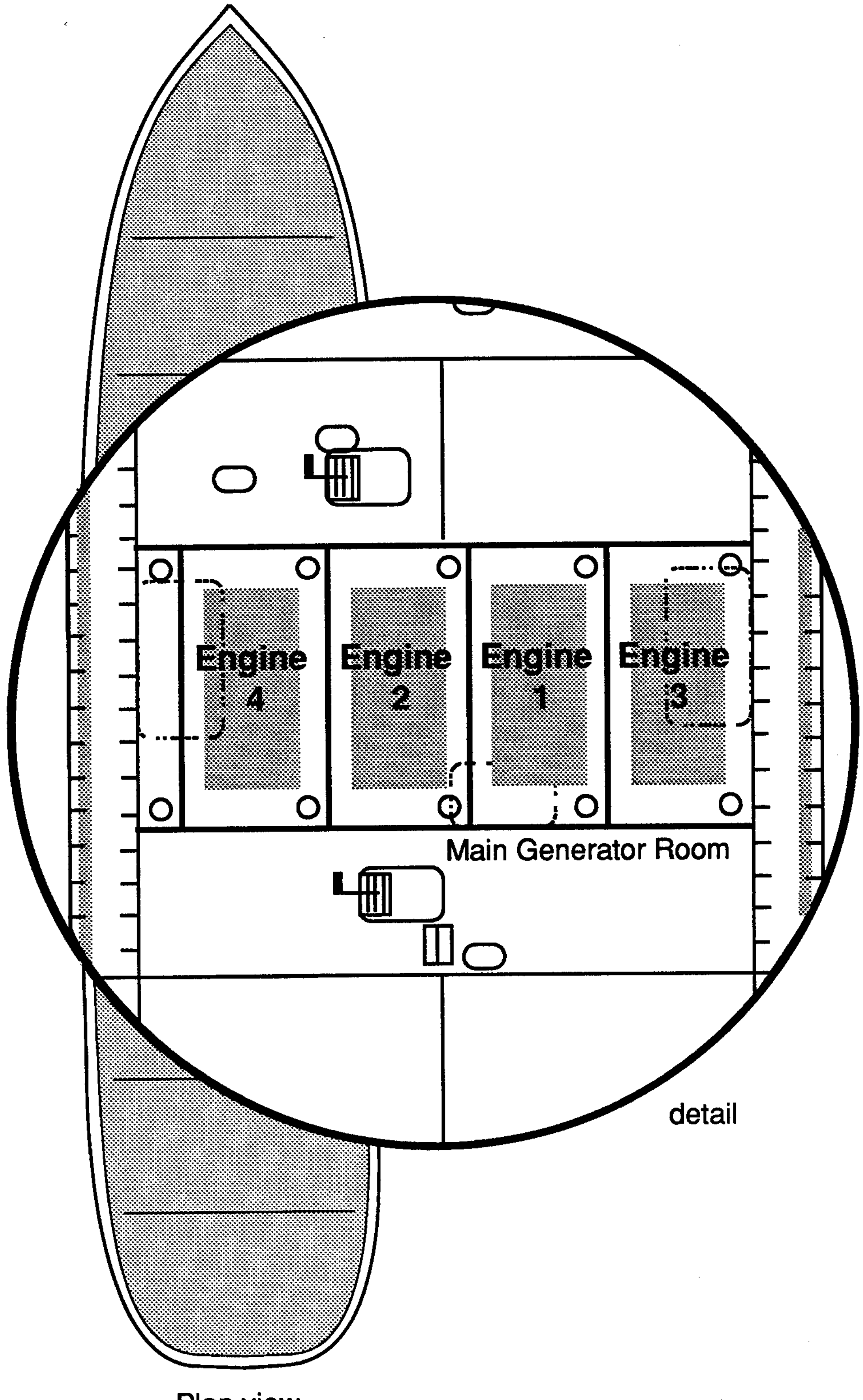

FIGURE 3
ENGINE ROOM, M/V KINGS POINTER

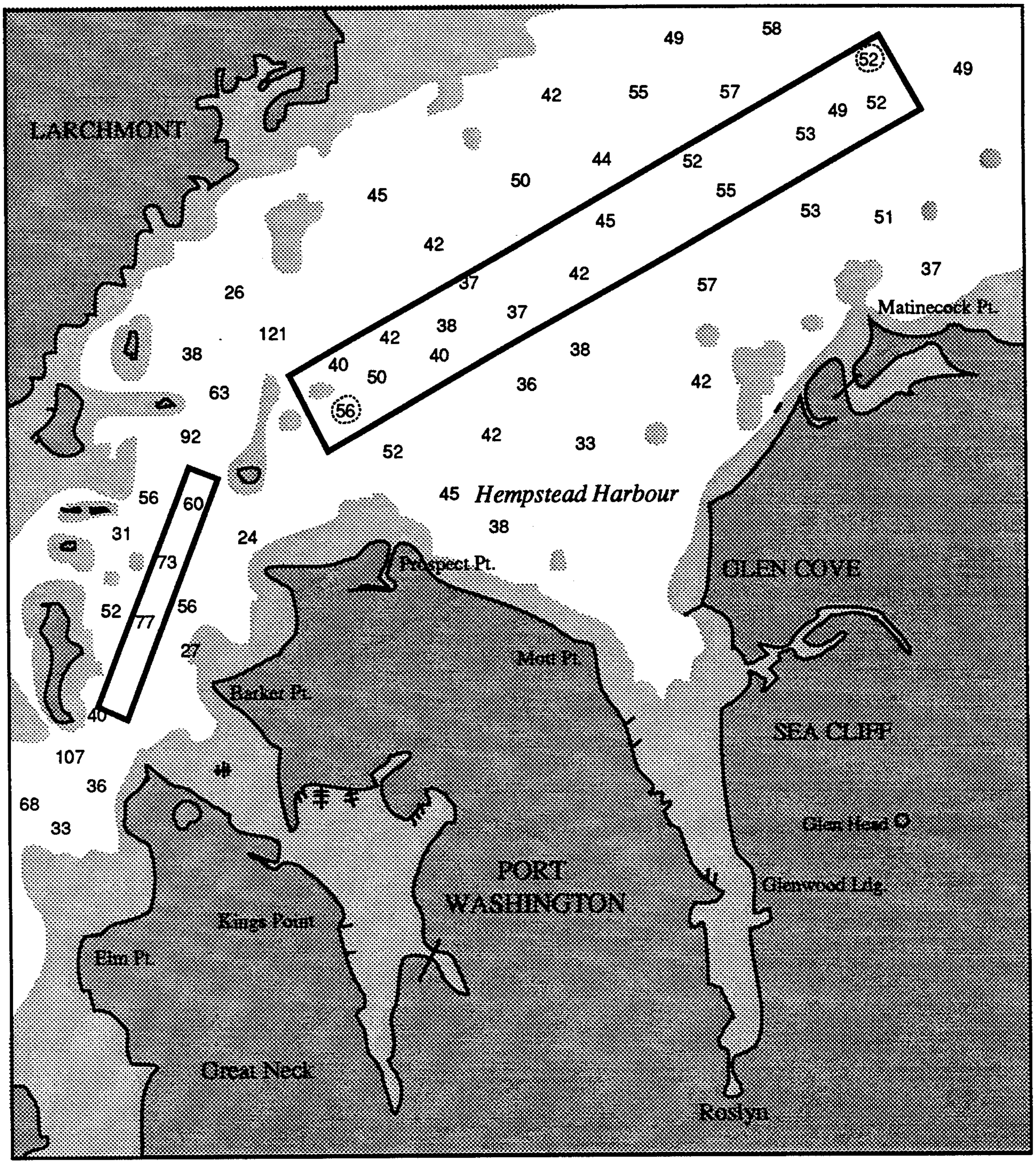

FIGURE 4
AREA OF OPERATIONS

3.3 Testing Period

14 December 1994	Initial ship check at Kings Point, NY, on M/V KINGS POINTER by A. Bentz, S. Allen, and W. Lincoln.
8 March 1995	Final ship check, M/V KINGS POINTER, by S. Allen and E. Weaver.
4–5 April 1995	Equipment installation/dockside testing on M/V KINGS POINTER by S. Allen, E. Weaver, and T. Brion.
11–13 April 1995	Underway testing of M/V KINGS POINTER by S. Allen, E. Weaver, and T. Brion.
9–12 May 1995	Completion of underway testing on M/V KINGS POINTER, equipment removal by S. Allen, E. Weaver, R. Desruisseau, and T. Brion.

3.4 Data Collected

In order to relate measured emissions data to ship physical and operating characteristics, several physical variables had to be measured. A complete discussion of the variables to be measured which affect engine exhaust emissions may be found in [4]. Data listed in Table 2 were collected. A discussion of how each variable was collected follows:

TABLE 2

SHIP TEST DATA COLLECTED

Barometric Pressure (inches of Hg)

Relative humidity near engine intake (%)

Temperature associated with relative humidity (°F)

Intake Air Temperature (°F)

Shaft RPM (both)

Engine RPM (all)

Shaft horsepower

Engine Power Output (kW)

Fuel Flow Rate (gallons/hour)

Intake Air Flow Rate (ft^3/min)

Stack Temperature (°F)

Oxygen volume (dry) in exhaust (%)

CO volume (dry) in exhaust (%)

Excess Air Volume (dry) in exhaust (%)

NO volume (dry) in exhaust (ppm)

NO_2 volume (dry) in exhaust (ppm)

NO_x volume (dry) in exhaust (ppm)

3.4.1 Barometric Pressure

Barometric pressure was recorded in the M/V KINGS POINTER engine room on a Control Data digital recorder in the engine room. Additional data were recorded by each of the Shortridge Flowhoods [9] installed on the turbocharger intake. These had been calibrated by the manufacturer within a few weeks prior to testing. Data were recorded on the chart continuously during the testing period and were entered into the data log during each block of data collected.

3.4.2 Relative Humidity

Relative humidity was recorded using The Dickson Company Model THDX chart recorder which was located in the engine room. Data were entered into the data log during each block of data collected. Calibration of the instrument was certified by the company and instrument readings were accurate to ± 2% R.H.

3.4.3 Air Temperature

Engine room air temperature was logged at intervals from the digital display on the Shortridge Flowhoods installed on engine 2 turbocharger. Accuracy was within ± 1.5°F.

3.4.4 Shaft RPM

Each of the DC propulsion motor shafts was equipped with a digital counter located in the propulsion motor room aft of the control room. For each run the counter was reset to zero and the number of shaft revolutions was recorded over a fixed time interval to give an average RPM value. The average value was compared to an instantaneous value obtained from a magnetic pickup on the shaft horsepower meter described in Section 3.4.6 and found to agree within 0.5%.

3.4.5 Engine RPM

Engine RPM was recorded from the digital meter mounted directly on each Caterpillar diesel engine. The diesel engines were either not running or running at a constant 1200 RPM.

3.4.6 Shaft Horsepower

Each of the two propulsion shafts was outfitted with a Wireless Data Corporation Model 1642A horsepower measuring system [10] which consisted of a strain gage bonded to the outside of the shaft, and a magnetic pickup which recorded the strain. The measured strain was then converted to torque, based upon the procedure outlined in [10]. Power (hp) may be found as follows:

$$P = M\,\omega$$

where:

P = shaft power (ft–lbs/sec),

M = torque (ft–lbs),

ω = angular velocity (radians/sec).

Power may be converted to units of horsepower since 1 hp = 550 ft–lb/sec = .746 kW. Angular velocity in revolutions/minute are converted to radians/sec since 1 RPM = (2)(3.14)/(60 sec). The measure of power in U.S. customary units of horsepower was converted into metric units of kW to be compatible with international conventions. Accuracy of the instrument was within 2% of full scale which was 1500 hp. Thus accuracy was ± 30 hp.

3.4.7 Fuel Flow Rate

Fuel flow was recorded for engines 2 and 4. Four Brooks model ER-11LHP positive displacement type flow meters were installed to measure the fuel flow supplied to and returned from the two diesel engines. Positive displacement flow meters were necessary because the fuel was gravity-fed to the engines from a day tank located just above the engine room. Since these meters had no electrical signal output, the net fuel flow had to be calculated using the difference between supply and return flow readings.

Flow rate data were corrected using calibration data for each flow meter. Each flow meter was individually calibrated at 85°F for these M/V KINGS POINTER tests. Fuel consumption rates were of the order of 1 gal/min. Fuel in the return line was warmer than the fuel in the supply line by approximately 30°F. The effect of this temperature increase was to decrease fuel density and fuel viscosity. The effect of this temperature increase in measuring fuel consumption rate is less than 2%.

3.4.8 Intake Air Flow Rate

Air flow was measured on engine 2 only, using Shortridge Flowhoods described in [9]. Filters on each of engine 2's turbochargers were removed and the flow meters were attached using a specially fabricated collar. Air flow entering engine 2 was continuously measured throughout the test period. The sum of the two meter readings provided the total intake in cubic feet per minute (cfm).

3.4.9 Stack Temperature (°F)

Stack temperatures were recorded on engines 2 and 4 by either the ECOM-KL or the ENERAC 2000E, using an internal thermocouple. Direct sampling of exhaust gas temperature was accomplished using the supplied probe inserted into the exhaust stream. Figure 5 shows a schematic of the Caterpillar D398TA diesel engine exhaust configuration with emission sampling probe access.

3.4.10 Exhaust Gas Concentration

An ECOM portable gas analyzer manufactured by ECOM AMERICA was used to measure exhaust gas concentrations. This instrument consisted of a probe with a pistol grip which was inserted into the exhaust gas stream. The sample gas passed through a water filter, to an electrochemical sensor for each gas to be measured. The output was printed on a strip chart listing gas concentrations in parts per million (ppm), or % at each sampling interval.

Two model ECOMs were to be used: the ECOM–KL belonging to the Coast Guard, and a leased ECOM–S PLUS. However, the ECOM–S PLUS malfunctioned and an ENERAC 2000E was substituted. The ENERAC 2000E is similar to the ECOMs in that it uses electrochemical sensors to determine gas concentrations. A complete discussion of each instrument's performance may be found in their respective technical manuals [11, 12].

All the above instruments were calibrated in the laboratory prior to testing using calibration gases with certified gas concentrations. In the field, recalibration was accomplished using portable gas bottles of certified gas concentrations. Probes on both the ECOM–KL and ENERAC 2000E were removed during transient engine operations. Probes were inserted in the exhaust gas stream only for the ten minute period of steady state conditions so as to minimize carbon build up in the probe tip. Cartridge filters were replaced after three hours and often showed some blackening and moisture content, but both instruments provided stable readings.

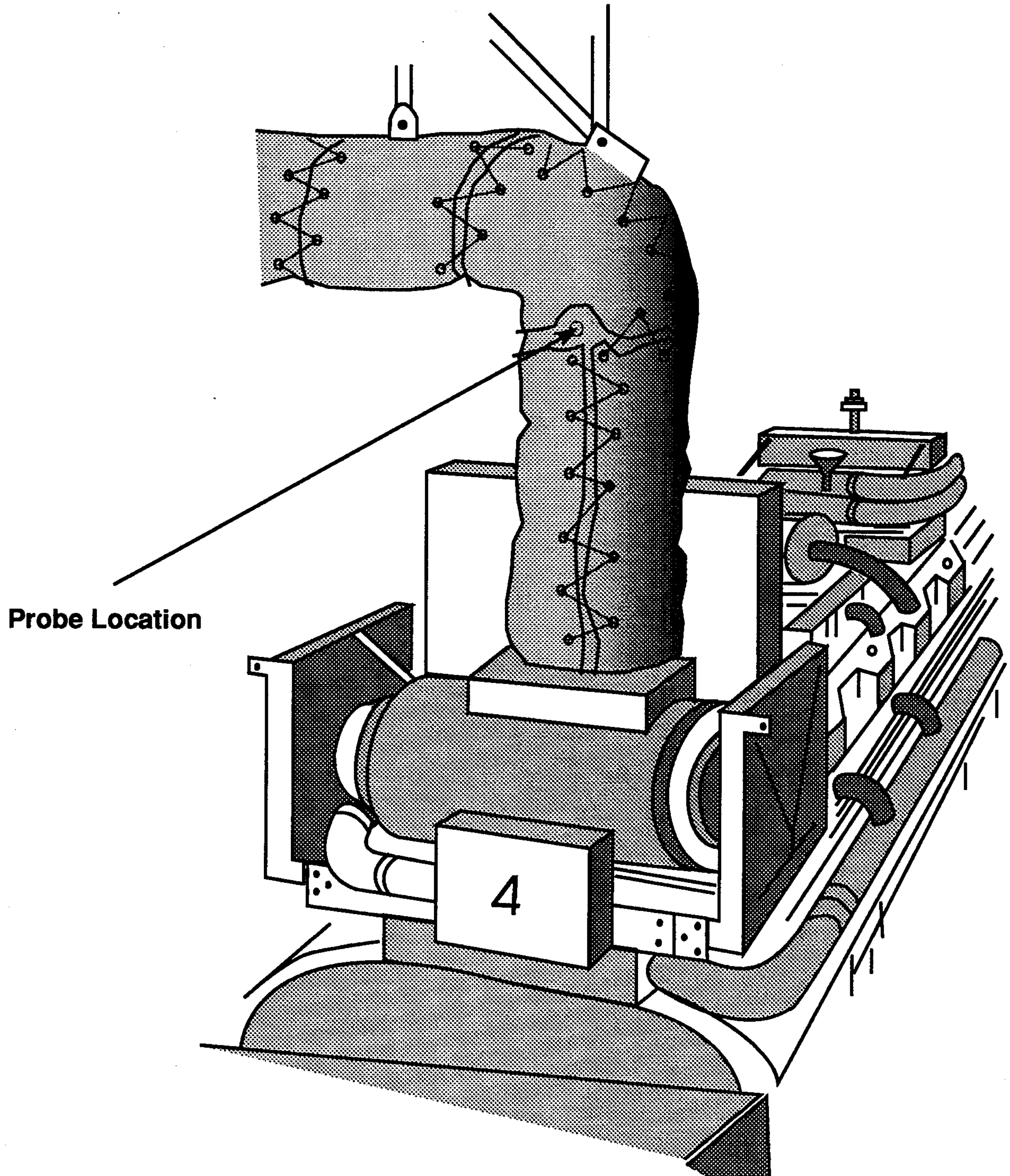

FIGURE 5
EXHAUST SAMPLING SCHEMATIC, CATERPILLAR D398TA

3.4.11 Engine Power Output

Engine power output from each of the diesel engines was continuously measured by a power meter within the control room. These read directly in kW. Data were recorded for engines 2 and 4.

3.5 Experimental Design

Emissions data were collected at several shaft RPM values. On the M/V KINGS POINTER, typically, three of its four diesel–electric generators were run to generate power for the two DC electric propulsion motors. Each diesel electric generator ran at a constant speed of 1200 RPM and, depending upon power demands, consumed fuel at different rates to maintain the 1200 RPM. Propulsion shaft RPM on each of the two shafts (port and starboard) was kept the same at all times during underway testing.

Data collection utilized a randomized test protocol developed by Goodwin [4] in which the vessel's engines are exercised over as wide a range of operating conditions as possible. These tests were at various shaft RPMs at five operating points representing idle to full ahead. Engine exhaust emissions and related data were collected at each operating point repeatedly over the test period. The collection of data was organized into several "blocks" consisting of "runs" at five different shaft RPM levels. RPM levels were selected using a face–centered cubic statistical procedure described in [4]. The objective of this procedure was to ensure random selection of engine speeds, reducing influence of previous speeds. A run consisted of data collected at a specific propulsion shaft RPM. A block consisted of a collection of five different runs arranged in random order. Each run began with acceleration or deceleration from the previous speed to test speed for the current run.

Once engines had stabilized at the current test speed as indicated by stable emissions levels and exhaust temperature, data were collected for a ten-minute period with all conditions kept at steady-state. During this period, the M/V KINGS POINTER maintained a steady course and speed with minor rudder corrections. At the end of the ten minute period, the ship was then brought to the next speed determined by the randomly selected shaft RPM. During each ten minute period, propulsion shaft RPM, fuel flow, and air flow were continuously recorded.

4.0 RESULTS

4.1 April 12, 1995

Underway testing commenced on April 12, 1995 at approximately 0900. The original test plan was to collect data on engines 2 and 4 since these had been fitted with ports for insertion and removal of emissions monitoring probes. However, due to problems with the fuel flow instrumentation on engine 4, engine 4 was not operated. Engine 4's fuel flow problems were determined to result from low fuel flow caused by obstruction in the flow meters. When this problem could not be corrected, its fuel flow meters were removed. Engine 4 was then put back into operation. As a result, fuel flow data were collected for engine 2 only.

The ECOM–S was used to collect emissions data on engine 2. The ECOM–KL was used on engine 4. The emissions data from engines 2 and 4 began to wildly fluctuate over the next several runs. Tips on the emission sampling probes were changed since it was suspected that soot may have been clogging the ECOMs. At 1140 the ECOM–KL on engine 4 stopped collecting emission data entirely. The ECOM–KL on engine 4 was then recalibrated at 1204 yet it continued to provide erratic results.

Because emissions data on both engines and fuel flow data on engine 4 could not be collected, the test was terminated and the ship returned to port at 1300 to resolve these instrumentation problems. Later it was discovered that engine 4's fuel flow meters were not working properly due to mechanical resistance in the impeller mechanism. The problems with the ECOMs were unresolvable at that time and it was decided to return them to the manufacturer for repair. Further ship testing was terminated until instrumentation problems could be resolved.

4.2 May 10 and 11, 1995

Subsequent to the termination of the April 12 testing, the fuel flow meters were removed from the ship and returned to the laboratory for overhaul and calibration. It was discovered that the meter impellers were obstructed by dried fuel residue. New flow meters were obtained and calibrated. Fuel flow calibration data are contained in Appendix C.

The malfunctioning ECOM–KL gas analyzer was returned to the manufacturer and disassembled. It was discovered that a defective solenoid valve was responsible for its erratic readings. The valve had been contaminated with foreign matter on the valve flap since there was no filter between the stack probe and the instrument case. A cartridge filter was installed in the gas line to prevent any future contamination. The ECOM–KL was then recalibrated.

Testing recommenced on May 10. It was planned to use the leased ECOM–S PLUS on engine 4 but an electrical hazard was discovered. An arc was observed between the probe and the exhaust gas stack. As a result, the ECOM–S PLUS was not used and the backup ENERAC 2000E was used in its place on engine 4. On engine 2, the ECOM–KL was used.

4.3 Summary Data

Data were successfully collected for all Blocks and Runs shown on the data sheets in Appendix B. The data sheets were provided to individuals stationed on the bridge, in the control room, engine room, and shaft room. As each run was executed, data were collected. The sequence of Blocks and Runs followed ensured a statistically random sampling procedure. Using these raw data, average values at each nominal propulsion shaft speed were obtained. These average data are used in the calculation procedure outline in Appendix A to obtain pollutant levels in g/kWh. Table 3 contains summary air flow data. Table 4 contains summar yair temperature data. Table 5 contains summary fuel flow data for engine 2. Table 6 contains summary fuel flow data for engine 4. Table 7 contains summary propulsion shaft horsepower and torque data. Note that due to instrument malfunctions, shaft horsepower data were available for the starboard propulsion shaft only. Table 8 contains summary pollutant data (in ppm) for engine 2, and Table 9 contains summary pollutant data (in ppm) for engine 4.

4.4 Calculation Procedure

Appendix A1.0 contains a sample calculation for the NOx level on engine 2 at 175 shaft RPM (SRPM). This calculation procedure is based upon a mass flow balance and combustion stoichiometry. The procedure was developed by A.P. Bentz at the Coast Guard Research and Development Center, and is unpublished. The calculation is used to illustrate how emission levels are converted from a volume percentage basis (ppm) to a more meaningful measure of mass/kWh. Input data are obtained from Appendix B data sheets and Tables 3 through 11. Stoichiometric calculations require fuel analysis, as shown in Figure 6.

Emissions may also be expressed in units of kg/tonne of fuel consumed as is commonly done by international convention. Results will also be presented in these units as discussed in paragraph 4.5.

TABLE 3

SUMMARY AIR FLOW DATA

ENGINE 2 – May 10 and 11, 1995

Propulsion Shaft Speed (RPM)	Air Flow (cfm)
0	698
50	716
100	796
140	982
175	1427

TABLE 4

SUMMARY AIR TEMPERATURE DATA

ENGINE 2 – May 10 and 11, 1995

Propulsion Shaft Speed (RPM)	Air Temperature (°F)
0	71.1
50	71.6
100	72.6
140	72.0
175	72.1

TABLE 5

SUMMARY FUEL FLOW DATA

ENGINE 2 – May 10 and 11, 1995

Propulsion Shaft Speed (RPM)	Fuel Consumption (gpm)
0	0.168
50	0.175
100	0.234
140	0.364
175	0.584

TABLE 6

SUMMARY FUEL FLOW DATA

ENGINE 4 – May 10 and 11, 1995

Propulsion Shaft Speed (RPM)	Fuel Consumption (gpm)
0	0.172
50	0.184
100	0.240
140	0.376
175	0.596

TABLE 7

SUMMARY SHAFT HORSEPOWER DATA

STARBOARD SHAFT – May 10 and 11, 1995

Propulsion Shaft Speed (RPM)	Torque (FT–LBS)	Shaft Horsepower
0	5.0	0.0
50	41.3	36.8
100	96.0	178.9
140	156.5	417.2
175	226.0	699.6

TABLE 8

SUMMARY POLLUTANT LEVELS

ENGINE 2 – May 10 and 11, 1995

Shaft Speed (RPM)	CO (ppm)	NO (ppm)	NO2 (ppm)	SO2 (ppm)
0	409	285	47	0
50	382	325	46	0
100	254	525	29	0
140	392	690	23	0
175	365	882	26	0

TABLE 9

SUMMARY POLLUTANT LEVELS

ENGINE 4 – May 10 and 11, 1995

Shaft Speed (RPM)	CO (ppm)	NO (ppm)	NO2 (ppm)	SO2 (ppm)
0	232	306	105	0
50	253	354	112	0
100	301	590	128	0
140	292	755	147	0
175	316	881	162	0

TABLE 10

POWER OUTPUT – ENGINE 2

May 10 and 11, 1995

Propulsion Shaft Speed (RPM)	Average Power Output (KW)
0	66
50	82
100	142
140	260
175	434

TABLE 11

POWER OUTPUT – ENGINE 4

May 10 and 11, 1995

Propulsion Shaft Speed (RPM)	Average Power Output (KW)
0	55
50	70
100	128
140	246
175	420

SAYBOLT INC.

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NEW HAVEN INSP. OFFICE

CUSTOMER
REF. NO(S) :2395325E00281

DATE : 04 14 95

LABORATORY ANALYSIS REPORT

LABORATORY NO. : 0805
INVOICE NO.:EU-19403A

DESCRIPTION

Sample designated as :
DIESEL OIL

Identifying Marks :
M V KINGS POINT
SUBMITTED ON 04 13 95
ORDER DTCG32-95-P-E00281
REF 239532E00281

Submitted by :
U.S. COAST GUARD

Client :
U.S. COAST GUARD

NOTES

- This laboratory report may not be published or used except in full. It shall not be used in connection with any form of advertising unless written consent is received from an officer of SAYBOLT INC.
- Results were based on analysis made at the time samples were received at the laboratory.
- Samples, if any, shall be retained for a period of 45 days unless a longer period is requested in writing.
- Sample nomenclature is designated by the customer.

ANALYSIS

TEST	METHOD	RESULT
GRAVITY, API AT 60 F	D-1298	32.4
SULFUR, X-RAY, WT PCT	D-4294	0.17
WATER & SEDIMENT (BS&W), VOL PCT	D-1796	0.05
ASH, WT PCT	D-482	0.005
ULTIMATE ANALYSIS, CARBON, WT PCT		86.33
ULTIMATE ANALYSIS, HYDROGEN, WT PCT		12.44
ULTIMATE ANALYSIS, NITROGEN, WT PCT		0.02
ULTIMATE ANALYSIS, OXYGEN, WT PCT		<0.02

MEMBERS ASTM-API-SAE

This report is issued solely for the use of our customers and supplies only information they specifically requested. There may be other relevant information which has not been reported. Saybolt will not be responsible to third parties for the contents of this report or for any omission therefrom.

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FIGURE 6

LABORATORY FUEL ANALYSIS REPORT

4.5 Calculated Emissions

Using the calculation procedure in Appendix A1.0, NOx levels and CO emission levels were calculated for engines 2 and 4 at the five propulsion shaft speeds. Results are shown in Appendix A2.0. NOx results as a function of SRPM are presented in Figure 7. NOx results as a function of propulsion shaft torque are shown in Tables 12–13 and in Figure 8. CO results are presented in Figure 9. Note that in this calculation procedure the measure of power output from each engine is available directly since each engine power output was continuously recorded from power meters located in the control room. Unlike vessels with coupling between the diesel engine and the propulsion shaft, M/V KINGS POINTER's diesel–electric generators supplied power to the DC propulsion motors.

NOx emissions in kg/tonne of fuel consumed are presented in Figure 10.

4.6 Discussion

As can be seen in Figure 7, engine 2 NOx values range from approximately 7.9 g/kWh at zero shaft speed and decrease to a low of 5.76 g/kWh at a shaft speed of 140 RPM. NOx levels measured for engine 4 were higher, starting from 12.1 g/kWh at idle to a low of about 7.7 g/kWh at 140 RPM. Typically the vessel operated below 180 RPM and frequently around 140 RPM. Actual vessel speed depends not only on shaft RPM but also wind, water depth, current, loading and hull bottom condition.

The difference in pollutant output levels may be attributable to two things. First, different gas analyzers were used on each engine. On engine 2 the ECOM–KL was used. On engine 4 the ENERAC 2000 was used. Although both instruments were calibrated with the same span gases,

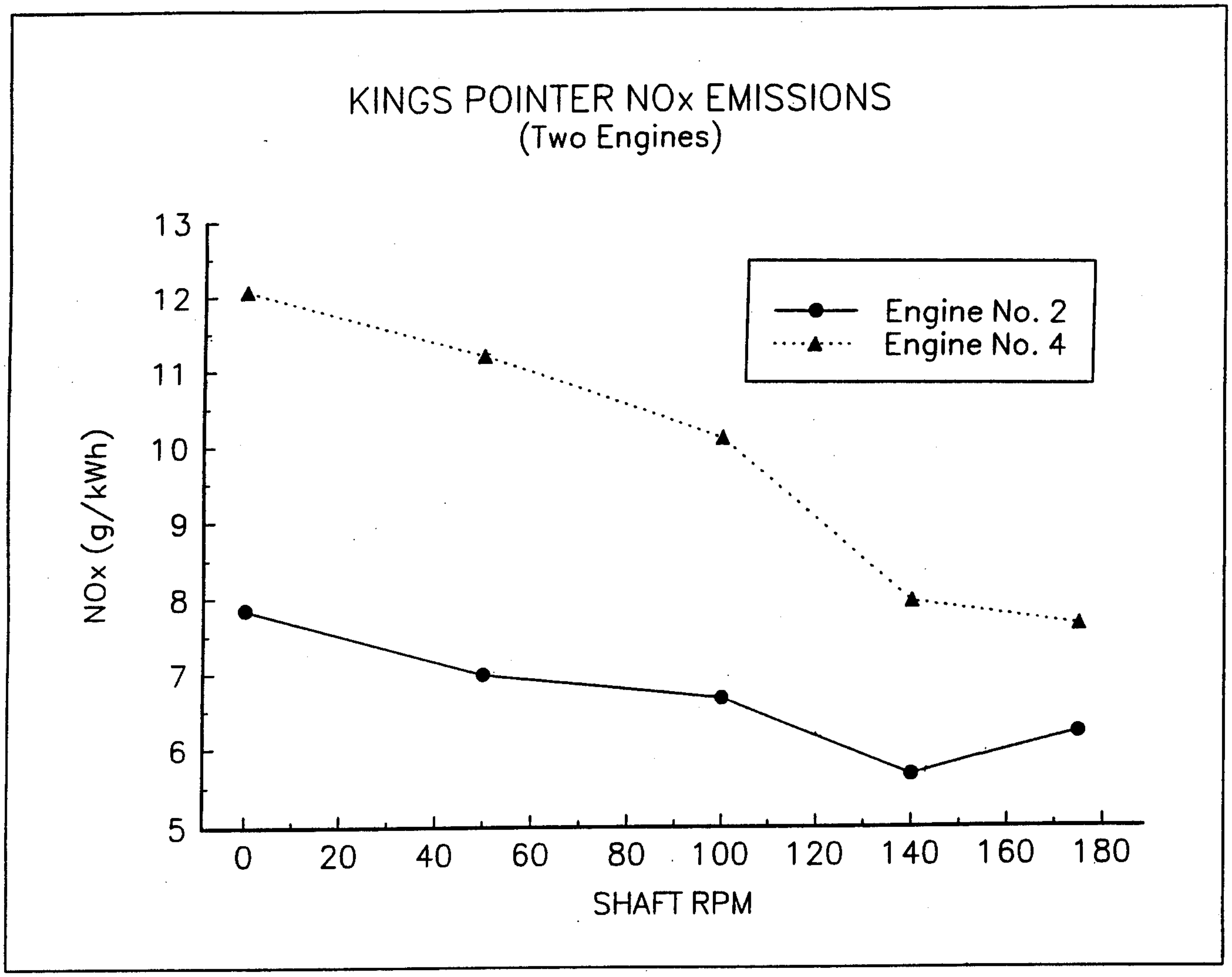

FIGURE 7

NOx EMISSIONS VS. SHAFT RPM

TABLE 12

ISO 8178 NOx FACTOR – ENGINE 2

May 10 and 11, 1995

% Full Torque	NOx (g/kWh)*	Weight.Fact	Weighted NOx (g/kWh)
25	5.9	0.15	0.89
50	6.8	0.15	1.02
75	7.2	0.50	3.60
100	7.8	0.20	1.56
			Total = 7.07

*To express in g/bhp–h, multiply by 0.746

TABLE 13

ISO 8178 NOx FACTOR – ENGINE 4

May 10 and 11, 1995

% Full Torque	NOx (g/kWh)*	Weight.Fact	Weighted NOx (g/kWh)
25	9	0.15	1.35
50	11.1	0.15	1.67
75	12.1	0.50	6.05
100	13.2	0.20	2.64
			Total = 11.71

*To express in g/bhp–h, multiply by 0.746

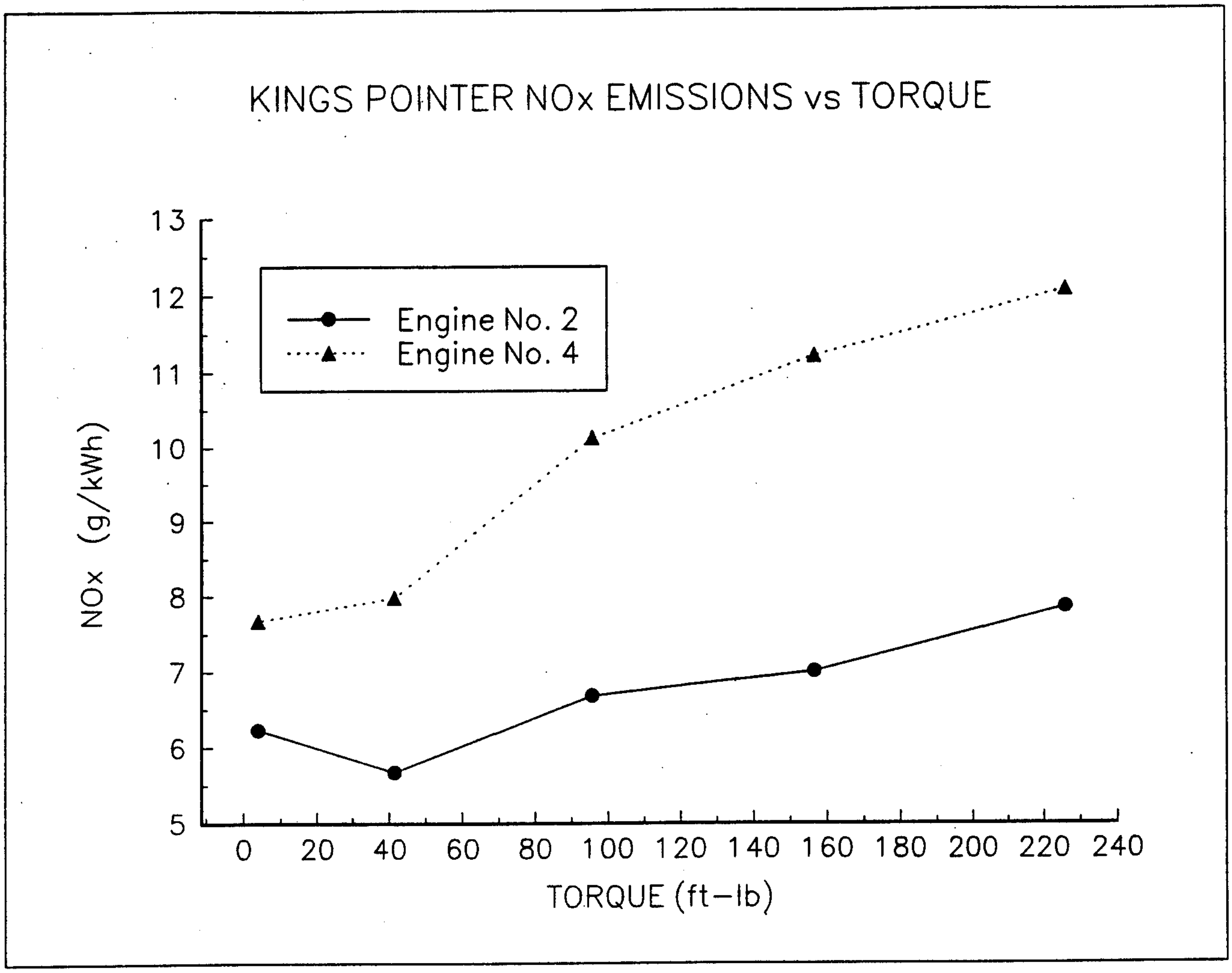

FIGURE 8

NOx VS PROPULSION SHAFT TORQUE

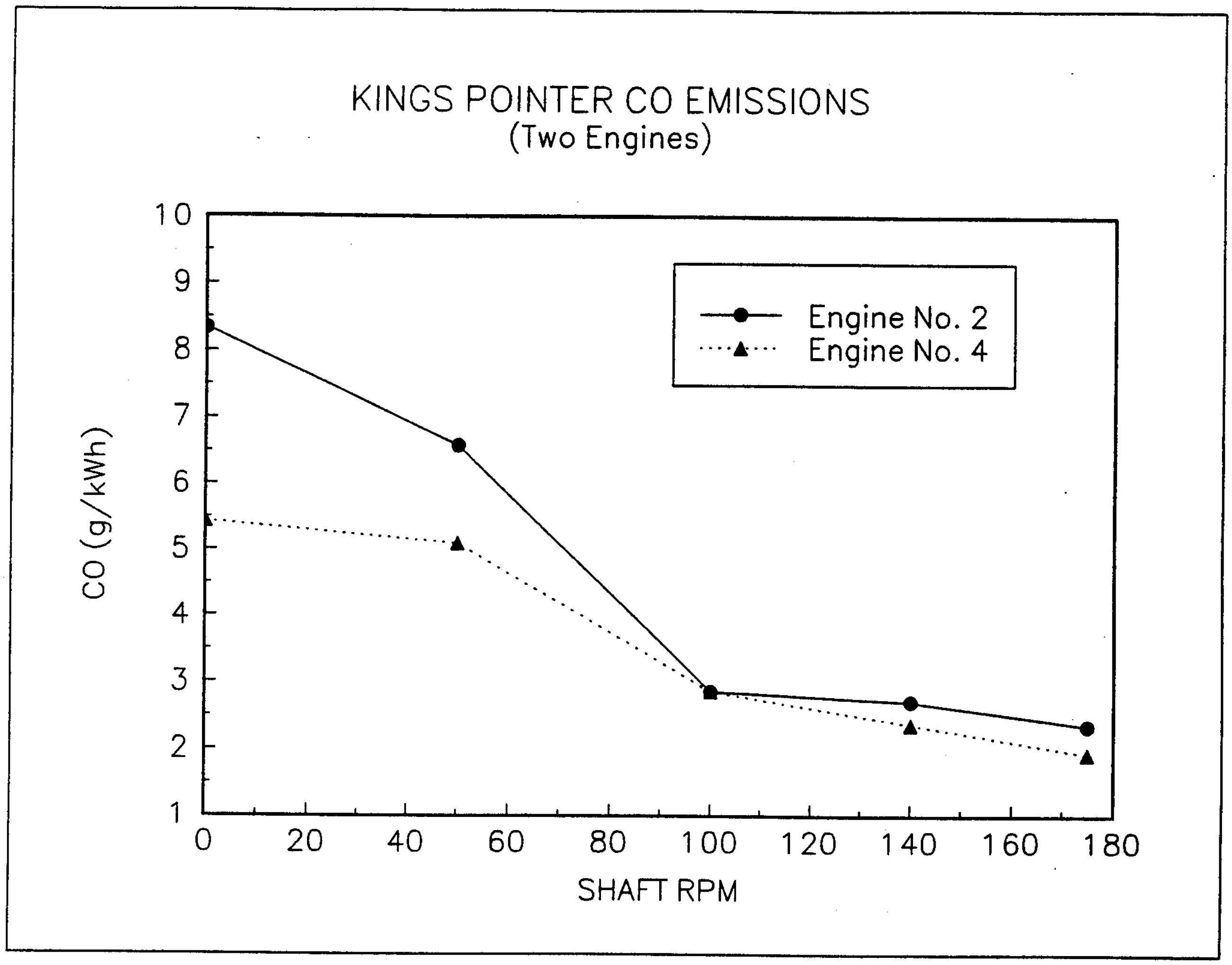

FIGURE 9

CO EMISSION VS. SHAFT RPM

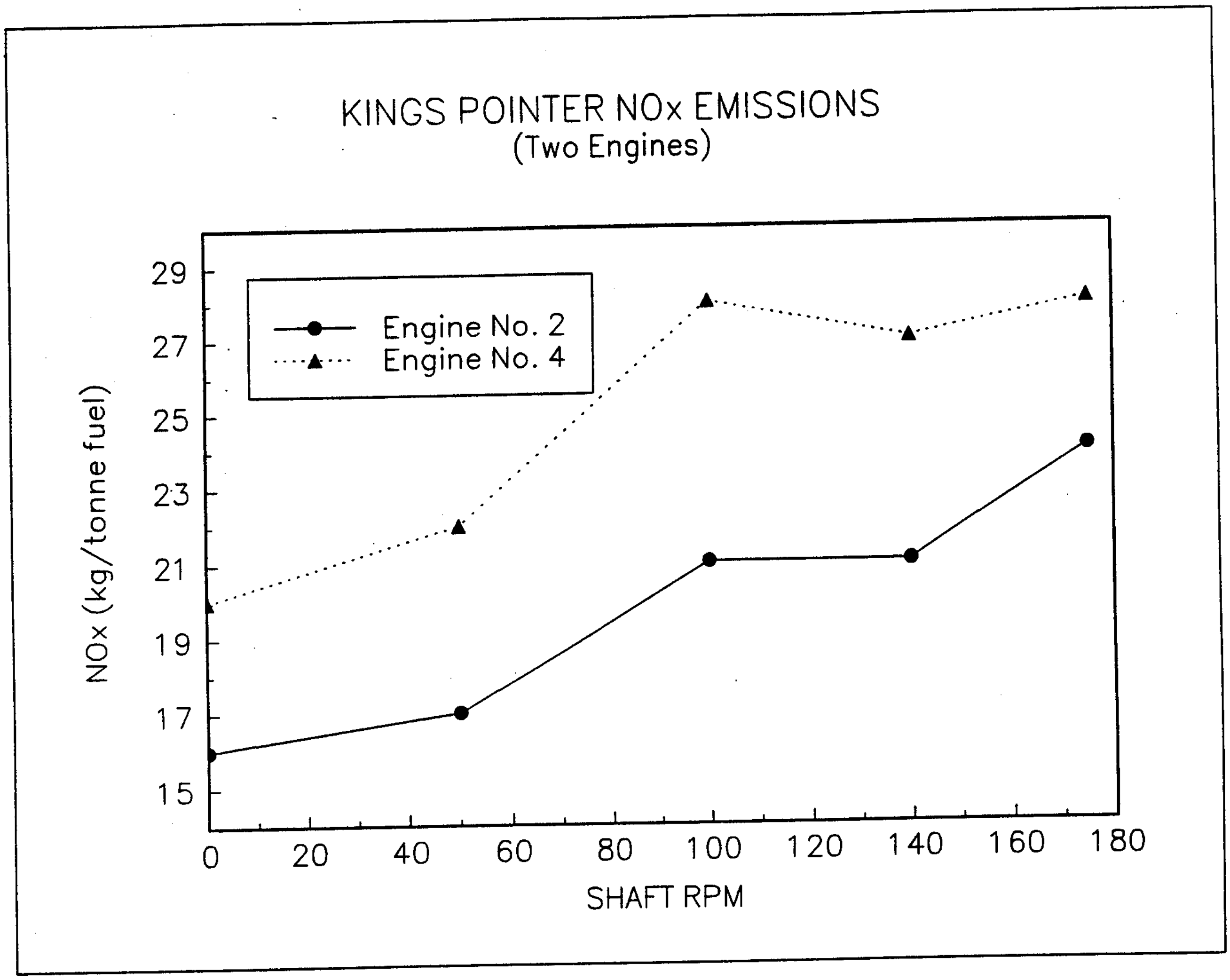

FIGURE 10

NOx EMISSION (kg/tonne) of FUEL CONSUMED VS. SHAFT RPM

there is a possibility of the electrochemical cells to vary with time. A discussion of the variability of the electrochemical cells used to sense NO and NO_2 may be found in a discussion of the EPA's Conditional Test Method, CTM–022, developed by Energy Efficiency Systems, Inc. [13].

To check on the differences between readings from both instruments, readings were compared on the same exhaust. At the end of Block 5 Run 5 with shaft speed at 175 RPM, the ENERAC probe was removed from engine 4 and inserted into engine 2. Only two readings were taken with the ENERAC. A comparison of the readings from the ENERAC with those from the ECOM–KL is shown in Table 14. As can be seen, there is a difference in readings for NOx of approximately 6% which indicates that for this run at least there is a measurable difference between instrument readings. Because this was the only run for which instruments were checked against each other, one may only speculate that there might be similar differences for other runs. While it is desired, of course, to have both instruments provide identical readings, this comparison illustrates that this was not the case. A possible source of the discrepancy was the difficulty in calibrating both instruments using the small quantities of calibration gas carried on board. Supplies of the calibration gas in portable cylinders could be quickly exhausted while waiting for the gas analyzer readings to stabilize for accurate calibration. To alleviate this discrepancy in readings, future emissions testing experiments may wish to consider alternating the same instrument on different engines.

The second reason for the difference is that engine 2 appeared to be more efficient than engine 4. For the same shaft RPM, engine 2 consistently produced more power typically in the range of 5–20%. Also, engine 2 generated fewer pollutants than engine 4. It was reported by the ship's crew that engine 2 had recently been serviced, which might explain the difference in performance.

TABLE 14

COMPARISON OF GAS ANALYZER READINGS

ENGINE 2 – 175 RPM

May 10 and 11, 1995

	ECOM KL (ppm)	ENERAC 2000 (ppm)
CO	365	306
NO	882	822
NO_2	26	142
NOx	908	964
SO_2	0	0

5.0 CONCLUSIONS

5.1 ISO 8178 Emission Factor

ISO 8178 provides that each vessel emission be evaluated by a single statistic which takes into account its operating profile. In the case of the M/V KINGS POINTER, the emission levels measured at each speed must be weighted to reflect the relative amount of time the vessel operated at each speed. Using the ISO E2 Duty Cycle engine load levels are weighted such to reflect operation as follows:

% Maximum Torque	Weighting Factor
25%	0.15
50%	0.15
75%	0.50
100%	0.20

As can be seen from the above, this ISO procedure prescribes the greatest weight to the load which contributes most to emissions (at 75% of maximum torque). Obviously this procedure is meant to provide a basis for computing a single emission factor and may not take into account the actual operating profile of the M/V KINGS POINTER. Notwithstanding the limitations of the above ISO procedure, the above power levels were applied to the NOx emission results as shown in Figure 8. The results of this application are shown in Table 12 for engine 2 and Table 13 for engine 4. Results show that the M/V KINGS POINTER computed NOx values are 7.1 g/kWh for engine 2 and 11.71 g/kWh for engine 4. The average NOx value between engine 2 and 4 is 9.4 g/kWh and thus is below the IMO recommended level of 10.9 g/kWh for a 1200 RPM engine.

5.2 Portable Emissions Testing Procedures

As stated earlier, the secondary objective of these tests was to continue to develop the technology of portable emissions testing. The results obtained provide a basis on which to make conclusions or recommendations for future testing. These include the following:

5.2.1 Air Flow

The air flow measuring hoods worked well. Flow in cfm was easily measured and stable. Additional temperature and barometric pressure data were also easily measured. It would also be helpful if the digital meters were interfaced with a portable data logger to facilitate data collection. The manufacturer is reported to be working on an improved version which will include such an interface.

Because of limited space between adjacent engine's turbochargers, only one engine could be fitted with air flow hoods by direct connection (i.e., without using flexible hoses). The assumption was made that both engines required the same air intake. However, based upon the measured power output variation between engines 2 and 4, this assumption may not be warranted. In future tests, the hoods should be fitted to each engine, if not at the same time, then in sequence. The engines could be run under load and cfm plotted against shaft speed for each engine. With these curves it may not be necessary to record air flow during the actual test, since air flow could then be read off the appropriate curve.

5.2.2 Shaft Horsepower Meters

Shaft horsepower measured during these tests was not used in the calculation of emission levels. If it had been, then the malfunction of the horsepower instrumentation on the port propulsion shaft might have resulted in uncertainty in overall engine power output. The strain gages were difficult to install on the shafts even with good access. The horsepower meters were heavy and bulky. Improved versions of these meters are available, and have been acquired. Another device has been made available that measures the torque directly from fuel rack readings.

5.2.3 Gas Analyzers

Both the ECOM-KL and the ENERAC 2000E gas analyzers provided stable readings which agreed within a few percent of each other. Both could be calibrated easily in the lab with ample supplies of calibration gas. Problems were discovered with the ECOM-KL probes due to contamination from soot in the exhaust gas stream. Installation of a replaceable cartridge filter appeared to rectify this problem. The difficulty in calibrating each instrument in the field is due to the need for more calibration gas than can be carried in small portable bottles. It might have been possible to carry larger bottles of calibration gas on board the M/V KINGS POINTER. Future tests should investigate this.

To eliminate the particulate contamination of the probe tips, the sampling was conducted by inserting the exhaust gas probes only after the engine had had several minutes to reach steady state operation.

The differences in instrument readings may be minimized in future tests by swapping gas analyzers from engine to engine so as to eliminate any bias.

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APPENDIX A

CALCULATIONS FOR EMISSIONS

CONTENTS

Page

A1.0 Sample Calculation – Engine 2 @ 175 SRPM A–2

A2.0 Spreadsheet Results – Engines 2 and 4, All Speeds. .A–10

APPENDIX A1.0
SAMPLE CALCULATION - Engine 2 @ 175 SRPM

Computations below are based on data taken on 10 and 11 May 1995 on M/V KINGS POINTER. The calculations are shown for engine 2 and vessel operation with both propulsion shaft speeds at 175 RPM. The calculations are based on a stoichiometric material balance of incoming fuel and air with exhaust, using the basic assumption that there is more than sufficient oxygen available in the air entering the diesel engine to effect complete combustion of the fuel components. For the material balance, the quantity of air per unit time (including water vapor), and the quantity of fuel per unit time account for all incoming materials.

Laboratory analysis of the fuel quantitatively measures the elemental components of the fuel. Theoretical amounts of combustion products (assuming complete combustion) are computed using the equations below:

$$C + O_2 = CO_2 \qquad S + O_2 = SO_2$$

$$4H + O_2 = 2H_2O \qquad N + O_2 = NO_2$$

These equations permit calculation of the theoretical amount of oxygen required (and therefore air) for complete combustion. Any air above that amount is "excess air." In actuality, complete stoichiometric combustion does not occur. Thus, not all carbon is completely converted to CO_2; some remains as CO. However, once the CO is experimentally determined, the actual CO_2 can be calculated. Similarly, not all nitrogen goes to NO_2, but the NO formed is independently measured.

Water is the product of combustion of hydrogen, but there is also water in the exhaust that entered as water vapor in the air. This source of water requires no additional oxygen, but must be accounted for in the total material balance. Any oxygen in the fuel (as oxygen-containing compounds) must be subtracted from the total oxygen required, since it contributes to the oxygen available. Sulfur in the fuel produces SO_2, but with the clean diesel fuels now in use, the levels are so low that they are near the threshold detection limits of the sensors.

Overall, the material balance is given schematically as follows:

FUEL		AIR		EXHAUST
C, H, N, O, S	+	N_2, O_2, H_2O	(combustion in -------------> diesel engine)	CO_2, CO, H_2O, NO, NO_2, SO_2, N_2, xs O_2

One can see from the above diagram that knowing the entering substances, and their amounts, it is possible to compute the amounts expected in the exhaust of primary combustion products. Analysis of the exhaust for CO, NO, NO_2, and SO_2, permits complete material balance.

The following table shows the fuel analysis in the first two columns. Using the equations from the previous page, with the appropriate atomic weights, the moles of oxygen needed can be calculated.

TABLE I
CALCULATED OXYGEN REQUIREMENT FOR COMPLETE COMBUSTION BASED ON FUEL ANALYSIS

FUEL COMPONENT	LB/100 LB FUEL[a]	MWT COMPONENT	MOLES COMPONENT	MOLES O_2 REQUIRED
C	86.33	12.011	7.188	7.188
H	12.44	1.008	12.341	3.085[b]
S	0.17	32.060	0.0053	0.005
O	<0.02	16.000	-0.0013	-0.001
N	0.02	14.007	0.0014	0.001
H_2O	0.05	18.016	0.0028	0.000
Ash	0.005			
TOTAL	99.035			10.278

[a] Based on fuel analysis
[b] Equivalent to 6.17 moles of H_2O/100 lb fuel

From the information above, the temperature, pressure, and humidity of the incoming air, the goal is to calculate the moles of dry flue gas (DFG) generated per unit time. Although the exiting gas is wet, the instrument used for quantitative measurement of the combustion products must first dry the air to protect the electrochemical sensors. Thus, the concentration of NOx in ppm, for example, is based on the amount found in the DFG.

DERIVED VALUES - used in calculations

The average MWt of air = 28.966. The MWt of atmospheric nitrogen (N_{2a}) = 28.161 (including argon and other trace components)

$$\text{lb } N_2/\text{lb } O_2 = 76.86/23.14 = 3.3215$$

$$\text{moles } N_2/\text{mole } O_2 = 79.05/20.95 = 3.773$$

$$\text{lb } O_2/\text{lb air} = 0.2314 \qquad \text{lb } N_2/\text{lb air} = 0.7686$$

Density of Wet Air

For this sample calculation, it is necessary to calculate the density of wet air. This is done in equation (1A) below, but requires the average molecular weight of wet air, rather than dry air. From a pschrometric chart at a measured temperature of $72.1^{o}F$, and 60% relative humidity, the amount of moisture is found to be 0.012 lb H_2O/lb air. (This is sometimes called RHc, or the humidity correction factor). This means that the weighted average molecular weight of wet air is:

$$MW\ (\text{Wet air}) = MW_{air} \times \%\ \text{Dry air} + MW_{H2O} \times \%\ \text{Water}$$

$$28.966 \times 0.988 + 18.0 \times 0.012 = \mathbf{28.84} \qquad (1)$$

Using the ideal gas laws, the density of wet air can be expressed as follows:

$$\rho_{wair}\ (lb/ft^3) = \frac{144 in^2/ft^2 \times \left(\dfrac{14.696\ lb/in^2}{29.92\ in}\right) \times P\ in}{\left(\dfrac{1545\ ft\text{-}lb/mol\ {}^\circ R}{28.84\ MW\ \text{wet air}}\right) \times ({}^\circ R + T{}^\circ F)} \qquad \mathbf{(1A)}$$

The gas law calculation of density reduces to:

$$\rho_{wair}\ [lb/ft^3] = \frac{1.320 \times P\ in}{459.6 + F} \qquad \mathbf{(1B)}$$

Air entering the engines had average temp 72.1°F and measured average pressure 30.3 in Hg, thus:

$$= \frac{1.320 \times 30.3}{459.6 + 72.1} = \mathbf{0.0752\ lb/ft^3} \qquad \mathbf{(2)}$$

Air Flow lb/min (wet)

$$= \rho_{air}(\text{wet}) \times \text{air}\ ft^3/min$$

$$= 0.0752\ lb/ft^3 \times 1427\ ft^3/min$$

$$= \mathbf{107.3\ lb/min} \qquad \mathbf{(3)}$$

Fuel lb/min @ 175 propulsion shaft RPM

Measured flow = **0.584 gal/min** **(4)**

Fuel Density = **0.850 g/mL** (standard marine diesel) x

$$\frac{0.850\ g}{mL} \times \frac{1\ lb}{453.6\ g} \times \frac{1000\ mL}{1\ L} \times \frac{1\ L}{0.26418\ gal} = \mathbf{7.09\ lb/gal} \qquad \mathbf{(5)}$$

Fuel Consumed = 0.584 gal/min x 7.09 lb/gal

= **4.14 lb/min** **(6)**

$$\underline{\text{A/F Ratio (wet)}} = \frac{\text{Air lb/min (wet)}}{\text{Fuel lb/min}}$$

$$= 107.3/4.141$$

$$= \mathbf{2592\ lb\ air/100\ lb\ fuel\ (wet)} \quad (7)$$

$$\underline{\text{Air lb/min (dry)}} = \text{Air lb/min (wet)} - [(\text{Air lb/min (wet)} \times RH_C]$$

$$RH_C = 0.012 \text{ lb } H_2O\text{/lb air [See Equation (1)]}$$

$$= 107.3 - 107.3 \times 0.012 = \mathbf{106.0\ lb/min\ dry\ air} \quad (8)$$

$$\underline{\text{A/F Ratio (dry)}} = \frac{\text{Air lb/min (dry)}}{\text{Fuel lb/min}} = \frac{106.0}{4.14} = 25.60$$

OR $= \mathbf{2560\ lb\ air/100\ lb\ fuel\ (dry)} \quad (9)$

Next the total oxygen and nitrogen available for combustion in the incoming air are found.

$$\underline{\text{Total } O_2} = (9) \times 0.2314 \text{ lb } O_2\text{/lb air}$$

$$= \mathbf{592.4\ lb\ O_2/100\ lb\ fuel} \quad (10)$$

$$\underline{\text{Total } N_2} = (9) \times 0.7686 \text{ lb } N_2\text{/lb air}$$

$$= \mathbf{1968\ \ lb\ N_2/100\ lb\ fuel} \quad (11)$$

<u>Moles of O_2 Theoretically Required</u> for full oxidation:

From Table I $= \mathbf{10.278\ moles\ O_2/100lb\ fuel} \quad (12)$

<u>Excess Air</u> = Actual Air In - Theor. Air (stoich. am't)

$$= (9) - \frac{10.278 \text{ moles } O_2}{100 \text{ lbs fuel}} \times \frac{32 \text{ lbs } O_2}{1 \text{ mole } O_2} \times \frac{1 \text{ lb air}}{0.2314 \text{ lbs} O_2}$$

$$= 2560 - 1421 \text{ lbs air/100 lb fuel}$$

$$= \mathbf{1139\ lb\ air/100lb\ fuel} \quad (13)$$

<u>Percent Excess Air</u>

$$= \text{Excess Air(13)/Theoretical (stoich)}$$

$$= \mathbf{1139/1421 \times 100 = 80.2\%\ Excess\ Air} \quad (14)$$

[From Instrument Reading = 85% Excess Air]

$$\underline{\text{Excess } O_2} = \frac{11,39 \text{ lb air}}{\text{lb fuel}} \left| \frac{0.2314 \text{ lb } O_2}{1 \quad \text{lb air}} \right. = \mathbf{2.64\ lb\ O_2/lb\ fuel}$$

OR $= \mathbf{264\ lb\ O_2/100\ lb\ fuel}$

$= 264/32 = 8.24$ moles/100 lb fuel (15)

Water in Air = (7) x lb H_2O/lb air (from Psychrom chart)

= 2592 lb wt air/100lb f x 0.012 lb H_2O/lb air

= 31.10 lb H_2O/100 lb fuel x $\frac{1 \text{ mole } H_2O}{18 \text{ lbs } H_2O}$

= 1.73 moles H_2O/100 lb fuel (16)

$CO_2 + SO_2$ = From Table p 2 = 7.188 + 0.005 (Max expect)

= 7.193 moles/100 lb fuel (17)

Oxygen Supplied = (10) = 592.4 lb O_2/100 lb fuel

592.4/32 = 18.51 moles O_2/100 lb fuel (18)

Nitrogen Supplied = (11)/28.161 = $\frac{19.68 \text{ lb } N_2\text{/lb fuel}}{28.161 \text{ lb } N_2\text{/mole (atmos N)}}$

= 69.88 moles N_2/100 lb fuel (19)

H_2O Total Moles = $\frac{(16) \text{ lb } H_2O\text{/lb fuel (in air)}}{18 \text{ lb } H_2O\text{/mole}}$ + combustion product

= 0.311/18 moles (in air)

+ 0.062 moles H_2O/lb fuel (from HCs)

= 0.017 + 0.062 = 0.079 moles/lb fuel

= 7.9 moles H_2O/100 lb fuel (20)

OR 7.9 moles x 18 lb/mole = 142.2 lb H_2O/100 lb fuel (21)

Total Moles of Wet Flue Gas(WFG)/100 lb fuel

= $(CO_2 + SO_2)$ + x's O_2 + N_2 + H_2O

= (17) + (15) + (19) + (20)

= 7.19 + 8.22 + 69.88 + 7.90

OR = 93.2 moles WFG/100 lb fuel (22)

Total Moles of Dry Flue Gas(DFG)/100 lb fuel

= moles WFG - moles H_2O = (22) - (20)

= 93.2 - 7.9 = 85.3 moles DFG/100 lb fuel (23)

Moles CO = Meas'd ppm CO x 10^{-6} x moles DFG (23)

= 365 x 10^{-6} x 85.3

= **0.0311 moles CO/100 lb fuel** **(24)**

Moles NO = Meas'd ppm NO x 10^{-6} x moles DFG (23)

= 882 x 10^{-6} x 85.3

= **0.0752 moles NO/100 lb fuel** **(25)**

Moles NO_2 = Meas'd ppm NO_2 x 10^{-6} x moles DFG (23)

= 26 x 10^{-6} x 85.3

= **0.00222 moles NO_2/100 lb fuel** **(26)**

Moles SO_2 = Meas'd ppm SO_2 x 10^{-6} x moles DFG (23)

= 0.0 x 10^{-6} x 85.3

= **0.0 moles SO_2/100 lb fuel** **(27)**

C to CO_2 = moles theoretical CO_2 - moles actual CO

= moles CO_2 (from table p 2) - moles CO (24)

= 7.188 - 0.0311

= **7.157 moles CO_2/100 lb fuel** **(28)**

(28A) From CO_2 Measurement on Instrument: 8% CO_2
= 0.08 x 85.3
= **6.82 moles CO_2 meas/100 lb fuel**

NOTE: The value of 6.82 for (28A), based on the instrument reading, is 4.7% less than the theoretical max from fuel of 7.157. Thus, the CO_2 value from the instrument may be low (Note, however, that there was only one significant figure in the instrument reading, and it is four orders of magnitude different from the CO reading).

Weight of NO = (25) x 30.008 lb/mole

= 0.0752 moles NO/100 lb fuel x 30.008

= **2.26 lb NO/100 lb fuel** **(29)**

Weight of NO_2 = (26) x 46.007 lb/mole

= 0.00222 moles NO_2/100 lb fuel x 46.007

= **0.102 lb NO_2/100 lb fuel** **(30)**

Weight of SO_2 = (27) x 64.006 lb/mole

= 0.0 moles SO_2/100 lb fuel x 64.06 lb/mole

= **0.0 lb SO_2/100 lb fuel** **(31)**

Although no sulfur was experimentally detected, there was sulfur in the fuel, and it should have given a reasonable amount as seen below:

(31A) From SO_2 Based on Fuel Analysis: of 0.17 lb S/100lb
0.0053 moles SO_2/100 lb fuel x 64.06 lb/mole
= **0.339lb SO_2/100 lb fuel**

Weight of CO_2 = (28) x 44.011 lb/mole

= 7.157 moles CO_2/100 lb fuel x 44.011

= **314.99 lb CO_2/100 lb fuel** **(32)**

NOx Weight (lb NOx/100 lb of Fuel)

= (29) + (30)

= 2.26 + 0.102

= **2.36 lb NOx/100 lb fuel (0.024/lb fuel) (33)**

Fuel Consumed in One Hour (lbs)

= (6) x 60 min

= 4.14 lbs/min x 60 min

= **248.40 lbs fuel** **(34)**

NO_x Produced in One Hour

= lb NOx/lb fuel x lb fuel/h = (33)/100 x (34)

= 0.024 x 248.40 = 5.96 lb NOx/hr

OR = 5.96 lbs NO_x x 453.4 g/lb = **2,703 g/hr** **(35)**

Work Done by Engine 2 in One Hour

At 175 RPM engine 2 supplied an average of 434 kWs of power recorded from the engine power meter in the control room. Thus the total work done is:

$$= \mathbf{434\ kWh} \qquad (36)$$

NOx (g/kW-hr) $= (35/36) = 2{,}703\ \text{g}/434\ \text{kWh}$

$$= \mathbf{6.23\ g/kWh} \qquad (37)$$

NOx (kg/tonne of fuel)

$$= \frac{\text{lb NOx}}{\text{lb fuel}} \Big| \frac{1\ \text{kg NOx}}{2.205\ \text{lb NOx}} \Big| \frac{2.205\ \text{lb fuel}}{1\ \text{kg fuel}} \Big| \frac{1000\ \text{kg fuel}}{\text{tonne fuel}}$$

$$= (33)/100 \times 1000 = (33) \times 10 = \mathbf{24\ kg/tonne\ of\ fuel} \qquad (38)$$

APPENDIX A2.0

SPREADSHEET RESULTS – ENGINES 2 AND 4, ALL SPEEDS

UPDATED 4/17/96

KINGS POINTER
ENGINE TESTING 10-11 MAY 1995

( ) = Equations in Appendix A

Engine	Speed rpm	Fuel Flow gal/h	Fuel Flow gal/min	Air Flow CFM	Air Temp F	Air Pres " Hg	RH %	CO ppm	NO ppm	NO2 ppm	NOx ppm	(2) Air #/cuft	(3) Air #/min
2	0	10.08	0.168	698	72.1	30.3	60	409	285	47	332	0.0756	52.77
	50	10.5	0.175	716	72.1	30.3	60	382	325	46	371	0.0756	54.13
	100	14.04	0.234	796	72.1	30.3	60	254	525	29	554	0.0756	60.18
	140	21.84	0.364	982	72.1	30.3	60	392	690	23	713	0.0756	74.24
	175	35.04	0.584	1427	72.1	30.3	60	365	882	26	908	0.0756	107.88
4	0	10.32	0.172	698	72.1	30.3	60	232	306	105	411	0.0756	52.77
	50	11.04	0.184	716	72.1	30.3	60	253	354	112	466	0.0756	54.13
	100	14.4	0.24	796	72.1	30.3	60	301	590	128	718	0.0756	60.18
	140	22.56	0.376	982	72.1	30.3	60	292	755	147	902	0.0756	74.24
	175	35.76	0.596	1427	72.1	30.3	60	316	881	162	1043	0.0756	107.88

(6) Fuel #F/min	(7) #A/#F	(8) wet#Air/minD	(9) #A/#Fdry	(13) Xs Air #A/#F	(15) Xs O #O/#F	(10) O Tot#O/#F	(11) N #N/#F	(16) H2O #Wtr/#F	Air #wetA/#F	(17) CO2+SO2 mol/#F	(11A) N mol/#F	(22) WFG mol/#F
1.19	44.34	52.14	43.82	29.61	6.85	10.14	33.68	0.53	44.35	0.072	1.2	1.577
1.24	43.65	53.48	43.13	28.92	6.69	9.98	33.15	0.52	43.65	0.072	1.18	1.552
1.66	36.25	59.46	35.82	21.61	5	8.29	27.54	0.44	36.26	0.072	0.98	1.294
2.58	28.78	73.35	28.43	14.22	3.29	6.58	21.86	0.35	28.78	0.072	0.78	1.036
4.14	26.06	106.59	25.75	11.54	2.67	5.96	19.8	0.31	26.06	0.072	0.7	0.934
1.22	43.25	52.14	42.74	28.53	6.6	9.89	32.85	0.52	43.26	0.072	1.17	1.539
1.31	41.32	53.48	40.82	26.61	6.16	9.45	31.39	0.5	41.32	0.072	1.11	1.464
1.7	35.4	59.46	34.98	20.77	4.81	8.1	26.9	0.42	35.4	0.072	0.96	1.267
2.67	27.81	73.35	27.47	13.26	3.07	6.36	21.12	0.33	27.8	0.072	0.75	0.998
4.23	25.5	106.59	25.2	10.99	2.54	5.83	19.36	0.31	25.51	0.072	0.69	0.92

(23) DFG mol/#F	(24) CO mol/#F	(25) NO mol/#F	(26) NO2 mol/#F	(28) CO2 mol/#F	O2 mol/#F	C&S 2	(21) Tot H2O	(29) NO #NO/#F	(30) NO2 #NO2/#F	(32) CO2 #CO2/#F	O2 #O/#F	N2 #N/#F
1.486	0.000607	0.000423	6.98e-05	0.072	0.103	0.072	1.64	0.013	0.0032	3.17	10.14	33.68
1.461	0.000558	0.000474	6.72e-05	0.072	0.103	0.072	1.63	0.014	0.0031	3.17	9.98	33.15
1.208	0.000306	0.000634	3.50e-05	0.072	0.103	0.072	1.55	0.019	0.0016	3.17	8.29	27.54
0.955	0.000374	0.000658	2.20e-05	0.072	0.103	0.072	1.46	0.02	0.001	3.17	6.58	21.86
0.855	0.000312	0.000754	2.22e-05	0.072	0.103	0.072	1.42	0.023	0.001	3.17	5.96	19.8
1.448	0.000335	0.000443	0.000152	0.072	0.103	0.072	1.63	0.013	0.007	3.17	9.89	32.85
1.375	0.000347	0.000486	0.000154	0.072	0.103	0.072	1.61	0.015	0.0071	3.17	9.45	31.39
1.182	0.000355	0.000697	0.000151	0.072	0.104	0.072	1.53	0.021	0.007	3.17	8.1	26.9
0.918	0.000268	0.000693	0.000134	0.072	0.103	0.072	1.44	0.021	0.0062	3.17	6.36	21.12
0.841	0.000265	0.000740	0.000136	0.072	0.103	0.072	1.42	0.022	0.0063	3.17	5.83	19.36

H2O #H2O/#F	CO #CO/#F	(33) NOx #NOx/#F	(36) Power kW	NO g/kWh	NO2 g/kWh	CO2 g/kWh	O2 g/kWh	N2 g/kWh	H2O g/kWh	CO g/kWh	(37) NOx g/kWh	(38) NOx kg/ tonne
1.64	0.017	0.016	66	6.38	1.57	1555.5	4975.8	16527	804.76	8.34	7.85	16
1.63	0.016	0.017	82	5.76	1.28	1304.6	4107.3	13643	670.84	6.58	7	17
1.55	0.009	0.021	142	6.04	0.51	1008.6	2637.5	8762	493.14	2.86	6.68	21
1.46	0.01	0.021	260	5.4	0.27	856.1	1777	5904	394.29	2.7	5.67	21
1.42	0.009	0.024	434	5.97	0.26	823	1547.3	5140	368.66	2.34	6.23	24
1.63	0.009	0.02	55	7.85	4.23	1913.7	5970.6	19831	984.03	5.43	12.07	20
1.61	0.01	0.022	70	7.64	3.62	1614.6	4813.1	15988	820.01	5.09	11.21	22
1.53	0.01	0.028	128	7.59	2.53	1145.8	2927.8	9723	553.03	3.61	10.12	28
1.44	0.008	0.027	246	6.2	1.83	936.4	1878.7	6239	425.36	2.36	7.98	27
1.42	0.007	0.028	420	6.03	1.73	868.9	1598	5307	389.23	1.92	7.67	28

APPENDIX B

DATA SHEETS

MAY 10 AND 11, 1995

CONTENTS

		Page
B1.0	Tabulated Data	B–2
	1.1 Bridge	B–3
	1.2 Switchboard	B–9
	1.3 Air Flow	B–15
	1.4 Shaft Information	B–21
	1.5 Fuel Flow	B–27
B2.0	Engine 2 Emission Data (ECOM K–L)	B–33
B3.0	Engine 4 Emission Data (ENERAC 2000E)	B–44

APPENDIX B1.0

TABULATED DATA

Data contained in Appendix B1.0 were recorded on data sheets prepared for the M/V KINGS POINTER series of tests. Data recorders were stationed at different locations throughout the ship as indicated by the data sheet title. The Test Director coordinated data collection from his station in the engine room.

APPENDIX B1.1

BRIDGE

TEST OF KINGS POINTER BRIDGE

DATE 5-10-95

BLOCK 1 DRAFT FWD 13-10 EST SIG WH 1 FT

AFT 14-02 WAVE DIR 145°

RUN	TEST RPM	TIME	WIND SPEED	WIND DIR	VSL COURSE	VSL SPEED	WATER DEPTH
1.1	50	0920	10 KtS	ESE	042°	2.4 KT	36 FT
1.2	50		10 KtS	ESE			
1.3	50						
2.1	100		10 KtS	ESE	063°	5.9 KT	40 FT
2.2	100						
2.3	100						
3.1	140	1042	12 KtS	SXE	063°	8.0 KT	40 FT
3.2	140						
3.3	140						
4.1	175	1108	12 KtS ~~[illegible]~~	SEXE	063°	9.6	45 FT
4.2	175						
4.3	175						
5.1	0	1135	12 KtS	SE	066°	0 Kt	65'
5.2	0						
5.3	0						

RECORDER

TEST OF KINGS POINTER

BRIDGE

DATE 5-10-95

BLOCK 2 DRAFT FWD 13-10 EST SIG WH 1 FT

AFT 14-02 WAVE DIR 135°

RUN	TEST RPM	TIME	WIND SPEED	WIND DIR	VSL COURSE	VSL SPEED	WATER DEPTH
1.1	0	1200	9kts	SE	Various	0	80
1.2	0						
1.3	0						
2.1	50	1220	9kts	SE	085	2.8kts	80 FT
2.2	50						
2.3	50						
3.1	140	1248	10 kts	SE	085	7.8kt	90'
3.2	140	~~1248~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~
3.3	140						
4.1	175	1320	12kts	SE	243	9.3kts	90FT
4.2	175						
4.3	175						
5.1	100	1347	10 kts	SE	245°	5.5kts	70'
5.2	100						
5.3	100						

RECORDER

TEST OF KINGS POINTER BRIDGE

DATE 5-10-95

BLOCK 3 DRAFT FWD 13-10 EST SIG WH 1 FT-2 FT

AFT 14-02 WAVE DIR 135°

RUN	TEST RPM	TIME	WIND SPEED	WIND DIR	VSL COURSE	VSL SPEED	WATER DEPTH
1.1	100	1400	10 kts	SE	245°	5.5 kts	70'
1.2	100						
1.3	100						
2.1	175	1444	10 KTS	SE	250°	10.0 KTS	43'
2.2	175						
2.3	175						
3.1	140	1513	10 KTS	SE	243°	7.8 KTS	37'
3.2	140						
3.3	140						
4.1	50	1545	10 KTS	NE	218°	2.7 KTS	84'
4.2	50						
4.3	50						
5.1	0	1615	10 KTS	NE	various	0	45 FT
5.2	0						
5.3	0						

RECORDER

TEST OF KINGS POINTER BRIDGE

DATE 05-11-95

BLOCK 4 DRAFT FWD 13'-10" EST SIG WH 1' TO 2'

AFT 14'-02" WAVE DIR NE

RUN	TEST RPM	TIME	WIND SPEED	WIND DIR	VSL COURSE	VSL SPEED	WATER DEPTH
1.1	0	0809	14KTS	NEXN	VARIOUS 338°	0	24'
1.2	0						
1.3	0						
2.1	50	0830	14KTS	NNE	020	1.9	40'
2.2	50						
2.3	50						
3.1	100	0857	14 kts	NEXN	015	4.4	60'
3.2	100						
3.3	100						
4.1	140	0920	18kts	NE	035	7.2	60'
4.2	140						
4.3	140						
5.1	175	0946	21 kts	NEXE	063	9.3	75'
5.2	175						
5.3	175						

RECORDER____________________

TEST OF KINGS POINTER BRIDGE

DATE 5-11-95

BLOCK 5 DRAFT FWD 13-10 EST SIG WH 3'-4'

AFT 14-02 WAVE DIR NE

RUN	TEST RPM	TIME	WIND SPEED	WIND DIR	VSL COURSE	VSL SPEED	WATER DEPTH
1.1	140	1015	22 kts.	NEXE	064°	7.9 kts	48'
1.2	140						
1.3	140						
2.1	100	1040	20 kts.	NEXE	240	5.2	40'
2.2	100						
2.3	100						
3.1	0	1110	20 kts	NE	VARIOUS ~~090°~~	0	43'
3.2	0						
3.3	0						
4.1	50	1135	20 kts	NE	various	1.4	45'
4.2	50						
4.3	50						
5.1	175	1200	20 kts	NE	215	9.8	45'
5.2	175						
5.3	175						

RECORDER

APPENDIX B1.2

SWITCHBOARD

TEST OF KINGS POINTER SWITCH BOARD F11a

DATE 5-10-95

BLOCK 1

	PORTABLE	CHART
ENG RM TEMP	68 9°F → 64"	70°F → 64°F later
HUMID	46% → 52%	52% → 60%
BARO PRESS	29.44 in Hg 29.47	

RUN	TEST RPM	TIME	~~STBD/PORT~~ 2&4 - ENGINE VOLT AC	AMP AC	KW	STBD/PORT ~~AMPS~~ SHAFTS RPM	ARM ~~VOLT~~ AMPS	~~AMP~~ ARM VOLTS	FIELD AMP
1.1	50	1000	600 / 600	130 / 110	80 / 60	52 / 49	62 / 61	200 / 180	70 / 59
1.2	50								
1.3	50								
2.1	100	1024	600 / 600	225 / 220	150 / 140	100 / 100	250 / 250	400 / 400	71 / 60
2.2	100								
2.3	100								
3.1	140	1050	600 / 600	340 / 340	262 / 250	142 / 142	500 / 500	570 / 570	70 / 58
3.2	140								
3.3	140								
4.1	175	1115	600 / 600	480 / 490	430 / 410	175 / 175	770 / 805	700 / 710	70 / 60
4.2	175								
4.3	175								
5.1	0	1145	600 / 600	100 / 80	35 / 30	8 / 2	0 / 0	0 / 0	70 / 68
5.2	0								
5.3	0								

RECORDER S.J. Allen

DIESEL-GEN PROP. SHAFTS MOTORS

(NOTE: ENERAC 2000E USED ON ENG. NO. 4
ECOM " " " " 2)

ENGINE NO. 1 WAS NOT RUNNING - ALL OTHER THREE WERE RUNNING

TEST OF KINGS POINTER SWITCH BOARD

DATE 9-10-95

BLOCK 2

	PORTABLE	CHART
ENG RM TEMP	63.5 °F	64 °F
HUMID	58 %	65 %
BARO PRESS	29.44 in Hg	—

RUN	TEST RPM	TIME	~~STBD/PORT~~ ENGINES 2 & 4 VOLT AC	AMP AC	KW	STBD/PORT SHAFT PROP. MOTORS RPM	ARM ~~VOLT~~ AMPS	~~HP~~ ARM V.	FIELD AMP
1.1	0	1200	600/600	100/80	75/60	10/5	0/0	0/0	70/58
1.2	0								
1.3	0								
2.1	50	[illegible]	600/600	140/120	80/70	50/50	70/60	200/180	70/60
2.2	50	1230							
2.3	50								
3.1	140	1:00 pm	600/600	350/350	270/250	144/140	500/500	570/570	70/70
3.2	140	1:30:00							
3.3	140								
4.1	175		600/600	480/440	480/420	175/178	770/810	700/720	70/60
4.2	175	1:30	600	484	440		760	700	70
4.3	175								
5.1	100								
5.2	100	155	600/600	210/200	140/120	100/100	240/210	400/400	70/60
5.3	100								

RECORDER S. J. ALLEN

(ENERTAC 2000E used on eng 4
ECOM used on eng 2)

TEST OF KINGS POINTER

DATE 5-10-95

BLOCK 3

SWITCH BOARD

	PORTABLE	CHART
ENG RM TEMP	64.4 °F	64°F
HUMID	60%	67%
BARO PRESS	29.41	

RUN	TEST RPM	TIME	ENG 2/4 VOLT AC	AMP AC	KW	STBD/PORT SHAFTS PROP. MOTOR RPM	ARM ~~VOLT~~ Amps	~~AMP~~ volts	FIELD AMP
1.1	100	1428	600/600	220/210	140/120	100/100	250/240	400/390	70/60
1.2	100								
1.3	100								
2.1	175	2:55	600/600	480/480	420/410	175/175	770/800	700/700	70/60
2.2	175								
2.3	175								
3.1	140	328	600/600	340/340	260/240	140/140	490/490	560/560	70/60
3.2	140								
3.3	140					55			
4.1	50		600/600	120/100	80/60	66/48	60/40	200/170	70/60
4.2	50	355							
4.3	50	end	@ 1612						
5.1	0	1622	600/600	100/80	88/65	8/3	0/0	0/0	70/58
5.2	0								
5.3	0								

Sj load change

RECORDER SJA

Inverac used on eng 4

ECOM used on eng 2

MRS

(CONTROL ROOM)
SWITCH BOARD

TEST OF KINGS POINTER
DATE 5-11-95
BLOCK 4

	PORTABLE	CHART
ENG RM TEMP	65.3°F	65°F
HUMID	57	63%
BARO PRESS	29.15 in Hg	—

RUN	TEST RPM	TIME	~~STBD/PORT~~ 3/4 ENGINE VOLT	AMP	KW	STBD/PORT SHAFT MOTORS RPM	ARM AMPS	VOLTS	FIELD AMP
1.1	0	0815	600/600	90/70	62/60	8/3	0/0	0/0	70/58
1.2	0								
1.3	0	END @ 0830							
2.1	50	0840	600/600	130/120	80/70	52/50	75/80	200/190	70/56
2.2	50								
2.3	50		(terminated @ 0857)						
3.1	100	0905	600/600	210/200	140/130	100/100	260/270	400/400	70/58
3.2	100								
3.3	100		(terminated @ 0921)						
4.1	140	0930	600/600	340/345	260/245	140/140	490/530	560/570	70/60
4.2	140								
4.3	140		(terminated @945)						
5.1	175	0955	600/600	500/520	450/440	175/178	820/840	710/710	70/60
5.2	175								
5.3	175		(terminated @1010)						

RECORDER Steve Allen

: ENGINES 3, 2, 4 USED TODAY, 1 IS IDLE

ENERAC USED ON ENG. 4
ECOM (OURS) USED ON ENG 2

PROBES WERE REMOVED BETWEEN RUNS. PROBES WERE IN STACKS APPROX 10 minutes FOR EACH RUN.

(CONTROL ROOM) ~~SWITCH BOARD~~

TEST OF KINGS POINTER

DATE 5-11-95

BLOCK 5

	PORTABLE	CHART
ENG RM TEMP	67.1 °F	67 °F
HUMID	53 %	60 %
BARO PRESS	29.12 in Hg	—

RUN	TEST RPM	TIME	2/4 ENGINES VOLT	AMP	KW	STBD/PORT SHAFT MOTORS RPM	ARM AMPS	VOLTS	FIELD AMP
1.1	140	1025	600 / 600	330 / 325	250 / 245	140 / 140	500 / 500	580 / 570	75 / 58
1.2	140								
1.3	140		(terminated at			1040)			
2.1	100	1055	600 / 600	200 / 200	140 / 130	100 / 100	240 / 240	400 / 400	70 / 60
2.2	100								
2.3	100		(terminated @			1110)			
3.1	0	1120	600 / 600	100 / 80	70 / 60	10 / 5	0 / 0	0 / 0	72 / 58
3.2	0								
3.3	0		(terminated @			1135)			
4.1	50	1145	600 / 600	140 / 130	90 / 90	55 / 50	100 / 60	200 / 180	70 / 58
4.2	50								
4.3	50		(terminated @				1200)		
5.1	175	1210	600 / 600	480 / 400	430 / 420	175 / 178	770 / 810	700 / 710	70 / 60
5.2	175								
5.3	175		(terminated @				1226)		

RECORDER Steve Allen

COMMENTS:

ENG 1 IS IDLE — NOT ON
ALL OTHERS ARE RUNNING

Enerac was used on No. 4
ECOM was used on No. 2.

~~[illegible]~~ on Run 5 Enerac was inserted into Eng 2 stack at 1227 to compare readings between instruments. Still @ 175 RPM

APPENDIX B1.3

AIR FLOW

TEST OF KINGS POINTER **AIR FLOW**

DATE 5-10-95 **PORTABLE** **CHART**

BLOCK 1 **ENG RM TEMP** ______ ______

HUMID ______ ______

BARO PRESS ______ ______

RUN	TEST RPM	TIME	PORT ENG NO. 2 FLOW CF	TEMP °F	B.P. HG	STBD ENG NO. 2 FLOW CF	TEMP °F	B.P. HG
1.1	50	1000	419	74.4	30.5	296	67.8	30.4
1.2	50	1003	423	73.1	30.4	319	69.4	30.3
1.3	50	1006	434	72.6	30.3	289	69.0	30.3
2.1	100	1024	474	72.8	30.4	365	68.7	30.4
2.2	100	1027	467	75.6	30.4	364	66.9	30.4
2.3	100	1030	479	74.2	30.4	360	67.1	30.4
3.1	140	1052	547	75.6	30.5	456	66.8	30.4
3.2	140	1053	551	72.8	30.4	489	68.4	30.4
3.3	140	1058	533	73.7	30.3	462	68.6	30.3
4.1	175	1124	752	74.1	30.5	677	68.9	30.4
4.2	175	1127	753	74.4	30.4	670	69.2	30.3
4.3	175	1130	743	76.3	30.4	674	67.1	30.3
5.1	0	1149	402	74.7	30.5	296	65.7	30.4
5.2	0	1152	416	73.3	30.4	283	65.7	30.4
5.3	0	1155	413	73.1	30.4	263	66.2	30.4

RECORDER [signature]

TREY HOWERTON
MIDN, USNR

TEST OF KINGS POINTER

AIR FLOW

DATE 5-10-95

BLOCK 2

	PORTABLE	CHART
ENG RM TEMP		
HUMID		
BARO PRESS		

RUN	TEST RPM	TIME	PORT ENG NO. 2 FLOW CF	TEMP °F	B.P. HG	STBD ENG NO. 2 FLOW CF	TEMP °F	B.P. HG
1.1	0	1200	401	72.3	30.3	316	68.0	30.3
1.2	0	1203	398	72.1	30.3	317	67.4	30.3
1.3	0	1206	413	74.3	30.4	290	66.2	30.3
2.1	50	1230	422	73.2	30.5	282	66.4	30.4
2.2	50	1233	432	73.4	30.4	303	66.9	30.4
2.3	50	1236	403	71.9	30.4	299	66.5	30.3
3.1	140	~~1239~~ 1300	539	74.8	30.5	456	65.0	30.4
3.2	140	~~1242~~ 1303	526	72.6	30.4	464	66.3	30.4
3.3	140	~~1245~~ 1306	532	72.9	30.4	439	66.5	30.3
4.1	175	1330	763	76.5	30.5	672	66.9	30.4
4.2	175	1333	752	76.3	30.4	666	66.3	30.3
4.3	175	1336	753	73.7	30.4	663	69.0	30.3
5.1	100	1355	453	74.9	30.5	343	68.1	30.3
5.2	100	1358	449	76.7	30.4	356	66.6	30.3
5.3	100	1401	454	76.0	30.4	358	67.1	30.3

RECORDER [signature]

#1 { Trey Howerton
MIDN, USNR

#2-#5 { [signature]
M/N Mark J. Snoozy 2/c [redacted]

TEST OF KINGS POINTER AIR FLOW

DATE 5-10-95 PORTABLE CHART

BLOCK 3 ENG RM TEMP ____ ____

HUMID ____ ____

BARO PRESS ____ ____

RUN	TEST RPM	TIME	PORT ENG NO. 2 FLOW CF	TEMP °F	B.P. HG	STBD ENG NO. 2 FLOW CF	TEMP °F	B.P. HG
1.1	100	1404	456	76.7	30.3	338	67.0	30.3
1.2	100	1407	466	73.8	30.3	330	68.8	30.3
1.3	100	1410	461	75.2	30.3	332	68.9	30.3
2.1	175	1455	734	74.1	30.4	674	69.4	30.4
2.2	175	1458	728	75.1	30.4	680	69.5	30.3
2.3	175	1501	753	76.9	30.3	683	67.6	30.3
3.1	140	1525	522	74.3	30.4	438	69.0	30.3
3.2	140	1528	539	75.0	30.3	449	69.1	30.3
3.3	140	1531	549	78.7	30.3	450	67.3	30.2
4.1	50	1555	423	76.4	30.4	297	67.2	30.3
4.2	50	1558	412	74.8	30.3	318	69.2	30.3
4.3	50	1601	412	73.4	30.3	307	69.3	30.2
5.1	0	1622	428	74.6	30.4	283	66.3	30.3
5.2	0	1625	398	75.1	30.3	309	66.3	30.3
5.3	0	1628	426	75.3	30.3	288	66.6	30.2

RECORDER

#1-#4 Mark J. Snoozy

#5 Trey Howerton
MIDN, USNR

TEST OF KINGS POINTER
DATE 5-11-95
BLOCK 4 ENG RM TEMP

AIR FLOW

	PORTABLE	CHART
ENG RM TEMP		
HUMID		
BARO PRESS		

RUN	TEST RPM	TIME	PORT FLOW	ENG NO. 2 TEMP	B.P.	STBD FLOW	ENG NO. 2 TEMP	B.P.
1.1	0	0815	415	71.1	30.3	322	76.1	30.1
1.2	0	0818	409	70.9	30.2	287	70.3	30.1
1.3	0	0821	389	71.6	30.2	282	69.8	30.0
2.1	50	0840	429	71.9	30.2	302	70.3	30.1
2.2	50	0843	403	71.6	30.2	304	69.9	30.1
2.3	50	0846	432	72.2	30.2	294	75.4	30.0
3.1	100	0905	439	71.8	30.2	348	76.9	30.1
3.2	100	0908	426	73.0	30.2	365	77.2	30.0
3.3	100	0911	425	73.4	30.1	332	77.5	30.0
4.1	140	0930	523	73.1	30.2	458	75.9	30.1
4.2	140	0933	529	73.0	30.2	459	71.5	30.0
4.3	140	0936	532	72.2	30.1	461	70.5	30.0
5.1	175	0955	787	73.0	30.2	702	72.8	30.0
5.2	175	0958	787	70.7	30.2	712	72.6	30.0
5.3	175	1001						

RECORDER Mark J. Snoozy

Mark J. Snoozy

TEST OF KINGS POINTER

AIR FLOW

DATE ____________________

PORTABLE CHART

BLOCK 5 ENG RM TEMP ____________ ____________

HUMID ____________ ____________

BARO PRESS ____________ ____________

RUN	TEST RPM	TIME	PORT ENG NO. 2 FLOW CF	PORT ENG NO. 2 TEMP °F	PORT ENG NO. 2 B.P. "Hg	STBD ENG NO. 2 FLOW CF	STBD ENG NO. 2 TEMP °F	STBD ENG NO. 2 B.P. "Hg
1.1	140	1025	496	74.1	30.2	432	76.0	30.0
1.2	140	1028	501	73.9	30.1	452	75.9	30.0
1.3	140	1031	514	73.7	30.1	440	73.2	30.0
2.1	100	1055	418	73.3	30.2	348	73.0	30.1
2.2	100	1058	419	74.4	30.1	322	73.0	30.0
2.3	100	1101	443	74.2	30.1	358	75.5	30.0
3.1	0	1120	374	76.1	30.2	301	70.6	30.1
3.2	0	1123	374	75.7	30.2	325	70.6	30.0
3.3	0	1126	380	75.9	30.1	280	70.8	30.0
4.1	50	1145	405	76.1	30.3	292	67.0	30.1
4.2	50	1148	401	78.2	30.1	307	66.3	30.1
4.3	50	1151	395	77.4	30.1	280	66.2	30.0
5.1	175	1210	736	79.5	30.2	665	67.9	30.1
5.2	175	1213	732	76.5	30.1	672	68.5	30.1
5.3	175	1216	724	75.0	30.1	672	70.3	30.0

RECORDER [signature]

TREY HOWERTON
MIDN, USNR

APPENDIX B1.4

SHAFT INFORMATION

TEST OF KINGS POINTER SHAFT INFO

DATE 5-10-95

BLOCK 1

OK Crapped out

RUN	TEST RPM	TIME	STBD ENG RPM	HP	TORQ	PORT ENG RPM	HP	TORQ
1.1	50	10:00:28	1		042	001	-007	-002
1.2	50	10:03	53 1		043	48		-001
1.3	50	10:05	1		042	0		-001
2.1	100	10:25	33/631	35/80	099	1	-007	-046
2.2	100	10:27	42/665	35/80	097	1	007	-047
2.3	100	10:29	77/630	38/76	098	1	-007	-046
3.1	140	10:46	0	1	162	1	-007	-113
3.2	140	10:48	0	1	162	1	-7	-107
3.3	140	10:50	0	1	160			-107
4.1	175	11:15	13/180	33/67	229	176	53	-197
4.2	175	11:17	1/181	0/63	229	176	53	-177
4.3	175	11:19	2/175	3/74	226	177	53	-196
5.1	0	11:43	1~~6~~	6	5	1	7	26
5.2	0	11:45	0	0	6			
5.3	0	11:47	1	0	5~~6~~			

RPM meter

Time Read Start Stop

10:00 318 2

stop 10:06:30

Start 1024:35 STBD P

Stop 1029.35 501 4

RPM 100

Start 10:45:30 STBD P

Stop 10:51 867 8

144

11:15 ~~936~~

~~1120~~ 1146

11:21 176

11:45 0 0

11:50 0 0

RECORDER Elizabeth Anthony

Zero out 11:45

180

STBD Port

175 11:25 176 175

11:26

(RPM) Torque / (63025) = HP

(176) 22900

Calc this page HP's on Sun 5/10 pm Chuck

TEST OF KINGS POINTER
DATE 5-10-95
BLOCK 2

SHAFT INFO

RUN	TEST RPM	TIME	STBD ENG RPM	HP	TORQ	PORT ENG RPM	HP	TORQ
1.1	0	1200	Tac 0 / 1	0	5	Tac 0 / 1	-607	-601
1.2	0	1217	1	0	5	1	-607	-001
1.3	0	12:19	1	0	5	1	-607	-1
2.1	50	1232	1	0	44	1	-7	-32
2.2	50	1234	1	0	44	1	-7	-31
2.3	50	1236	1	0	44	1	-7	-31
3.1	140	1:02	1	0	159	1	-7	-134
3.2	140	1:04	1	0	159	1	-7	-134
3.3	140	1:06	1	0	158	1	-7	-134
4.1	175	1:34	178	75	223	178	62	-202
4.2	175	1:36	183	76	223	178	62	-202
4.3	175	1:38	181	76	223	178	62	-201
5.1	100	1:58	84/480	15/79	95	1	-7	-72
5.2	100	2:00	125/616	23/84	94	1	-7	-72
5.3	100	2:02	110	28	95	1	-7	-72

New Tape

Re Zeroed at 12:00

Time Port St
1232 46 S
1234 48 S
1:02 138 14
1:04 138 14
1:35 180
180/175
1:38 528 S
1:59 97/10
2:03 387

RECORDER Elizabeth [illegible]

TEST OF KINGS POINTER
DATE 5/10/95
BLOCK 3

SHAFT INFO

RUN	TEST RPM	TIME	STBD ENG RPM	HP	TORQ	PORT ENG RPM	HP	TORQ	
1.1	100	2:30	#93	93	94	1	-7	-69	230 35
1.2	100	2:32	95	87	95	1	-7	-71	98 9
1.3	100	2:33	94	54	94	1	-7	-70	2 3235 194 20
2.1	175	2:55	1	[illegible]	227	176	61	-199	255
2.2	175	257	1	0	226	176	61	-200	258 518/532
2.3	175	259	1	0	225	176	61	-200	
3.1	140	329	1	0	156	1	-7	-132	330 1340 1
3.2	140	331	1	0	156	1	-7	-133	
3.3	140	333	1	0	156	1	-7	-132	333 420 4
4.1	50	357	1	0	39	1	-7	-25	356
4.2	50	359	1	0	38	1	-7	-25	44 4
4.3	50	401	1	0	38	1	-7	-24	4:00 87 10
5.1	0	422	1	0	0	1	-7	-13	4:22
5.2	0	424	1	0	0	1	-7	-13	60
5.3	0	426	1	0	0	1	-7	-13	

RECORDER [illegible signature]

Zeroing Problems

TEST OF ~~KINGS~~ POINTER
DATE 5/11/95
BLOCK 4

SHAFT INFO

RUN	TEST RPM	TIME	STBD RPM	ENG 48 → 0 HP -32	TORQ	PORT RPM	ENG -23 → 0 HP +17	TORQ	TAC
1.1	0	817	0	0	0	0	-7	0	
1.2	0	819	1	0	0	0	-7	0	
1.3	0	821	0	0	0	0	-7	0	0 0
2.1	50	8:40	1	0	36	0	-7	-12	840 48 4
2.2	50	8:42	1	0	35	0	-7	-12	842 95 9
2.3	50	8:44	1	0	33	0	-7	-13	843 142 1
3.1	100	902	50/621	38/63	91	0	-7	-58	902 100 1
3.2	100	904	50/608	34	92	0	-7	-56	904 196 198
3.3	100	906	195	18	92	0	-7	-56	905 295 3
4.1	140	9:30	1	0	152	0	-7	-119	930 138
4.2	140	9:32	1	0	152	0	-7	-117	931
4.3	140	934	1	0	153	0	-7	-117	934 275 2 (2)
5.1	175	956	1	0	231	176	-56	-186	956 177 17
5.2	175	958	1	0	231	176	-56	-185	957 351 35
5.3	175	10:00	1	0	232	+177	-56	-185	1030 613 6

Bot. Filter Change

RECORDER [signature]

TEST OF KINGS POINTER
DATE 5/11/95
BLOCK 5

SHAFT INFO

RUN	TEST RPM	TIME	STBD ENG RPM	HP	TORQ	PORT ENG RPM	HP	TORQ	SHAFT INFO
1.1	140	1023	1	0	155	0	-7	-110	1023 140 14
1.2	140	1025	1	6	154	0	-7	-109	1025 2280 28
1.3	140	1027	1	6	153	0	-7	-109	1026 3420 43
2.1	100	1048	73	56	112	1	-7	-57	1048 195 2.
2.2	100	1050	87	77	94	1	-7	-56	1050 290 30
2.3	100	1052	162	30	97	1	-7	-53	1051
3.1	0	11:17	0	1	5	1	-7	-003	0 0
3.2	0	1123 ~~1120~~	0	1	5	1	-7	-003	
3.3	0	11:26	0	1	9	1	-7	-003	
4.1	50	1144	0	1	48	1	-7	-009	1147 (2) 92 1(
4.2	50	1146	0	1	48	1	-7	-009	229 2(
4.3	50	1149	0	1	48	1	-7	-008	1150 (5)
5.1	175	1211	0	1	221	177	54	-180	1212
5.2	175	1216	0	1	219	177	54	-179	181 179
5.3	175	1215	0	1	219	~~88~~ 177	54	-179	885 88

RECORDER [signature]

1217

APPENDIX B1.5

FUEL FLOW

TEST OF KINGS POINTER

FUEL FLOW

DATE 5-10-95

BLOCK 1

RUN	TEST RPM	TIME		FUEL FLOW NO. 4 SUPPLY	RETRN	NET	FUEL FLOW NO. 2 SUPPLY	RETRN	NET
1	50	START	10:00	75.40	32.30		1202.65	755.6	
		END	10:10	77.85	32.90		1209.57	759.60	
		NET	10	2.45	0.6	1.85	6.92	4.00	2.92
2	100	START	10:24:00	82.12	33.68		1220.00	766.65	
		END	10:39:00	86.76	34.50		1231.37	774.16	
		NET	15	4.64	0.82	3.82	11.37	7.51	3.86
3	140	START	10:50:00	91.46	35.04		1240.78	779.60	
		END	11:05:00	98.04	35.77		1253.90	786.92	
		NET	15	6.58	0.73	5.85	13.12	7.32	5.80
4	175	START	11:15:00	104.05	36.10		1263.90	791.75	
		END	11:30:00	113.75	36.83		1279.87	798.85	
		NET	15	9.70	0.73	8.97	15.97	7.10	8.87
5	0	START	11:45	117.94	37.64		1291.11	806.33	
		END	12:00	121.49	38.51		1301.35	813.87	
		NET		3.55	0.87	2.68	10.24	7.54	2.70

RECORDER MICHAEL IACOVELLI

TEST OF KINGS POINTER
DATE 10 MAY 1995
BLOCK 2

FUEL FLOW

RUN	TEST RPM	TIME		FUEL FLOW NO. 4 SUPPLY	RETRN	NET	FUEL FLOW NO. 2 SUPPLY	RETRN	NET
1	0	START	1200	121.49	38.51		1301.35	813.87	
		END	12:15	125.08	39.37		1311.64	821.42	
		NET	15	3.59	0.86	2.73	10.29	7.55	2.74
2	50	START	12:30:00	128.76	40.22		1322.00	828.92	
		END	12:45:00	132.51	41.06		1332.47	836.45	
		NET	15	3.75	0.84	2.91	10.47	7.53	2.94
3	140	START	13:02:00	139.54	41.87		1346.70	844.77	
		END	13:17:00	146.05	42.58		1359.71	852.19	
		NET	15	6.51	0.71	5.80	13.01	7.42	5.59
4	175	START	13:30:00	153.72	43.09		1372.24	858.03	
		END	13:45:00	163.38	43.69		1388.13	865.00	
		NET	15	9.66	0.6	9.06	15.89	6.97	8.92
5	100	START	13:55:00	166.98	44.20		1396.80	870.24	
		END	14:10:00	171.52	45.00		1407.92	877.66	
		NET	15	4.54	0.80	3.74	11.12	7.42	3.70

RECORDER MICHAEL IACOVELLI

TEST OF KINGS POINTER
DATE 10 MAY 1995
BLOCK 3

FUEL FLOW

RUN	TEST RPM	TIME		FUEL FLOW NO. 4 SUPPLY	RETRN	NET	FUEL FLOW NO. 2 SUPPLY	RETRN	NET
1	100	START	14:10:00	171.52	45.00		1407.92	877.66	
		END	14:25:00	176.04	45.78		1419.02	885.09	
		NET		4.52	0.78	3.74	11.10	7.43	3.67
2	175	START	14:56:00	190.08	47.24		1446.00	900.15	
		END	15:11:00	199.71	47.84		1461.82	907.21	
		NET	15	9.63	0.60	9.03	15.82	7.06	8.76
3	140	START	15:28:00	207.34	48.59		1476.90	915.43	
		END	15:43:00	213.80	49.29		1489.77	922.73	
		NET	15	6.46	0.70	5.76	12.87	7.30	5.57
4	50	START	15:55:00	216.89	49.91		1498.30	928.69	
		END	16:10:00	220.54	50.74		1508.56	936.18	
		NET	15	3.65	0.83	2.82	10.26	7.49	2.77
5	0	START	16:22:00	223.71	51.40		1517.00	942.15	
		END	16:37:00	227.29	52.24		1527.16	949.67	
		NET	15	3.58	0.84	2.74	10.16	7.52	2.64

RECORDER MICHAEL IACOVELLI

TEST OF KINGS POINTER
DATE 11 MAY 1995
BLOCK 4

FUEL FLOW

RUN	TEST RPM	TIME		FUEL FLOW NO. 4			FUEL FLOW NO. 2		
				SUPPLY	RETRN	NET	SUPPLY	RETRN	NET
1	0	START	08:15:00	254.00	59.37		1612.66	1015.70	
		END	08:30:00	257.49	60.22		1622.74	1023.22	
		NET	15	3.49	0.85	2.64	10.08	7.52	2.56
2	50	START	08:40:00	259.91	60.78		1629.52	1028.22	
		END	08:55:00	263.55	61.63		1639.73	1035.71	
		NET	15	3.64	0.85	2.79	10.21	7.49	2.72
3	100	START	09:05:00	266.51	62.16		1646.95	1040.67	
		END	09:20:00	271.10	62.94		1657.98	1048.10	
		NET	15	4.59	0.78	3.81	11.03	7.43	3.60
4	140	START	09:30:00	275.32	63.41		1666.29	1052.98	
		END	09:45:00	281.89	64.08		1679.14	1060.23	
		NET	15	6.57	0.67	5.90	12.85	7.25	5.60
5	175	START	09:55:00	288.48	64.47		1689.44	1064.98	
		END	10:10:00	298.70	65.04		1705.60	1071.98	
		NET	15	10.22	0.57	9.65	16.16	7.00	9.16

RECORDER MICHAEL IACOVELLI

TEST OF KINGS POINTER

FUEL FLOW

DATE 11 MAY 1995

BLOCK 5

RUN	TEST RPM	TIME		FUEL FLOW NO. 4 SUPPLY	FUEL FLOW NO. 4 RETRN	FUEL FLOW NO. 4 NET	FUEL FLOW NO. 2 SUPPLY	FUEL FLOW NO. 2 RETRN	FUEL FLOW NO. 2 NET
1	140	START	10:25:00	306.58	65.60		1719.80	1079.10	
		END	10:40:00	313.18	66.29		1732.58	1086.35	
		NET	15	6.60	0.69	5.91	12.78	7.25	5.53
2	100	START	10:55:00	318.00	67.00		1743.88	1093.67	
		END	11:10:00	322.55	67.73		1754.78	1101.06	
		NET	15	4.55	0.73	3.82	10.90	7.39	3.51
3	0	START	11:20:00	325.02	68.23		1761.63	1106.00	
		END	11:35:00	328.59	68.98		1771.72	1113.42	
		NET	15	3.57	0.75	2.82	10.09	7.42	2.67
4	50	START	11:45:00	331.08	69.47		1778.52	1118.37	
		END	12:00:00	334.82	70.19		1788.78	1125.74	
		NET	15	3.74	0.72	3.02	10.26	7.37	2.89
5	175	START	12:10:00	340.54	70.56		1798.13	1130.48	
		END	12:25:00	350.31	71.05		1813.88	1137.43	
		NET	15	9.77	0.49	9.28	15.75	6.95	8.80

RECORDER MICHAEL IACOVELLI

APPENDIX B2.0

ENGINE 2 EMISSION DATA (ECOM K–L)

Emissions data were collected for Engine 2 using a computer connected to the ECOM K–L instrument. Data were continuously recorded at one–minute intervals.

Data selected for each run number are circled and the applicable run number is annotated on the data sheet alongside the data.

5/10/95 ENZ

	TIME HR:MN:SE	O2 (0%)	CO (ppm)	NO (ppm)	NO2 (ppm)	TEMP PROBE	TEMP ROOM	t4	t3	t2	t1	t5			SO2 (ppm)
	08:10:34	210	0	0	0	85	80	0	0	0	0	0	0	0	0
	08:10:36	210	0	0	0	85	80	0	0	0	0	0	0	0	0
	08:10:38	210	0	0	0	85	80	0	0	0	0	0	0	0	0
	08:10:40	210	0	0	0	85	80	0	0	0	0	0	0	0	0
	08:10:42	210	0	0	0	85	80	0	0	0	0	0	0	0	0
	08:10:44	210	0	0	0	85	80	0	0	0	0	0	0	0	0
	08:10:46	210	0	0	0	85	80	0	0	0	0	0	0	0	0
	08:10:48	210	0	0	0	85	80	0	0	0	0	0	0	0	0
	08:11:48	210	0	0	0	85	80	0	0	0	0	0	0	0	0
	09:46:48	159	355	319	38	490	68	0	0	0	0	0	0	0	0
	09:47:48	158	355	334	39	492	68	0	0	0	0	0	0	0	0
	09:48:48	158	350	316	41	488	68	0	0	0	0	0	0	0	0
	09:49:48	158	345	329	41	489	68	0	0	0	0	0	0	0	0
	09:50:48	157	355	332	43	489	67	0	0	0	0	0	0	0	0
	09:51:48	157	355	331	44	490	69	0	0	0	0	0	0	0	0
	09:52:48	157	345	339	45	495	70	0	0	0	0	0	0	0	0
	09:53:48	157	345	340	46	492	67	0	0	0	0	0	0	0	0
	09:54:48	157	360	330	47	488	66	0	0	0	0	0	0	0	0
	09:55:48	157	345	343	47	492	66	0	0	0	0	0	0	0	0
	09:56:48	157	355	341	48	492	66	0	0	0	0	0	0	0	0
	09:57:48	157	350	332	48	490	66	0	0	0	0	0	0	0	0
	09:58:48	157	350	335	49	489	66	0	0	0	0	0	0	0	0
	09:59:48	157	350	330	50	489	66	0	0	0	0	0	0	0	0
2	10:00:48	157	355	334	51	489	66	0	0	0	0	0	0	0	0
1.1.1	10:01:48	157	350	335	51	489	66	0	0	0	0	0	0	0	0
	10:02:48	158	360	320	51	485	67	0	0	0	0	0	0	0	0
	10:03:48	158	360	319	52	484	67	0	0	0	0	0	0	0	0
2 50	10:04:48	158	360	321	52	484	67	0	0	0	0	0	0	0	0
	10:05:48	158	360	321	52	484	67	0	0	0	0	0	0	0	0
3	10:06:48	158	370	323	53	484	67	0	0	0	0	0	0	0	0
	10:07:48	158	360	320	53	484	67	0	0	0	0	0	0	0	0
	10:08:48	157	350	320	50	482	67	0	0	0	0	0	0	0	0
	10:09:48	156	350	346	54	490	67	0	0	0	0	0	0	0	0
	10:10:48	156	355	345	54	490	65	0	0	0	0	0	0	0	0
	10:11:48	208	5	15	12	123	66	0	0	0	0	0	0	0	0
	10:12:48	209	0	9	10	87	65	0	0	0	0	0	0	0	0
	10:13:48	209	0	7	9	79	65	0	0	0	0	0	0	0	0
	10:14:48	209	0	6	8	75	65	0	0	0	0	0	0	0	0
	10:15:48	209	0	5	7	74	65	0	0	0	0	0	0	0	0
	10:16:48	209	0	4	7	73	65	0	0	0	0	0	0	0	0
	10:17:48	209	0	4	6	72	65	0	0	0	0	0	0	0	0
	10:18:48	208	0	3	6	73	66	0	0	0	0	0	0	0	0
	10:19:48	209	0	3	6	72	66	0	0	0	0	0	0	0	0
	10:20:48	146	0	488	35	568	66	0	0	0	0	0	0	0	0
	10:21:48	144	245	519	44	568	67	0	0	0	0	0	0	0	0
	10:22:48	144	255	544	42	574	67	0	0	0	0	0	0	0	0
5	10:23:48	144	260	508	37	569	67	0	0	0	0	0	0	0	0
	~~10:24:48~~	142	255	557	40	581	67	0	0	0	0	0	0	0	0
	10:25:48	142	260	574	40	586	67	0	0	0	0	0	0	0	0
	10:26:48	141	255	570	39	588	66	0	0	0	0	0	0	0	0
1.2.1	~~10:27:48~~	142	250	563	39	586	66	0	0	0	0	0	0	0	0
2 160	10:28:48	142	250	567	40	589	66	0	0	0	0	0	0	0	0
	10:29:48	142	245	531	37	587	66	0	0	0	0	0	0	0	0
	~~10:30:48~~	207	185	30	14	196	65	0	0	0	0	0	0	0	0
6	10:31:48	208	0	13	9	110	66	0	0	0	0	0	0	0	0
	10:32:48	208	0	9	8	91	66	0	0	0	0	0	0	0	0
	10:33:48	208	0	7	7	81	65	0	0	0	0	0	0	0	0
	10:34:48	208	0	5	7	77	65	0	0	0	0	0	0	0	0
	10:35:48	208	0	5	6	76	67	0	0	0	0	0	0	0	0
	10:36:48	208	0	4	6	75	67	0	0	0	0	0	0	0	0
	10:37:48	208	0	4	5	75	67	0	0	0	0	0	0	0	0
	10:38:48	208	0	3	5	74	67	0	0	0	0	0	0	0	0
	10:39:48	208	0	3	5	73	67	0	0	0	0	0	0	0	0
	10:40:48	208	0	3	5	74	67	0	0	0	0	0	0	0	0
	10:41:48	208	0	3	4	74	67	0	0	0	0	0	0	0	0
	10:42:48	208	0	2	4	71	65	0	0	0	0	0	0	0	0
	10:43:48	208	0	2	4	72	65	0	0	0	0	0	0	0	0
	10:44:48	208	0	2	4	73	65	0	0	0	0	0	0	0	0
	10:45:48	122	320	641	38	714	66	0	0	0	0	0	0	0	0
9	10:46:48	122	395	688	31	713	65	0	0	0	0	0	0	0	0
	10:47:48	122	415	697	28	712	65	0	0	0	0	0	0	0	0
	10:48:48	122	420	692	27	712	65	0	0	0	0	0	0	0	0
1.3.1 140	10:49:48	122	425	699	27	712	65	0	0	0	0	0	0	0	0
	$\boxed{10:50:48}$	123	415	695	26	712	66	0	0	0	0	0	0	0	0

	TIME HR:MN:SE	O2 (0%)	CO (ppm)	NO (ppm)	NO2 (ppm)	TEMP PROBE	TEMP ROOM	t4	t3	t2	t1	t5			SO2 (ppm)
	10:51:48	122	405	710	26	717	66	0	0	0	0	0	0	0	0
9	10:52:48	122	390	693	25	716	66	0	0	0	0	0	0	0	0
	10:53:48	122	400	700	25	716	67	0	0	0	0	0	0	0	0
	10:54:48	122	410	703	25	719	67	0	0	0	0	0	0	0	0
1.3.3 140	10:55:48	121	415	700	25	721	67	0	0	0	0	0	0	0	0
	10:56:48	121	420	693	24	721	67	0	0	0	0	0	0	0	0
	10:57:48	121	425	700	24	721	67	0	0	0	0	0	0	0	0
	10:58:48	121	425	696	24	722	67	0	0	0	0	0	0	0	0
	10:59:48	199	420	72	13	295	67	0	0	0	0	0	0	0	0
	11:00:48	208	0	13	4	110	66	0	0	0	0	0	0	0	5
	11:01:48	208	0	9	4	92	65	0	0	0	0	0	0	0	6
	11:02:48	208	0	6	3	83	65	0	0	0	0	0	0	0	4
	11:03:48	208	0	5	3	78	65	0	0	0	0	0	0	0	3
	11:04:48	208	0	4	3	77	65	0	0	0	0	0	0	0	2
	11:05:48	208	0	3	3	74	65	0	0	0	0	0	0	0	2
	11:06:48	208	0	3	3	73	65	0	0	0	0	0	0	0	1
	11:07:48	208	0	2	3	74	65	0	0	0	0	0	0	0	1
	11:08:48	208	0	2	2	75	66	0	0	0	0	0	0	0	1
	11:09:48	208	0	2	2	74	67	0	0	0	0	0	0	0	1
	11:10:48	208	0	2	2	75	67	0	0	0	0	0	0	0	1
	11:11:48	208	0	2	2	75	67	0	0	0	0	0	0	0	1
	11:12:48	109	0	803	19	864	67	0	0	0	0	0	0	0	0
	11:13:48	105	335	896	27	869	67	0	0	0	0	0	0	0	0
	11:14:48	104	370	914	27	872	67	0	0	0	0	0	0	0	0
	11:15:48	104	400	903	27	873	66	0	0	0	0	0	0	0	0
	11:16:48	104	380	897	27	874	66	0	0	0	0	0	0	0	0
	11:17:48	105	380	899	27	873	66	0	0	0	0	0	0	0	0
11	11:18:48	105	370	898	27	875	66	0	0	0	0	0	0	0	0
	11:19:48	105	365	897	27	874	66	0	0	0	0	0	0	0	0
	11:20:48	105	360	898	27	874	66	0	0	0	0	0	0	0	0
	11:21:48	105	350	898	27	874	66	0	0	0	0	0	0	0	0
	11:22:48	105	350	897	27	876	66	0	0	0	0	0	0	0	0
	11:23:48	105	350	897	26	873	65	0	0	0	0	0	0	0	0
1.4.1	11:24:48	105	345	893	26	873	66	0	0	0	0	0	0	0	0
	11:25:48	105	340	889	26	874	67	0	0	0	0	0	0	0	0
2	11:26:48	105	355	893	26	876	67	0	0	0	0	0	0	0	0
175	11:27:48	108	355	773	26	544	67	0	0	0	0	0	0	0	0
	11:28:48	208	0	14	2	136	67	0	0	0	0	0	0	0	11
3	11:39:48	159	340	305	22	515	64	0	0	0	0	0	0	0	0
	11:40:48	159	375	309	22	506	65	0	0	0	0	0	0	0	0
	11:41:48	159	380	305	26	500	66	0	0	0	0	0	0	0	0
	11:42:48	159	385	304	30	495	66	0	0	0	0	0	0	0	0
	11:43:48	158	390	315	33	494	66	0	0	0	0	0	0	0	0
	11:44:48	158	395	305	36	490	66	0	0	0	0	0	0	0	0
	11:45:48	158	390	306	38	487	66	0	0	0	0	0	0	0	0
	11:46:48	158	395	315	40	484	66	0	0	0	0	0	0	0	0
14	11:47:48	159	400	291	41	481	65	0	0	0	0	0	0	0	0
	11:48:48	158	405	301	44	482	65	0	0	0	0	0	0	0	0
	11:49:48	159	395	291	45	479	65	0	0	0	0	0	0	0	0
	11:50:48	159	415	287	48	477	65	0	0	0	0	0	0	0	0
1.5.1	11:51:48	158	395	291	46	478	64	0	0	0	0	0	0	0	0
	11:52:48	158	395	296	50	478	64	0	0	0	0	0	0	0	0
0	11:53:48	158	410	300	50	478	64	0	0	0	0	0	0	0	0
2	11:54:48	159	415	285	51	476	65	0	0	0	0	0	0	0	0
	11:55:48	159	420	284	52	474	65	0	0	0	0	0	0	0	0
3	11:56:48	159	420	288	52	474	65	0	0	0	0	0	0	0	0
	11:57:48	159	420	286	52	473	66	0	0	0	0	0	0	0	0
17	11:58:48	159	425	281	55	471	66	0	0	0	0	0	0	0	0
	11:59:48	158	435	293	55	474	66	0	0	0	0	0	0	0	0
2.1.1	12:00:48	158	430	296	54	474	66	0	0	0	0	0	0	0	0
	12:01:48	158	440	297	53	475	67	0	0	0	0	0	0	0	0
2	12:02:48	158	435	299	51	476	67	0	0	0	0	0	0	0	0
0	12:03:48	157	435	319	51	477	67	0	0	0	0	0	0	0	0
	12:04:48	158	430	306	52	477	66	0	0	0	0	0	0	0	0
3	12:05:48	156	430	323	52	481	65	0	0	0	0	0	0	0	0
	12:06:48	158	425	300	51	476	65	0	0	0	0	0	0	0	0
	12:07:48	158	425	301	52	478	66	0	0	0	0	0	0	0	0
	12:08:48	157	430	308	52	479	65	0	0	0	0	0	0	0	0
	12:09:48	157	430	303	53	479	65	0	0	0	0	0	0	0	0
	12:10:48	157	435	308	54	479	65	0	0	0	0	0	0	0	0
	12:11:48	158	430	298	54	478	65	0	0	0	0	0	0	0	0
	12:12:48	158	435	297	54	477	65	0	0	0	0	0	0	0	0
	12:13:48	157	435	317	54	481	65	0	0	0	0	0	0	0	0
	12:14:48	158	435	300	55	475	66	0	0	0	0	0	0	0	0
	12:15:48	158	450	292	55	475	66	0	0	0	0	0	0	0	0

TIME HR:MN:SE	O2 (0%)	CO (ppm)	NO (ppm)	NO2 (ppm)	TEMP PROBE	TEMP ROOM	t4	t3	t2	t1	t5			SO2 (ppm)
12:16:48	158	445	304	56	476	66	0	0	0	0	0	0	0	0
12:17:48	158	440	299	56	476	66	0	0	0	0	0	0	0	0
12:18:48	207	25	21	20	134	66	0	0	0	0	0	0	0	0
12:19:48	208	0	12	15	100	66	0	0	0	0	0	0	0	0
12:20:48	208	0	9	13	86	66	0	0	0	0	0	0	0	0
12:21:48	208	0	7	11	80	65	0	0	0	0	0	0	0	0
12:22:48	208	0	6	10	73	64	0	0	0	0	0	0	0	0
12:23:48	208	0	5	9	72	63	0	0	0	0	0	0	0	0
12:24:48	208	0	4	9	71	64	0	0	0	0	0	0	0	0
12:25:48	208	0	4	8	70	64	0	0	0	0	0	0	0	0
12:26:48	208	0	4	8	70	63	0	0	0	0	0	0	0	0
12:27:48	156	280	310	35	492	63	0	0	0	0	0	0	0	0
12:28:48	156	395	320	44	491	63	0	0	0	0	0	0	0	0
12:29:48	156	410	331	46	491	63	0	0	0	0	0	0	0	0
12:30:48	156	415	340	47	492	63	0	0	0	0	0	0	0	0
12:31:48	156	415	331	49	489	64	0	0	0	0	0	0	0	0
12:32:48	156	425	337	50	490	64	0	0	0	0	0	0	0	0
12:33:48	155	425	347	51	492	65	0	0	0	0	0	0	0	0
12:34:48	155	380	339	50	491	65	0	0	0	0	0	0	0	0
12:35:48	155	410	336	52	491	64	0	0	0	0	0	0	0	0
12:36:48	155	410	348	53	492	65	0	0	0	0	0	0	0	0
12:37:48	155	400	343	53	491	65	0	0	0	0	0	0	0	0
12:38:48	155	400	353	53	500	64	0	0	0	0	0	0	0	0
12:39:48	153	385	390	53	502	63	0	0	0	0	0	0	0	0
12:40:48	153	325	383	53	504	63	0	0	0	0	0	0	0	0
12:41:48	153	385	381	53	503	63	0	0	0	0	0	0	0	0
12:42:48	153	355	376	52	502	63	0	0	0	0	0	0	0	0
12:43:48	153	370	384	54	504	64	0	0	0	0	0	0	0	0
12:44:48	154	390	378	52	502	63	0	0	0	0	0	0	0	0
12:45:48	156	375	348	51	495	63	0	0	0	0	0	0	0	0
12:46:48	155	400	355	50	495	63	0	0	0	0	0	0	0	0
12:47:48	207	15	22	21	123	64	0	0	0	0	0	0	0	0
12:48:48	208	0	13	16	91	64	0	0	0	0	0	0	0	0
12:49:48	208	0	9	14	82	64	0	0	0	0	0	0	0	0
12:50:48	208	0	7	13	78	65	0	0	0	0	0	0	0	0
12:51:48	208	0	6	12	76	65	0	0	0	0	0	0	0	0
12:52:48	122	30	614	34	699	65	0	0	0	0	0	0	0	0
12:53:48	121	365	676	36	706	65	0	0	0	0	0	0	0	0
12:54:48	121	420	700	33	708	64	0	0	0	0	0	0	0	0
12:55:48	121	430	703	31	710	63	0	0	0	0	0	0	0	0
12:56:48	121	415	701	30	712	64	0	0	0	0	0	0	0	0
12:57:48	121	410	707	30	717	64	0	0	0	0	0	0	0	0
12:58:48	121	395	706	29	717	64	0	0	0	0	0	0	0	0
12:59:48	121	405	702	29	717	64	0	0	0	0	0	0	0	0
13:00:48	121	405	709	28	717	64	0	0	0	0	0	0	0	0
13:01:48	122	380	697	28	716	64	0	0	0	0	0	0	0	0
13:02:48	121	395	702	28	714	64	0	0	0	0	0	0	0	0
13:03:48	122	400	706	28	714	64	0	0	0	0	0	0	0	0
13:04:48	121	405	705	27	715	65	0	0	0	0	0	0	0	0
13:05:48	122	410	701	27	714	65	0	0	0	0	0	0	0	0
13:06:48	122	415	703	27	713	65	0	0	0	0	0	0	0	0
13:07:48	122	415	696	26	714	66	0	0	0	0	0	0	0	0
13:08:48	122	425	709	26	714	65	0	0	0	0	0	0	0	0
13:09:48	122	430	706	26	715	66	0	0	0	0	0	0	0	0
13:10:48	121	410	694	25	719	64	0	0	0	0	0	0	0	0
13:11:48	121	430	696	25	718	64	0	0	0	0	0	0	0	0
13:12:48	122	430	696	25	717	64	0	0	0	0	0	0	0	0
13:13:48	122	410	703	25	716	64	0	0	0	0	0	0	0	0
13:14:48	122	410	703	24	717	63	0	0	0	0	0	0	0	0
13:15:48	204	395	37	11	258	64	0	0	0	0	0	0	0	0
13:16:48	207	0	15	7	126	64	0	0	0	0	0	0	0	1
13:17:48	207	0	10	6	101	64	0	0	0	0	0	0	0	2
13:18:48	207	0	8	6	86	64	0	0	0	0	0	0	0	2
13:19:48	207	0	6	6	80	64	0	0	0	0	0	0	0	2
13:20:48	207	0	5	5	77	64	0	0	0	0	0	0	0	2
13:21:48	208	0	5	5	76	65	0	0	0	0	0	0	0	1
13:22:48	102	45	856	25	869	66	0	0	0	0	0	0	0	0
13:23:48	103	355	879	28	868	67	0	0	0	0	0	0	0	0
13:24:48	103	385	888	28	870	66	0	0	0	0	0	0	0	0
13:25:48	104	400	880	28	872	66	0	0	0	0	0	0	0	0
13:26:48	103	405	884	28	875	67	0	0	0	0	0	0	0	0
13:27:48	103	410	885	28	877	66	0	0	0	0	0	0	0	0
13:28:48	104	400	884	28	877	66	0	0	0	0	0	0	0	0
13:29:48	104	400	881	27	878	66	0	0	0	0	0	0	0	0
13:30:48	104	395	879	27	877	65	0	0	0	0	0	0	0	0

2.R.1 2 3 50 20

2.3.1 190 23

23.4.1 175

	TIME HR:MN:SE	O2 (0%)	CO (ppm)	NO (ppm)	NO2 (ppm)	TEMP PROBE	TEMP ROOM	t4	t3	t2	t1	t5			SO2 (ppm)
	13:31:48	104	390	877	27	878	66	0	0	0	0	0	0	0	0
	13:32:48	104	395	876	27	878	65	0	0	0	0	0	0	0	0
2.4.3 175	13:33:48	104	395	876	27	878	65	0	0	0	0	0	0	0	0
	13:34:48	104	385	874	27	877	66	0	0	0	0	0	0	0	0
	13:35:48	104	385	870	27	879	67	0	0	0	0	0	0	0	0
	13:36:48	104	380	870	27	877	68	0	0	0	0	0	0	0	0
	13:37:48	104	370	875	27	876	68	0	0	0	0	0	0	0	0
	13:38:48	104	370	875	27	878	68	0	0	0	0	0	0	0	0
	13:39:48	204	370	33	8	292	68	0	0	0	0	0	0	0	0
	13:40:48	207	0	14	4	145	68	0	0	0	0	0	0	0	6
	13:41:48	207	0	9	4	104	67	0	0	0	0	0	0	0	6
	13:42:48	207	0	7	3	89	67	0	0	0	0	0	0	0	4
	13:43:48	207	0	6	3	84	67	0	0	0	0	0	0	0	3
	13:44:48	207	0	5	3	81	66	0	0	0	0	0	0	0	3
	13:45:48	208	0	4	3	78	67	0	0	0	0	0	0	0	2
	13:46:48	208	0	4	3	74	67	0	0	0	0	0	0	0	2
	13:47:48	208	0	3	3	76	67	0	0	0	0	0	0	0	3
	13:53:25	210	0	2	3	74	71	0	0	0	0	0	0	0	0
	13:54:25	210	0	2	2	74	68	0	0	0	0	0	0	0	0
	13:55:25	210	0	2	2	74	68	0	0	0	0	0	0	0	0
	13:56:25	145	260	548	15	591	68	0	0	0	0	0	0	0	0
2.5.1 / 29	13:57:25	144	275	504	15	586	67	0	0	0	0	0	0	0	0
	13:58:25	144	285	562	15	586	67	0	0	0	0	0	0	0	0
	13:59:25	144	290	504	14	580	67	0	0	0	0	0	0	0	0
30	14:00:25	144	290	556	16	584	67	0	0	0	0	0	0	0	0
100	14:01:25	144	275	537	15	580	69	0	0	0	0	0	0	0	0
	14:02:25	144	275	550	16	582	67	0	0	0	0	0	0	0	0
32 / 31	14:03:25	144	285	538	16	579	67	0	0	0	0	0	0	0	0
	14:04:25	144	280	502	15	578	67	0	0	0	0	0	0	0	0
3.1.1 / 32	14:05:25	144	285	502	17	578	67	0	0	0	0	0	0	0	0
	14:06:25	144	275	528	17	575	68	0	0	0	0	0	0	0	0
100 / 33	14:07:25	144	280	507	17	576	69	0	0	0	0	0	0	0	0
	14:08:25	144	280	549	18	579	68	0	0	0	0	0	0	0	0
34	14:09:25	144	270	483	16	569	68	0	0	0	0	0	0	0	0
	14:10:25	209	65	21	3	143	68	0	0	0	0	0	0	0	0
	14:11:25	210	5	12	3	110	68	0	0	0	0	0	0	0	0
	14:12:25	210	0	9	2	94	68	0	0	0	0	0	0	0	0
	14:13:25	210	0	7	2	85	66	0	0	0	0	0	0	0	0
	14:14:25	210	0	5	2	80	66	0	0	0	0	0	0	0	0
	14:15:25	210	0	4	2	77	67	0	0	0	0	0	0	0	0
	14:16:25	210	0	4	2	74	66	0	0	0	0	0	0	0	0
	14:17:25	210	0	3	2	73	67	0	0	0	0	0	0	0	0
	14:18:25	210	0	3	2	74	67	0	0	0	0	0	0	0	0
	14:19:25	210	0	3	2	72	66	0	0	0	0	0	0	0	0
	14:20:25	210	0	3	2	74	67	0	0	0	0	0	0	0	0
	14:21:25	210	0	3	2	73	68	0	0	0	0	0	0	0	0
	14:22:25	210	0	2	1	74	69	0	0	0	0	0	0	0	0
	14:23:25	210	0	1	1	74	69	0	0	0	0	0	0	0	0
	14:24:25	210	0	1	1	74	68	0	0	0	0	0	0	0	0
	14:25:25	210	0	1	1	74	68	0	0	0	0	0	0	0	0
	14:26:25	210	0	1	1	74	68	0	0	0	0	0	0	0	0
	14:27:25	210	0	1	1	72	66	0	0	0	0	0	0	0	0
	14:28:25	145	230	454	26	572	67	0	0	0	0	0	0	0	0
35	14:29:25	145	255	457	29	567	67	0	0	0	0	0	0	0	0
	14:30:25	145	265	519	34	574	66	0	0	0	0	0	0	0	0
	14:31:25	145	275	513	36	574	66	0	0	0	0	0	0	0	0
3.1.1	14:32:25	145	270	467	31	566	66	0	0	0	0	0	0	0	0
	14:33:25	145	280	499	37	568	65	0	0	0	0	0	0	0	0
	14:34:25	145	275	514	36	573	65	0	0	0	0	0	0	0	0
	14:35:25	145	275	501	35	569	67	0	0	0	0	0	0	0	0
(100)	14:36:25	145	280	520	37	573	67	0	0	0	0	0	0	0	0
	14:37:25	144	270	488	35	570	67	0	0	0	0	0	0	0	0
	14:38:25	144	275	485	35	573	67	0	0	0	0	0	0	0	0
	14:39:25	145	285	478	36	568	67	0	0	0	0	0	0	0	0
	14:40:25	145	285	513	39	571	67	0	0	0	0	0	0	0	0
	14:41:25	144	275	518	38	574	67	0	0	0	0	0	0	0	0
	14:42:25	144	290	530	39	579	66	0	0	0	0	0	0	0	0
	14:43:25	210	30	16	5	141	65	0	0	0	0	0	0	0	0
	14:44:25	210	5	9	4	99	66	0	0	0	0	0	0	0	0
	14:45:25	210	5	7	3	84	65	0	0	0	0	0	0	0	0
	14:46:25	210	0	5	3	78	65	0	0	0	0	0	0	0	0
	14:47:25	210	0	4	3	75	65	0	0	0	0	0	0	0	0
	14:48:25	210	0	4	2	73	66	0	0	0	0	0	0	0	0
	14:49:25	210	5	3	2	72	66	0	0	0	0	0	0	0	0
	14:50:25	210	0	3	2	71	66	0	0	0	0	0	0	0	0

	TIME HR:MN:SE	O2 (0%)	CO (ppm)	NO (ppm)	NO2 (ppm)	TEMP PROBE	TEMP ROOM	t4	t3	t2	t1	t5			SO2 (ppm)
	14:51:25	210	5	3	2	71	67	0	0	0	0	0	0	0	0
	14:52:25	106	270	805	35	876	66	0	0	0	0	0	0	0	0
38	14:53:25	106	355	864	26	875	67	0	0	0	0	0	0	0	0
	14:54:25	106	360	877	25	875	68	0	0	0	0	0	0	0	0
	14:55:25	106	365	879	25	875	68	0	0	0	0	0	0	0	0
	14:56:25	105	365	875	26	877	68	0	0	0	0	0	0	0	0
3,2,1	14:57:25	105	360	877	27	875	68	0	0	0	0	0	0	0	0
	14:58:25	106	355	878	27	877	67	0	0	0	0	0	0	0	0
	14:59:25	106	360	875	27	877	67	0	0	0	0	0	0	0	0
175	15:00:25	105	345	880	27	879	66	0	0	0	0	0	0	0	0
	15:01:25	105	340	876	28	878	67	0	0	0	0	0	0	0	0
	15:02:25	105	345	875	28	877	67	0	0	0	0	0	0	0	0
	15:03:25	106	350	876	28	876	67	0	0	0	0	0	0	0	0
	15:04:25	205	365	42	11	302	67	0	0	0	0	0	0	0	0
	15:05:25	210	20	12	4	113	67	0	0	0	0	0	0	0	10
	15:06:25	210	5	8	4	93	67	0	0	0	0	0	0	0	7
	15:07:25	210	5	6	4	80	66	0	0	0	0	0	0	0	3
	15:08:25	210	5	4	3	76	67	0	0	0	0	0	0	0	2
	15:09:25	210	5	3	3	77	69	0	0	0	0	0	0	0	1
	15:10:25	210	5	3	3	77	69	0	0	0	0	0	0	0	0
	15:11:25	210	5	2	3	75	69	0	0	0	0	0	0	0	0
	15:12:25	210	5	2	2	74	69	0	0	0	0	0	0	0	0
	15:13:25	210	5	2	2	76	69	0	0	0	0	0	0	0	0
	15:14:25	210	5	2	2	75	69	0	0	0	0	0	0	0	0
	15:15:25	210	5	2	2	72	68	0	0	0	0	0	0	0	0
	15:16:25	210	5	2	2	73	67	0	0	0	0	0	0	0	0
41	15:26:25	210	5	1	1	73	72	0	0	0	0	0	0	0	0
	15:27:25	126	105	619	19	720	69	0	0	0	0	0	0	0	0
	15:28:25	124	395	650	24	720	68	0	0	0	0	0	0	0	0
	15:29:25	123	415	657	23	720	68	0	0	0	0	0	0	0	0
	15:30:25	123	435	663	23	718	68	0	0	0	0	0	0	0	0
3,3,1	15:31:25	123	425	660	24	717	67	0	0	0	0	0	0	0	0
	16:32:25	123	420	664	24	719	67	0	0	0	0	0	0	0	0
	15:33:25	123	405	664	25	717	67	0	0	0	0	0	0	0	0
140	15:34:25	123	420	668	25	715	67	0	0	0	0	0	0	0	0
	15:35:25	123	420	663	25	717	67	0	0	0	0	0	0	0	0
	15:36:25	123	420	671	26	716	67	0	0	0	0	0	0	0	0
	15:37:25	123	420	662	26	715	67	0	0	0	0	0	0	0	0
	15:38:25	123	420	665	26	716	67	0	0	0	0	0	0	0	0
	15:39:25	123	430	657	26	713	67	0	0	0	0	0	0	0	0
	15:40:25	210	35	15	4	141	67	0	0	0	0	0	0	0	0
	15:41:25	210	10	8	3	102	68	0	0	0	0	0	0	0	3
	15:42:25	210	5	6	3	88	69	0	0	0	0	0	0	0	2
	15:43:25	210	5	4	3	82	69	0	0	0	0	0	0	0	1
	15:44:25	210	5	3	3	79	69	0	0	0	0	0	0	0	0
	15:45:25	210	5	3	2	78	69	0	0	0	0	0	0	0	0
	15:46:25	210	5	2	2	76	69	0	0	0	0	0	0	0	0
	15:47:25	210	5	2	2	76	69	0	0	0	0	0	0	0	0
	15:48:25	210	5	2	2	74	68	0	0	0	0	0	0	0	0
	15:49:25	210	5	2	2	74	67	0	0	0	0	0	0	0	0
	15:50:25	160	225	297	26	511	67	0	0	0	0	0	0	0	0
	15:51:25	159	350	318	34	509	68	0	0	0	0	0	0	0	0
44	15:52:25	159	370	315	37	504	68	0	0	0	0	0	0	0	0
	15:53:25	159	380	314	38	501	68	0	0	0	0	0	0	0	0
	15:54:25	159	385	312	41	498	68	0	0	0	0	0	0	0	0
	15:55:25	159	370	319	42	496	67	0	0	0	0	0	0	0	0
	15:56:25	159	380	315	43	494	67	0	0	0	0	0	0	0	0
3,4,1	15:57:25	159	375	307	44	491	68	0	0	0	0	0	0	0	0
	15:58:25	159	385	308	46	488	69	0	0	0	0	0	0	0	0
	15:59:25	159	385	302	48	487	68	0	0	0	0	0	0	0	0
50	16:00:25	160	395	295	49	485	68	0	0	0	0	0	0	0	0
	16:01:25	160	405	295	51	484	68	0	0	0	0	0	0	0	0
	16:02:25	159	400	304	51	484	69	0	0	0	0	0	0	0	0
	16:03:25	159	400	304	52	484	67	0	0	0	0	0	0	0	0
	16:04:25	159	390	312	53	486	68	0	0	0	0	0	0	0	0
	16:05:25	159	390	312	54	486	68	0	0	0	0	0	0	0	0
	16:06:25	158	390	315	54	487	68	0	0	0	0	0	0	0	0
	16:07:25	159	390	315	54	487	67	0	0	0	0	0	0	0	0
	16:08:25	159	395	313	55	487	68	0	0	0	0	0	0	0	0
	16:09:25	159	400	312	55	487	68	0	0	0	0	0	0	0	0
	16:10:25	159	395	318	55	487	67	0	0	0	0	0	0	0	0
	16:11:25	159	395	308	56	486	68	0	0	0	0	0	0	0	0
	16:12:25	159	405	303	57	484	69	0	0	0	0	0	0	0	0
	16:13:25	128	360	600	52	600	69	0	0	0	0	0	0	0	0
	16:14:25	120	415	629	44	658	69	0	0	0	0	0	0	0	0

TIME HR:MN:SE	O2 (O%)	CO (ppm)	NO (ppm)	NO2 (ppm)	TEMP PROBE	TEMP ROOM	t4	t3	t2	t1	t5			SO2 (ppm)
16:15:25	161	390	300	40	521	69	0	0	0	0	0	0	0	0
16:16:25	161	400	282	44	501	69	0	0	0	0	0	0	0	0
16:17:25	161	420	272	48	491	68	0	0	0	0	0	0	0	0
16:18:25	161	430	284	51	489	67	0	0	0	0	0	0	0	0
16:19:25	161	430	274	52	485	67	0	0	0	0	0	0	0	0
16:20:25	161	435	272	54	482	67	0	0	0	0	0	0	0	0
16:21:25	160	435	279	55	481	66	0	0	0	0	0	0	0	0
16:22:25	160	445	278	56	479	66	0	0	0	0	0	0	0	0
16:23:25	160	450	277	56	478	65	0	0	0	0	0	0	0	0
16:24:25	160	445	290	55	480	65	0	0	0	0	0	0	0	0
16:25:25	160	440	285	54	478	65	0	0	0	0	0	0	0	0
16:26:25	160	450	281	54	477	66	0	0	0	0	0	0	0	0
16:27:25	160	450	283	53	476	65	0	0	0	0	0	0	0	0
16:28:25	160	455	287	53	477	66	0	0	0	0	0	0	0	0
16:29:25	160	450	281	52	476	66	0	0	0	0	0	0	0	0
16:30:25	161	450	266	53	473	66	0	0	0	0	0	0	0	0
16:31:25	161	460	266	53	471	67	0	0	0	0	0	0	0	0
16:32:25	169	465	202	50	285	68	0	0	0	0	0	0	0	0
16:33:25	210	30	15	15	111	67	0	0	0	0	0	0	0	0
16:34:25	210	15	11	13	89	68	0	0	0	0	0	0	0	0
16:35:25	210	10	8	11	81	67	0	0	0	0	0	0	0	0
16:36:25	210	10	7	11	78	68	0	0	0	0	0	0	0	0
16:37:25	210	10	6	10	74	67	0	0	0	0	0	0	0	0
16:38:25	210	10	5	9	72	66	0	0	0	0	0	0	0	0

47

.3,5,1

0

9

1

40

9 - ae

en4, wks, wkt

1-49 9 -ae

9'' 31 5/11/95 RN2

TIME HR:MN:SE	O2 (0%)	CO (ppm)	NO (ppm)	NO2 (ppm)	TEMP PROBE	TEMP ROOM	t4	t3	t2	t1	t5			SO2 (ppm)
07:59:30	208	5	1	6	70	71	0	0	0	0	0	0	0	0
08:00:30	207	0	1	5	70	71	0	0	0	0	0	0	0	0
08:01:30	207	0	1	4	71	71	0	0	0	0	0	0	0	0
08:02:30	206	0	1	3	71	71	0	0	0	0	0	0	0	0
08:11:30	206	0	0	1	74	75	0	0	0	0	0	0	0	0
08:12:30	160	405	232	35	469	75	0	0	0	0	0	0	0	0
08:13:30	160	440	241	37	467	74	0	0	0	0	0	0	0	0
08:14:30	159	440	249	38	466	74	0	0	0	0	0	0	0	0
08:15:30	158	440	259	40	466	75	0	0	0	0	0	0	0	0
08:16:30	158	435	270	40	467	73	0	0	0	0	0	0	0	0
08:17:30	158	425	269	41	468	73	0	0	0	0	0	0	0	0
08:18:30	158	425	266	42	466	72	0	0	0	0	0	0	0	0
08:19:30	158	425	266	42	466	72	0	0	0	0	0	0	0	0
08:20:30	159	425	259	42	464	72	0	0	0	0	0	0	0	0
08:21:30	159	435	257	43	463	72	0	0	0	0	0	0	0	0
08:22:30	159	435	257	44	462	72	0	0	0	0	0	0	0	0
08:23:30	158	430	260	44	463	72	0	0	0	0	0	0	0	0
08:24:30	205	265	19	13	167	72	0	0	0	0	0	0	0	0
08:25:30	206	10	9	8	107	73	0	0	0	0	0	0	0	0
08:26:30	206	0	7	7	91	75	0	0	0	0	0	0	0	0
08:38:30	156	395	293	43	479	72	0	0	0	0	0	0	0	0
08:39:30	156	400	302	43	478	73	0	0	0	0	0	0	0	0
08:40:30	156	395	306	43	479	72	0	0	0	0	0	0	0	0
08:41:30	156	375	299	43	478	72	0	0	0	0	0	0	0	0
08:42:30	157	395	301	44	478	73	0	0	0	0	0	0	0	0
08:43:30	156	395	300	44	478	72	0	0	0	0	0	0	0	0
08:44:30	157	395	295	45	477	73	0	0	0	0	0	0	0	0
08:45:30	157	400	295	45	476	74	0	0	0	0	0	0	0	0
08:46:30	157	400	293	46	475	75	0	0	0	0	0	0	0	0
08:47:30	157	390	294	46	475	75	0	0	0	0	0	0	0	0
08:48:30	157	395	300	46	476	74	0	0	0	0	0	0	0	0
08:49:30	157	390	294	47	476	74	0	0	0	0	0	0	0	0
08:50:30	157	395	293	47	475	74	0	0	0	0	0	0	0	0
08:51:30	157	395	293	47	474	74	0	0	0	0	0	0	0	0
08:52:30	157	390	300	47	475	75	0	0	0	0	0	0	0	0
08:53:30	156	390	305	47	477	74	0	0	0	0	0	0	0	0
08:54:30	157	385	301	47	477	73	0	0	0	0	0	0	0	0
08:55:30	200	395	55	33	241	73	0	0	0	0	0	0	0	0
08:56:30	207	0	12	12	110	72	0	0	0	0	0	0	0	0
08:57:30	207	0	9	11	92	72	0	0	0	0	0	0	0	0
08:58:30	207	0	7	10	82	72	0	0	0	0	0	0	0	0
08:59:30	207	0	6	9	78	72	0	0	0	0	0	0	0	0
09:00:30	207	0	5	8	74	72	0	0	0	0	0	0	0	0
09:01:30	207	0	4	7	74	72	0	0	0	0	0	0	0	0
09:02:30	207	0	4	7	73	72	0	0	0	0	0	0	0	0
09:03:30	204	0	56	7	483	73	0	0	0	0	0	0	0	0
09:04:30	144	240	509	38	563	74	0	0	0	0	0	0	0	0
09:05:30	144	250	510	37	564	75	0	0	0	0	0	0	0	0
09:06:30	144	250	474	32	559	75	0	0	0	0	0	0	0	0
09:07:30	144	255	529	36	564	75	0	0	0	0	0	0	0	0
09:08:30	144	250	533	35	566	75	0	0	0	0	0	0	0	0
09:09:30	144	245	488	34	561	75	0	0	0	0	0	0	0	0
09:10:30	144	250	534	36	567	75	0	0	0	0	0	0	0	0
09:11:30	143	245	539	36	570	75	0	0	0	0	0	0	0	0
09:12:30	143	245	543	36	573	73	0	0	0	0	0	0	0	0
09:13:30	143	245	496	35	568	73	0	0	0	0	0	0	0	0
09:14:30	144	240	534	35	569	73	0	0	0	0	0	0	0	0
09:15:30	144	245	529	35	569	73	0	0	0	0	0	0	0	0
09:16:30	143	245	489	33	570	73	0	0	0	0	0	0	0	0
09:17:30	143	245	491	32	567	73	0	0	0	0	0	0	0	0
09:18:30	143	245	484	32	567	73	0	0	0	0	0	0	0	0
09:19:30	143	245	541	36	573	73	0	0	0	0	0	0	0	0
09:20:30	207	25	22	14	152	72	0	0	0	0	0	0	0	0
09:21:30	207	0	12	11	105	72	0	0	0	0	0	0	0	0
09:22:30	206	0	37	9	110	75	0	0	0	0	0	0	0	0
09:23:30	207	0	8	11	85	76	0	0	0	0	0	0	0	0
09:24:30	207	0	7	10	81	76	0	0	0	0	0	0	0	0
09:25:30	208	0	6	9	78	76	0	0	0	0	0	0	0	0
09:26:30	208	0	6	9	75	77	0	0	0	0	0	0	0	0
09:27:29	123	250	649	32	702	76	0	0	0	0	0	0	0	0
09:28:29	122	385	683	30	705	76	0	0	0	0	0	0	0	0
09:29:29	122	405	686	27	709	75	0	0	0	0	0	0	0	0
09:30:29	121	405	697	25	710	76	0	0	0	0	0	0	0	0
09:31:29	122	405	702	24	710	75	0	0	0	0	0	0	0	0

4,1,1 0

4,2,1 50

4,3,1 100

5,4,1 140

4.4.3
140

14

4.5.1
175

17

[illegible].7.1
140

TIME HR:MN:SE	O2 (0%)	CO (ppm)	NO (ppm)	NO2 (ppm)	TEMP PROBE	TEMP ROOM	t4	t3	t2	t1	t5			SO2 (ppm)
09:33:29	121	385	693	23	715	74	0	0	0	0	0	0	0	0
09:34:29	121	385	693	22	714	74	0	0	0	0	0	0	0	0
09:35:29	122	395	692	22	714	74	0	0	0	0	0	0	0	0
09:36:29	122	405	690	21	712	74	0	0	0	0	0	0	0	0
09:37:29	122	400	696	21	714	74	0	0	0	0	0	0	0	0
09:38:29	122	385	690	21	714	74	0	0	0	0	0	0	0	0
09:39:29	122	385	696	20	714	74	0	0	0	0	0	0	0	0
09:40:29	122	400	691	20	714	75	0	0	0	0	0	0	0	0
09:41:29	121	405	689	20	716	76	0	0	0	0	0	0	0	0
09:42:29	121	395	694	20	717	76	0	0	0	0	0	0	0	0
09:43:29	121	380	697	20	717	77	0	0	0	0	0	0	0	0
09:44:29	207	0	17	6	168	77	0	0	0	0	0	0	0	2
09:45:29	208	0	11	5	118	77	0	0	0	0	0	0	0	6
09:46:29	208	0	8	5	98	77	0	0	0	0	0	0	0	4
09:47:29	208	0	7	5	87	77	0	0	0	0	0	0	0	3
09:48:29	208	0	6	4	81	76	0	0	0	0	0	0	0	2
09:49:29	208	0	5	4	77	76	0	0	0	0	0	0	0	2
09:50:29	102	310	881	23	888	76	0	0	0	0	0	0	0	0
09:51:29	102	365	903	22	891	75	0	0	0	0	0	0	0	0
09:52:29	102	370	907	22	892	76	0	0	0	0	0	0	0	0
09:53:29	102	365	905	22	895	76	0	0	0	0	0	0	0	0
09:54:29	102	360	910	22	895	76	0	0	0	0	0	0	0	0
09:55:29	102	365	906	21	893	76	0	0	0	0	0	0	0	0
09:56:29	102	365	905	21	894	76	0	0	0	0	0	0	0	0
09:57:29	102	355	903	21	897	76	0	0	0	0	0	0	0	0
09:58:29	102	355	905	21	896	76	0	0	0	0	0	0	0	0
09:59:29	102	350	908	21	900	76	0	0	0	0	0	0	0	0
10:00:29	100	350	918	21	902	77	0	0	0	0	0	0	0	0
10:01:29	102	340	907	21	898	78	0	0	0	0	0	0	0	0
10:02:29	102	335	911	21	899	78	0	0	0	0	0	0	0	0
10:03:29	101	325	903	21	901	78	0	0	0	0	0	0	0	0
10:04:29	102	325	900	20	897	78	0	0	0	0	0	0	0	0
10:05:29	102	325	905	20	894	78	0	0	0	0	0	0	0	0
10:06:29	102	315	906	20	897	78	0	0	0	0	0	0	0	0
10:07:29	101	315	911	20	901	78	0	0	0	0	0	0	0	0
10:08:29	207	0	18	3	148	76	0	0	0	0	0	0	0	13
10:09:29	208	0	11	3	101	76	0	0	0	0	0	0	0	12
10:10:29	208	0	9	2	88	75	0	0	0	0	0	0	0	7
10:11:29	208	0	7	2	77	75	0	0	0	0	0	0	0	5
10:12:29	208	0	6	2	75	74	0	0	0	0	0	0	0	4
10:13:29	208	0	6	2	74	75	0	0	0	0	0	0	0	3
10:14:29	208	0	5	2	71	75	0	0	0	0	0	0	0	3
10:15:29	208	0	5	2	72	75	0	0	0	0	0	0	0	3
10:16:29	208	0	5	2	71	74	0	0	0	0	0	0	0	3
10:17:29	208	0	5	2	73	75	0	0	0	0	0	0	0	3
10:18:29	208	0	4	1	75	75	0	0	0	0	0	0	0	3
10:19:29	208	0	4	1	75	75	0	0	0	0	0	0	0	3
10:20:29	208	0	4	1	75	76	0	0	0	0	0	0	0	2
10:21:29	208	0	8	1	670	77	0	0	0	0	0	0	0	2
10:22:29	122	315	690	13	734	78	0	0	0	0	0	0	0	0
10:23:29	122	335	703	13	728	79	0	0	0	0	0	0	0	0
10:24:29	121	355	713	13	726	79	0	0	0	0	0	0	0	0
10:25:29	121	350	701	14	725	78	0	0	0	0	0	0	0	0
10:26:29	122	330	712	14	723	78	0	0	0	0	0	0	0	0
10:27:29	121	320	703	14	722	79	0	0	0	0	0	0	0	0
10:28:29	121	335	703	14	722	78	0	0	0	0	0	0	0	0
10:29:29	121	340	703	14	720	77	0	0	0	0	0	0	0	0
10:30:29	121	330	698	14	718	76	0	0	0	0	0	0	0	0
10:31:29	121	305	694	14	720	76	0	0	0	0	0	0	0	0
10:32:29	121	320	693	14	718	76	0	0	0	0	0	0	0	0
10:33:29	121	330	696	14	719	76	0	0	0	0	0	0	0	0
10:34:29	121	330	692	14	719	75	0	0	0	0	0	0	0	0
10:35:29	121	335	687	14	718	76	0	0	0	0	0	0	0	0
10:36:29	120	315	696	14	725	76	0	0	0	0	0	0	0	0
10:37:29	119	320	698	14	728	76	0	0	0	0	0	0	0	0
10:38:29	205	310	32	4	233	76	0	0	0	0	0	0	0	0
10:39:29	208	0	14	2	130	76	0	0	0	0	0	0	0	10
10:40:29	208	0	10	1	105	78	0	0	0	0	0	0	0	9
10:41:29	208	0	8	1	94	79	0	0	0	0	0	0	0	7
10:42:29	208	0	7	1	87	79	0	0	0	0	0	0	0	6
10:43:29	208	0	6	1	82	79	0	0	0	0	0	0	0	5
10:44:29	208	0	6	1	80	79	0	0	0	0	0	0	0	4
10:45:29	208	0	5	1	79	79	0	0	0	0	0	0	0	4
10:46:29	208	0	5	1	78	78	0	0	0	0	0	0	0	4

20
5.2.1
100
23
5.3.1
0
26
5.4.1
50

TIME HR:MN:SE	O2 (0%)	CO (ppm)	NO (ppm)	NO2 (ppm)	TEMP PROBE	TEMP ROOM	t4	t3	t2	t1	t5			SO2 (ppm)
10:47:29	208	0	5	1	77	77	0	0	0	0	0	0	0	4
10:48:29	208	0	5	1	76	76	0	0	0	0	0	0	0	4
10:49:29	208	0	5	1	75	77	0	0	0	0	0	0	0	4
10:50:29	208	0	4	1	75	76	0	0	0	0	0	0	0	3
10:51:29	208	0	4	1	75	76	0	0	0	0	0	0	0	3
10:52:29	208	0	4	1	74	76	0	0	0	0	0	0	0	3
10:53:29	208	0	4	1	73	76	0	0	0	0	0	0	0	3
10:54:29	147	0	517	6	566	76	0	0	0	0	0	0	0	3
10:55:29	144	205	530	14	571	76	0	0	0	0	0	0	0	0
10:56:29	145	210	521	15	568	77	0	0	0	0	0	0	0	0
10:57:29	145	215	479	16	563	77	0	0	0	0	0	0	0	0
10:58:29	144	205	481	15	561	77	0	0	0	0	0	0	0	0
10:59:29	144	215	532	20	567	76	0	0	0	0	0	0	0	0
11:00:29	145	215	475	18	563	78	0	0	0	0	0	0	0	0
11:01:29	145	205	471	18	558	79	0	0	0	0	0	0	0	0
11:02:29	145	210	515	21	562	79	0	0	0	0	0	0	0	0
11:03:29	145	225	502	22	562	79	0	0	0	0	0	0	0	0
11:04:29	145	220	469	21	560	79	0	0	0	0	0	0	0	0
11:05:29	145	210	507	21	561	79	0	0	0	0	0	0	0	0
11:06:29	145	215	509	24	562	79	0	0	0	0	0	0	0	0
11:07:29	144	210	528	24	566	79	0	0	0	0	0	0	0	0
11:08:29	142	210	495	22	568	77	0	0	0	0	0	0	0	0
11:09:29	143	210	538	24	575	77	0	0	0	0	0	0	0	0
11:10:29	149	210	420	21	545	76	0	0	0	0	0	0	0	0
11:11:29	155	225	358	23	520	75	0	0	0	0	0	0	0	0
11:12:29	160	280	283	25	496	75	0	0	0	0	0	0	0	0
11:13:29	160	305	277	27	488	75	0	0	0	0	0	0	0	0
11:14:29	160	320	275	29	483	74	0	0	0	0	0	0	0	0
11:15:29	160	320	274	31	479	75	0	0	0	0	0	0	0	0
11:16:29	159	330	288	32	481	75	0	0	0	0	0	0	0	0
11:17:29	159	310	286	32	478	71	0	0	0	0	0	0	0	0
11:18:29	159	315	280	32	477	69	0	0	0	0	0	0	0	0
11:19:29	160	320	272	33	473	69	0	0	0	0	0	0	0	0
11:20:29	160	325	279	34	473	69	0	0	0	0	0	0	0	0
11:21:29	159	330	279	35	473	69	0	0	0	0	0	0	0	0
11:22:29	159	335	280	36	472	69	0	0	0	0	0	0	0	0
11:23:29	159	335	282	36	473	69	0	0	0	0	0	0	0	0
11:24:29	159	330	287	37	474	69	0	0	0	0	0	0	0	0
11:25:29	158	330	294	37	476	69	0	0	0	0	0	0	0	0
11:26:29	158	330	302	37	478	68	0	0	0	0	0	0	0	0
11:27:29	158	330	295	37	476	67	0	0	0	0	0	0	0	0
11:28:29	158	335	302	38	477	67	0	0	0	0	0	0	0	0
11:29:29	158	335	298	39	477	66	0	0	0	0	0	0	0	0
11:33:29	158	360	292	40	454	66	0	0	0	0	0	0	0	0
11:34:29	207	5	18	13	123	66	0	0	0	0	0	0	0	0
11:35:29	207	0	12	10	94	66	0	0	0	0	0	0	0	0
11:36:29	207	0	9	9	84	66	0	0	0	0	0	0	0	0
11:37:29	207	0	8	8	80	67	0	0	0	0	0	0	0	0
11:38:29	207	0	7	7	78	66	0	0	0	0	0	0	0	0
11:39:29	207	0	6	7	76	67	0	0	0	0	0	0	0	0
11:40:29	207	0	5	6	75	67	0	0	0	0	0	0	0	0
11:41:29	155	125	325	26	489	66	0	0	0	0	0	0	0	0
11:42:29	154	325	334	33	492	67	0	0	0	0	0	0	0	0
11:43:29	154	330	347	35	499	66	0	0	0	0	0	0	0	0
11:44:29	153	340	357	36	496	65	0	0	0	0	0	0	0	0
11:45:29	153	345	359	37	497	65	0	0	0	0	0	0	0	0
11:46:29	154	350	353	37	496	65	0	0.	0	0	0	0	0	0
11:47:29	154	350	356	37	497	65	0	0	0	0	0	0	0	0
11:48:29	153	350	360	38	497	65	0	0	0	0	0	0	0	0
11:49:29	153	340	355	38	496	64	0	0	0	0	0	0	0	0
11:50:29	153	345	356	38	497	65	0	0	0	0	0	0	0	0
11:51:29	153	355	359	39	497	64	0	0	0	0	0	0	0	0
11:52:29	153	355	355	39	497	64	0	0	0	0	0	0	0	0
11:53:29	153	355	351	39	496	64	0	0	0	0	0	0	0	0
11:54:29	153	335	350	39	495	65	0	0	0	0	0	0	0	0
11:55:29	153	350	347	39	494	66	0	0	0	0	0	0	0	0
11:56:29	153	355	348	40	493	66	0	0	0	0	0	0	0	0
11:57:29	153	330	347	39	493	66	0	0	0	0	0	0	0	0
11:58:29	153	360	348	39	493	66	0	0	0	0	0	0	0	0
11:59:29	202	360	51	28	211	66	0	0	0	0	0	0	0	0
12:00:29	205	0	18	14	117	66	0	0	0	0	0	0	0	0
12:01:29	205	0	13	11	94	65	0	0	0	0	0	0	0	0
12:02:29	205	0	9	10	81	64	0	0	0	0	0	0	0	0
12:03:29	205	0	8	9	77	64	0	0	0	0	0	0	0	0
12:04:29	205	0	7	8	73	64	0	0	0	0	0	0	0	0

5,5,1

.175

TIME HR:MN:SE	O2 (0%)	CO (ppm)	NO (ppm)	NO2 (ppm)	TEMP PROBE	TEMP ROOM	t4	t3	t2	t1	t5			SO2 (ppm)
12:05:29	205	0	6	8	72	64	0	0	0	0	0	0	0	0
12:06:29	205	0	5	7	71	65	0	0	0	0	0	0	0	0
12:07:29	205	0	5	7	70	66	0	0	0	0	0	0	0	0
12:08:29	171	0	365	8	860	66	0	0	0	0	0	0	0	0
12:09:29	102	320	886	29	875	67	0	0	0	0	0	0	0	0
12:10:29	102	380	899	29	875	67	0	0	0	0	0	0	0	0
12:11:29	102	395	900	29	876	67	0	0	0	0	0	0	0	0
12:12:29	102	390	890	28	875	68	0	0	0	0	0	0	0	0
12:13:29	102	380	892	28	878	69	0	0	0	0	0	0	0	0
12:14:29	102	375	888	28	876	69	0	0	0	0	0	0	0	0
12:15:29	102	370	888	28	877	69	0	0	0	0	0	0	0	0
12:16:29	102	365	895	28	879	70	0	0	0	0	0	0	0	0
12:17:29	102	370	892	28	880	70	0	0	0	0	0	0	0	0
12:18:29	102	365	895	28	880	70	0	0	0	0	0	0	0	0
12:19:29	102	355	893	27	881	69	0	0	0	0	0	0	0	0
12:20:29	102	365	899	27	881	68	0	0	0	0	0	0	0	0
12:21:29	102	360	902	27	881	68	0	0	0	0	0	0	0	0
12:22:29	102	350	892	27	881	68	0	0	0	0	0	0	0	0
12:23:29	102	340	891	27	882	68	0	0	0	0	0	0	0	0
12:24:29	102	335	892	27	881	68	0	0	0	0	0	0	0	0
12:25:29	129	340	557	26	460	68	0	0	0	0	0	0	0	0

908

APPENDIX B3.0

ENGINE 4 EMISSION DATA (ENERAC 2000E)

Engine 4 emission data were captured on the ENERAC 2000E ship chart recorder for all of May 10 and up until 15:29 hours on May 11. Beginning at 15:25 hours on May 11, a computer collected Engine 4 emissions data. Run numbers are annotated by hand on the strip chart.

SERIAL # 1E001121

Eng. 4 —

SERIAL # 1E001121

SERIAL # 1E001121

SERIAL # 1E001121

SERIAL # 1E001121

DATE:_05/10/95_____TIME:__08:53:03_____
MODE:PPM OXY_REF=TRUE%
SCALE: 4 TIME= 1sec

0	3.1	6.2	O	9.3	12.5
0	250	500	C	750	1000
75	81.2	87.5	E	93.5	100%
0	100	200	N	300	400

E . C . . N

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 09:54:06
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	70.6	%
AMBIENT TEMPERATURE:	73	°F
STACK TEMPERATURE:	364	°F
OXYGEN:	15.7	%
CARBON MONOXIDE:	331	PPM
CARBON DIOXIDE:	03.9	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	276	%
NITRIC OXIDE:	353	PPM
NITROGEN DIOXIDE:	93	PPM
NOX (NO + NO2):	445	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 09:57:47
DATE: 05/10/95

1.1.2

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	70.4	%
AMBIENT TEMPERATURE:	72	°F
STACK TEMPERATURE:	363	°F
OXYGEN:	15.7	%
CARBON MONOXIDE:	341	PPM
CARBON DIOXIDE:	03.9	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	276	%
NITRIC OXIDE:	351	PPM
NITROGEN DIOXIDE:	98	PPM
NOX (NO + NO2):	449	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

1.1.3

TIME: 10:01:04
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	70.6	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	361	°F
OXYGEN:	15.7	%
CARBON MONOXIDE:	321	PPM
CARBON DIOXIDE:	03.9	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	276	%
NITRIC OXIDE:	357	PPM
NITROGEN DIOXIDE:	100	PPM
NOX (NO + NO2):	457	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

1,1,2 —

TIME: 10:03:40
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	70.8	%
AMBIENT TEMPERATURE:	72	°F
STACK TEMPERATURE:	357	°F
OXYGEN:	15.8	%
CARBON MONOXIDE:	314	PPM
CARBON DIOXIDE:	03.8	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	282	%
NITRIC OXIDE:	337	PPM
NITROGEN DIOXIDE:	98	PPM
NOX (NO + NO2):	435	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

1,1,3

FOR: U.S.COAST GUARD

10.

TIME: 10:08:19
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	70.8	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	357	°F
OXYGEN:	15.7	%
CARBON MONOXIDE:	315	PPM
CARBON DIOXIDE:	03.9	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	276	%
NITRIC OXIDE:	341	PPM
NITROGEN DIOXIDE:	100	PPM
NOX (NO + NO2):	440	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

1,2,1

TIME: 10:24:16
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	72.0	%
AMBIENT TEMPERATURE:	72	°F
STACK TEMPERATURE:	438	°F
OXYGEN:	14.3	%
CARBON MONOXIDE:	404	PPM
CARBON DIOXIDE:	04.9	%
COMBUSTIBLE GASES:	0.03	%
EXCESS AIR:	199	%
NITRIC OXIDE:	597	PPM
NITROGEN DIOXIDE:	125	PPM
NOX (NO + NO2):	722	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

1,2,2

TIME: 10:27:04
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	72.1	%
AMBIENT TEMPERATURE:	7[illegible]	°F
STACK TEMPERATURE:	45[illegible]	°F
OXYGEN:	14.0	%
CARBON MONOXIDE:	405	PPM
CARBON DIOXIDE:	05.1	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	187	%
NITRIC OXIDE:	628	PPM
NITROGEN DIOXIDE:	130	PPM
NOX (NO + NO2):	758	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

SERIAL # 1E001121 ...ODEL 2000E

COMBUS

FOR: U .COAST GUARD

B.2.3

TIME: 10:30:21
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	70.7	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	455	°F
OXYGEN:	14.0	%
CARBON MONOXIDE:	393	PPM
CARBON DIOXIDE:	05.1	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	186	%
NITRIC OXIDE:	630	PPM
NITROGEN DIOXIDE:	131	PPM
NOX (NO + NO2):	760	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

B.3.1

TIME: 10:50:04
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	70.6	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	587	°F
OXYGEN:	12.0	%
CARBON MONOXIDE:	401	PPM
CARBON DIOXIDE:	06.6	%
COMBUSTIBLE GASES:	0.04	%
EXCESS AIR:	124	%
NITRIC OXIDE:	757	PPM
NITROGEN DIOXIDE:	154	PPM
NOX (NO + NO2):	911	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

R.3.2

TIME: 10:53:14
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	69.3	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	596	°F
OXYGEN:	11.9	%
CARBON MONOXIDE:	389	PPM
CARBON DIOXIDE:	06.6	%
COMBUSTIBLE GASES:	0.04	%
EXCESS AIR:	123	%
NITRIC OXIDE:	766	PPM
NITROGEN DIOXIDE:	[illegible]	PPM
NOX (NO + NO2):	[illegible]	
SULFUR DIOXIDE:		
CARBON MONOXIDE ALARM:	150[illegible]	

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

R.3.3

TIME: 10:56:12
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	69.3	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	601	°F
OXYGEN:	11.9	%
CARBON MONOXIDE:	379	PPM
CARBON DIOXIDE:	06.7	%
COMBUSTIBLE GASES:	0.06	%
EXCESS AIR:	122	%
NITRIC OXIDE:	763	PPM
NITROGEN DIOXIDE:	154	PPM
NOX (NO + NO2):	917	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

TIME: 10:59:03
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	69.1	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	604	°F
OXYGEN:	11.9	%
CARBON MONOXIDE:	369	PPM
CARBON DIOXIDE:	06.7	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	122	%
NITRIC OXIDE:	765	PPM
NITROGEN DIOXIDE:	155	PPM
NOX (NO + NO2):	920	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 11:17:05
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	67.5	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	730	°F
OXYGEN:	10.0	%
CARBON MONOXIDE:	454	PPM
CARBON DIOXIDE:	08.0	%
COMBUSTIBLE GASES:	0.08	%
EXCESS AIR:	85	%
NITRIC OXIDE:	872	PPM
NITROGEN DIOXIDE:	166	PPM
NOX (NO + NO2):	1037	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E

COMBUSTION TEST RECORD

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

1.4.1

TIME: 11:20:49
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	68.0	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	739	°F
OXYGEN:	10.1	%
CARBON MONOXIDE:	420	PPM
CARBON DIOXIDE:	08.0	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	86	%
NITRIC OXIDE:	877	PPM
NITROGEN DIOXIDE:	165	PPM
NOX (NO + NO2):	1041	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

1.4.2

TIME: 11:23:55
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	68.0	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	741	°F
OXYGEN:	10.0	%
CARBON MONOXIDE:	408	PPM
CARBON DIOXIDE:	08.0	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	85	%
NITRIC OXIDE:	879	PPM
NITROGEN DIOXIDE:	165	PPM
NOX (NO + NO2):	1043	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

1,4,13

TIME: 11:27:21
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	68.0	%
AMBIENT TEMPERATURE:	73	°F
STACK TEMPERATURE:	741	°F
OXYGEN:	10.1	%
CARBON MONOXIDE:	386	PPM
CARBON DIOXIDE:	08.[illegible]	%
COMBUSTIBLE GASES:	[illegible]	%
EXCESS AIR:	[illegible]	%
NITRIC OXIDE:	872	PPM
NITROGEN DIOXIDE:	163	PPM
NOX (NO + NO2):	1035	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

~~1,5,1~~

TIME: 11:45:05
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	66.5	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	382	°F
OXYGEN:	15.8	%
CARBON MONOXIDE:	238	PPM
CARBON DIOXIDE:	03.8	%
COMBUSTIBLE GASES:	0.09	%
EXCESS AIR:	285	%
NITRIC OXIDE:	336	PPM
NITROGEN DIOXIDE:	62	PPM
NOX (NO + NO2):	398	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

1.5.1

TIME: 11:48:02
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	70.7	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	366	°F
OXYGEN:	15.9	%
CARBON MONOXIDE:	232	PPM
CARBON DIOXIDE:	03.7	%
COMBUSTIBLE GASES:	0.03	%
EXCESS AIR:	294	%
NITRIC OXIDE:	308	PPM
NITROGEN DIOXIDE:	75	PPM
NOX (NO + NO2):	382	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

1.5.2

TIME: 11:51:42
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	71.6	%
AMBIENT TEMPERATURE:	69	°F
STACK TEMPERATURE:	361	°F
OXYGEN:	15.8	%
CARBON MONOXIDE:	234	PPM
CARBON DIOXIDE:	03.8	%
COMBUSTIBLE GASES:	0.04	%
EXCESS AIR:	285	%
NITRIC OXIDE:	312	PPM
NITROGEN DIOXIDE:	88	PPM
NOX (NO + NO2):	399	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E
COMBUSTION TEST RECORD

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

1.53

TIME: 11:54:41
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	70.2	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	358	°F
OXYGEN:	15.8	%
CARBON MONOXIDE:	234	PPM
CARBON DIOXIDE:	03.8	%
COMBUSTIBLE GASES:	0.08	%
EXCESS AIR:	284	%
NITRIC OXIDE:	316	PPM
NITROGEN DIOXIDE:	94	PPM
NOX (NO + NO2):	410	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 11:57:13
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	70.5	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	354	°F
OXYGEN:	15.8	%
CARBON MONOXIDE:	231	PPM
CARBON DIOXIDE:	03.8	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	284	%
NITRIC OXIDE:	311	PPM
NITROGEN DIOXIDE:	95	PPM
NOX (NO + NO2):	405	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

2.1.8

TIME: 12:00:58
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	68.8	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	350	°F
OXYGEN:	15.8	%
CARBON MONOXIDE:	232	PPM
CARBON DIOXIDE:	03.8	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	287	%
NITRIC OXIDE:	301	PPM
NITROGEN DIOXIDE:	97	PPM
NOX (NO + NO2):	398	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

2.1.9

TIME: 12:03:35
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	70.5	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	349	°F
OXYGEN:	15.9	%
CARBON MONOXIDE:	230	PPM
CARBON DIOXIDE:	03.7	%
COMBUSTIBLE GASES:	0.04	%
EXCESS AIR:	291	%
NITRIC OXIDE:	299	PPM
NITROGEN DIOXIDE:	99	PPM
NOX (NO + NO2):	397	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

2.13

TIME: 12:06:09
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	73.0	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	349	°F
OXYGEN:	15.7	%
CARBON MONOXIDE:	232	PPM
CARBON DIOXIDE:	03.9	%
COMBUSTIBLE GASES:	0.04	%
EXCESS AIR:	276	%
NITRIC OXIDE:	317	PPM
NITROGEN DIOXIDE:	104	PPM
NOX (NO + NO2):	421	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 12:09:36
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	72.9	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	349	°F
OXYGEN:	15.7	%
CARBON MONOXIDE:	231	PPM
CARBON DIOXIDE:	03.9	%
COMBUSTIBLE GASES:	0.04	%
EXCESS AIR:	278	%
NITRIC OXIDE:	315	PPM
NITROGEN DIOXIDE:	104	PPM
NOX (NO + NO2):	419	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 12:12:42
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	7:.0	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	349	°F
OXYGEN:	15.8	%
CARBON MONOXIDE:	229	PPM
CARBON DIOXIDE:	03.8	%
COMBUSTIBLE GASES:	0.06	%
EXCESS AIR:	282	%
NITRIC OXIDE:	311	PPM
NITROGEN DIOXIDE:	104	PPM
NOX (NO + NO2):	415	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 12:15:35
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	71.1	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	347	°F
OXYGEN:	15.8	%
CARBON MONOXIDE:	226	PPM
CARBON DIOXIDE:	03.8	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	284	%
NITRIC OXIDE:	308	PPM
NITROGEN DIOXIDE:	103	PPM
NOX (NO + NO2):	410	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

2.2.1

TIME: 12:30:27
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	70.8	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	366	°F
OXYGEN:	15.5	%
CARBON MONOXIDE:	233	PPM
CARBON DIOXIDE:	04.0	%
COMBUSTIBLE GASES:	0.06	%
EXCESS AIR:	265	%
NITRIC OXIDE:	349	PPM
NITROGEN DIOXIDE:	100	PPM
NOX (NO + NO2):	448	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

2.2.2

TIME: 12:33:18
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	70.6	%
AMBIENT TEMPERATURE:	69	°F
STACK TEMPERATURE:	365	°F
OXYGEN:	15.6	%
CARBON MONOXIDE:	232	PPM
CARBON DIOXIDE:	04.0	%
COMBUSTIBLE GASES:	0.06	%
EXCESS AIR:	268	%
NITRIC OXIDE:	347	PPM
NITROGEN DIOXIDE:	107	PPM
NOX (NO + NO2):	453	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

2,2,3

TIME: 12:36:02
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	72.2	%
AMBIENT TEMPERATURE:	69	°F
STACK TEMPERATURE:	365	°F
OXYGEN:	15.6	%
CARBON MONOXIDE:	231	PPM
CARBON DIOXIDE:	04.0	%
COMBUSTIBLE GASES:	0.04	%
EXCESS AIR:	268	%
NITRIC OXIDE:	347	PPM
NITROGEN DIOXIDE:	111	PPM
NOX (NO + NO2):	457	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 12:39:58

DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	71.2	%
AMBIENT TEMPERATURE:	69	°F
STACK TEMPERATURE:	370	°F
OXYGEN:	15.3	%
CARBON MONOXIDE:	234	PPM
CARBON DIOXIDE:	04.2	%
COMBUSTIBLE GASES:	0.04	%
EXCESS AIR:	252	%
NITRIC OXIDE:	381	PPM
NITROGEN DIOXIDE:	117	PPM
NOX (NO + NO2):	497	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 12:42:17
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	70.8	%
AMBIENT TEMPERATURE:	68	°F
STACK TEMPERATURE:	374	°F
OXYGEN:	15.3	%
CARBON MONOXIDE:	238	PPM
CARBON DIOXIDE:	04.1	%
COMBUSTIBLE GASES:	0.04	%
EXCESS AIR:	253	%
NITRIC OXIDE:	389	PPM
NITROGEN DIOXIDE:	119	PPM
NOX (NO + NO2):	507	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 12:45:04
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	70.8	%
AMBIENT TEMPERATURE:	68	°F
STACK TEMPERATURE:	374	°F
OXYGEN:	15.3	%
CARBON MONOXIDE:	236	PPM
CARBON DIOXIDE:	04.1	%
COMBUSTIBLE GASES:	0.03	%
EXCESS AIR:	253	%
NITRIC OXIDE:	389	PPM
NITROGEN DIOXIDE:	119	PPM
NOX (NO + NO2):	507	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

2,3,1

TIME: 13:00:43
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	69.8	%
AMBIENT TEMPERATURE:	69	°F
STACK TEMPERATURE:	589	°F
OXYGEN:	11.9	%
CARBON MONOXIDE:	252	PPM
CARBON DIOXIDE:	06.7	%
COMBUSTIBLE GASES:	0.06	%
EXCESS AIR:	121	%
NITRIC OXIDE:	753	PPM
NITROGEN DIOXIDE:	161	PPM
NOX (NO + NO2):	913	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

2,3,2

TIME: 13:03:46
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	69.5	%
AMBIENT TEMPERATURE:	68	°F
STACK TEMPERATURE:	591	°F
OXYGEN:	12.0	%
CARBON MONOXIDE:	242	PPM
CARBON DIOXIDE:	06.6	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	124	%
NITRIC OXIDE:	749	PPM
NITROGEN DIOXIDE:	160	PPM
NOX (NO + NO2):	908	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

2,3,3

TIME: 13:06:16
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	69.4	%
AMBIENT TEMPERATURE:	68	°F
STACK TEMPERATURE:	592	°F
OXYGEN:	12.0	%
CARBON MONOXIDE:	242	PPM
CARBON DIOXIDE:	06.6	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	123	%
NITRIC OXIDE:	753	PPM
NITROGEN DIOXIDE:	161	PPM
NOX (NO + NO2):	914	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 13:10:23
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

[illegible]ON EFFICIENCY:	69.[illegible]	[illegible]
AMBIENT TEMPERATURE:	68	°F
STACK TEMPERATURE:	594	°F
OXYGEN:	12.0	%
CARBON MONOXIDE:	235	PPM
CARBON DIOXIDE:	06.6	%
COMBUSTIBLE GASES:	0.03	%
EXCESS AIR:	124	%
NITRIC OXIDE:	750	PPM
NITROGEN DIOXIDE:	161	PPM
NOX (NO + NO2):	911	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 13:13:06
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	69.3	%
AMBIENT TEMPERATURE:	68	°F
STACK TEMPERATURE:	596	°F
OXYGEN:	11.9	%
CARBON MONOXIDE:	235	PPM
CARBON DIOXIDE:	06.6	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	123	%
NITRIC OXIDE:	750	PPM
NITROGEN DIOXIDE:	161	PPM
NOX (NO + NO2):	911	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 13:15:02
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	69.3	%
AMBIENT TEMPERATURE:	68	°F
STACK TEMPERATURE:	596	°F
OXYGEN:	11.9	%
CARBON MONOXIDE:	230	PPM
CARBON DIOXIDE:	06.7	%
COMBUSTIBLE GASES:	0.06	%
EXCESS AIR:	122	%
NITRIC OXIDE:	751	PPM
NITROGEN DIOXIDE:	161	PPM
NOX (NO + NO2):	912	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

2,4,1

TIME: 13:30:55
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	66.8	%
AMBIENT TEMPERATURE:	69	°F
STACK TEMPERATURE:	749	°F
OXYGEN:	10.0	%
CARBON MONOXIDE:	281	PPM
CARBON DIOXIDE:	08.0	%
COMBUSTIBLE GASES:	0.09	%
EXCESS AIR:	85	%
NITRIC OXIDE:	859	PPM
NITROGEN DIOXIDE:	167	PPM
NOX (NO + NO2):	1025	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

2,4,2

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 13:33:28
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	67.6	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	750	°F
OXYGEN:	10.0	%
CARBON MONOXIDE:	272	PPM
CARBON DIOXIDE:	08.0	%
COMBUSTIBLE GASES:	0.08	%
EXCESS AIR:	85	%
NITRIC OXIDE:	857	PPM
NITROGEN DIOXIDE:	167	PPM
NOX (NO + NO2):	1024	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

2.4.3

TIME: 13:36:44
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	66.7	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	751	°F
OXYGEN:	10.0	%
CARBON MONOXIDE:	262	PPM
CARBON DIOXIDE:	08.0	%
COMBUSTIBLE GASES:	0.10	%
EXCESS AIR:	85	%
NITRIC OXIDE:	853	PPM
NITROGEN DIOXIDE:	167	PPM
NOX (NO + NO2):	1020	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 13:39:01
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	66.7	%
AMBIENT TEMPERATURE:	72	°F
STACK TEMPERATURE:	752	°F
OXYGEN:	10.0	%
CARBON MONOXIDE:	258	PPM
CARBON DIOXIDE:	08.0	%
COMBUSTIBLE GASES:	0.09	%
EXCESS AIR:	86	%
NITRIC OXIDE:	846	PPM
NITROGEN DIOXIDE:	164	PPM
NOX (NO + NO2):	1010	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

2,5,1

TIME: 14:00:21
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	71.1	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	443	°F
OXYGEN:	14.1	%
CARBON MONOXIDE:	250	PPM
CARBON DIOXIDE:	05.1	%
COMBUSTIBLE GASES:	0.06	%
EXCESS AIR:	189	%
NITRIC OXIDE:	587	PPM
NITROGEN DIOXIDE:	114	PPM
NOX (NO + NO2):	700	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

~~2,5,1~~ 3,1,1

TIME: 14:03:12
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	69.9	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	440	°F
OXYGEN:	14.0	%
CARBON MONOXIDE:	251	PPM
CARBON DIOXIDE:	05.1	%
COMBUSTIBLE GASES:	0.09	%
EXCESS AIR:	188	%
NITRIC OXIDE:	582	PPM
NITROGEN DIOXIDE:	122	PPM
NOX (NO + NO2):	703	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E

FOR: U.S.COAST GUARD

3.1.2

TIME: 14:06:02
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	70.1	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	434	°F
OXYGEN:	14.1	%
CARBON MONOXIDE:	249	PPM
CARBON DIOXIDE:	05.1	%
COMBUSTIBLE GASES:	0.10	%
EXCESS AIR:	189	%
NITRIC OXIDE:	573	PPM
NITROGEN DIOXIDE:	127	PPM
NOX (NO + NO2):	699	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

3.1.3

TIME: 14:09:03

DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	70.1	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	432	°F
OXYGEN:	14.1	%
CARBON MONOXIDE:	248	PPM
CARBON DIOXIDE:	05.1	%
COMPUSTIBLE GASES:	0.09	%
EXCESS AIR:	191	%
NITRIC OXIDE:	567	PPM
NITROGEN DIOXIDE:	131	PPM
NOX (NO + NO2):	697	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD (2.5.1)

TIME: 14:34:20
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	69.1	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	466	°F
OXYGEN:	14.3	%
CARBON MONOXIDE:	258	PPM
CARBON DIOXIDE:	04.9	%
COMBUSTIBLE GASES:	0.02	%
EXCESS AIR:	197	%
NITRIC OXIDE:	558	PPM
NITROGEN DIOXIDE:	113	PPM
NOX (NO + NO2):	671	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD (2.5.2)

TIME: 14:37:00
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	67.4	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	472	°F
OXYGEN:	14.2	%
CARBON MONOXIDE:	251	PPM
CARBON DIOXIDE:	04.9	%
COMBUSTIBLE GASES:	0.08	%
EXCESS AIR:	197	%
NITRIC OXIDE:	564	PPM
NITROGEN DIOXIDE:	115	PPM
NOX (NO + NO2):	679	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

(2.5.3)

TIME: 14:39:37
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	68.5	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	473	°F
OXYGEN:	14.3	%
CARBON MONOXIDE:	249	PPM
CARBON DIOXIDE:	04.9	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	199	%
NITRIC OXIDE:	566	PPM
NITROGEN DIOXIDE:	119	PPM
NOX (NO + NO2):	684	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 14:41:47
DATE: 05/10/95

FUEL #2 FUEL OIL,AMERADA HESS

COMBUSTION EFFICIENCY:	68.4	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	473	°F
OXYGEN:	14.3	%
CARBON MONOXIDE:	251	PPM
CARBON DIOXIDE:	04.9	%
COMBUSTIBLE GASES:	0.05	%
EXCESS AIR:	201	%
NITRIC OXIDE:	558	PPM
NITROGEN DIOXIDE:	120	PPM
NOX (NO + NO2):	678	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121
ENERAC MODEL 2000E

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

3.2.1

TIME: 14:55:41
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	67.1	%
AMBIENT TEMPERATURE:	70	°F
STACK TEMPERATURE:	753	°F
OXYGEN:	10.2	%
CARBON MONOXIDE:	271	PPM
CARBON DIOXIDE:	07.9	%
COMBUSTIBLE GASES:	0.03	%
EXCESS AIR:	88	%
NITRIC OXIDE:	844	PPM
NITROGEN DIOXIDE:	159	PPM
NOX (NO + NO2):	1002	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

3.2.2

TIME: 14:58:08
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	67.7	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	758	°F
OXYGEN:	10.2	%
CARBON MONOXIDE:	265	PPM
CARBON DIOXIDE:	07.9	%
COMBUSTIBLE GASES:	0.03	%
EXCESS AIR:	88	%
NITRIC OXIDE:	842	PPM
NITROGEN DIOXIDE:	157	PPM
NOX (NO + NO2):	999	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD 3.2.3

TIME: 15:01:02
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	66.9	%
AMBIENT TEMPERATURE:	71	°F
STACK TEMPERATURE:	763	°F
OXYGEN:	10.2	%
CARBON MONOXIDE:	260	PPM
CARBON DIOXIDE:	07.9	%
COMBUSTIBLE GASES:	0.04	%
EXCESS AIR:	87	%
NITRIC OXIDE:	845	PPM
NITROGEN DIOXIDE:	158	PPM
NOX (NO + NO2):	1002	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E
COMBUSTION TEST RECORD

FOR: U.S.COAST GUARD

TIME: 15:04:02
DATE: 05/10/95

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	67.6	%
AMBIENT TEMPERATURE:	72	°F
STACK TEMPERATURE:	764	°F
OXYGEN:	10.2	%
CARBON MONOXIDE:	251	PPM
CARBON DIOXIDE:	07.9	%
COMBUSTIBLE GASES:	0.02	%
EXCESS AIR:	88	%
NITRIC OXIDE:	839	PPM
NITROGEN DIOXIDE:	158	PPM
NOX (NO + NO2):	997	PPM
SULFUR DIOXIDE:	0	PPM
CARBON MONOXIDE ALARM:	1500	PPM

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E
COMBUSTION TEST RECORD

MODE:PPM OXY_REF=TRUE%

SERIAL # 1E001121

ENERAC MODEL 2000E

COMBUSTION TEST RECORD

FOR: U.S.COAST ~~GD~~

TIME: 15:29:24
DATE: 05/10/95

3,302

FUEL #2 FUEL OIL.AMERADA HESS

COMBUSTION EFFICIENCY:	68.9	%
AMBIENT TEMPERATURE:	73	°F
STACK TEMPERATURE:	618	°F
OXYGEN:	12.1	%
CARBON MONOXIDE:	229	PPM
CARBON DIOXIDE:	06.5	%
COMBUSTIBLE GASES:	0.02	%

TIME (HR: MN: SE)	DATE	COMB. EFFIC. %	TEMP AMB. (°F)	TEMP STACK (°F)	O2 (%) BY VOL	CO (ppm)	CO2 (ppm)			NO (ppm)	NO2 (ppm)	NOx (ppm)	SO2 (ppm)
15:25:58	05/10/95	0.0	73	0	21.1	0	0.0	0.00	OVER	0	0	0	0
15:26:35	05/10/95	0.0	73	0	21.1	0	0.0	0.00	OVER	0	0	0	0
15:27:12	05/10/95	0.0	73	0	21.1	0	0.0	0.00	OVER	0	0	0	0
15:27:49	05/10/95	0.0	73	0	21.1	0	0.0	0.00	OVER	0	0	0	0
15:28:26	05/10/95	73.9	73	413	14.0	114	5.1	0.00	188	276	14	289	0
15:29:04	05/10/95	69.6	73	594	12.3	218	6.4	0.00	131	654	97	751	0
15:29:17	05/10/95	69.1	73	611	12.2	226	6.5	0.00	129	683	112	795	0
15:29:41	05/10/95	68.7	73	627	12.1	232	6.5	0.00	126	705	128	833	0
15:30:18	05/10/95	68.4	73	632	12.1	235	6.5	0.00	127	717	137	853	0
15:30:55	05/10/95	67.4	72	634	12.1	233	6.5	0.02	126	719	140	858	0
15:31:32	05/10/95	68.5	72	633	12.0	232	6.6	0.00	125	721	140	861	0
15:32:09	05/10/95	68.6	72	633	12.0	234	6.6	0.00	124	726	141	867	0
15:32:46	05/10/95	68.5	72	636	12.0	230	6.6	0.00	124	727	141	868	0
15:33:23	05/10/95	68.5	72	635	12.0	230	6.6	0.03	124	732	143	875	0
15:34:00	05/10/95	68.5	72	633	12.0	229	6.6	0.00	125	729	143	871	0
15:34:37	05/10/95	67.5	71	632	12.0	231	6.6	0.02	125	731	143	873	0
15:35:14	05/10/95	68.5	71	635	12.0	229	6.6	0.00	124	735	144	878	0
15:35:51	05/10/95	67.6	71	635	12.0	226	6.6	0.03	123	731	143	874	0
15:36:28	05/10/95	68.6	71	635	11.9	223	6.6	0.00	123	731	143	874	0
15:37:05	05/10/95	68.6	71	635	12.0	223	6.6	0.03	123	735	144	879	0
15:37:42	05/10/95	67.5	71	635	12.0	223	6.6	0.03	124	733	144	877	0
15:38:19	05/10/95	67.6	71	635	12.0	224	6.6	0.05	123	733	144	877	0
15:38:56	05/10/95	67.6	71	635	12.0	223	6.6	0.04	123	734	144	878	0
15:39:33	05/10/95	67.5	71	635	12.0	222	6.6	0.05	124	733	144	877	0
15:40:10	05/10/95	65.5	71	568	13.8	219	5.3	0.04	178	732	144	875	0
15:46:53	05/10/95	0.0	72	0	21.1	0	0.0	0.00	OVER	0	0	0	0
15:47:50	05/10/95	0.0	72	0	21.1	0	0.0	0.00	OVER	0	0	0	0
15:48:47	05/10/95	0.0	72	0	21.1	0	0.0	0.00	OVER	0	0	0	0
15:49:44	05/10/95	0.0	73	0	21.1	0	0.0	0.00	OVER	0	0	0	0
15:50:41	05/10/95	OVER	73	27	20.4	0	0.5	0.00	OVER	0	0	0	0
15:51:38	05/10/95	71.2	72	360	15.9	182	3.7	0.00	293	289	64	352	0
15:52:35	05/10/95	66.5	72	410	15.8	215	3.8	0.03	283	334	78	411	4
15:53:32	05/10/95	67.9	72	414	15.8	214	3.8	0.03	283	328	88	416	0
15:54:29	05/10/95	68.2	71	411	15.8	209	3.8	0.02	282	329	97	425	0
15:55:26	05/10/95	68.5	71	409	15.7	210	3.9	0.00	280	330	105	435	0
15:56:23	05/10/95	68.7	71	406	15.7	209	3.9	0.00	279	330	111	441	0
15:57:20	05/10/95	68.6	71	403	15.8	208	3.8	0.00	283	320	112	432	0
15:58:17	05/10/95	68.8	71	401	15.8	214	3.8	0.00	283	313	115	428	0
15:59:14	05/10/95	68.9	71	399	15.8	217	3.8	0.02	285	308	116	424	0
16:00:11	05/10/95	68.8	71	397	15.9	217	3.8	0.00	289	299	115	413	0
16:01:08	05/10/95	68.9	71	392	15.9	209	3.7	0.02	293	291	114	405	4
16:02:05	05/10/95	67.5	71	389	15.9	210	3.7	0.02	291	291	115	406	0
16:03:02	05/10/95	69.5	71	389	15.8	214	3.8	0.02	287	294	118	411	0
16:03:59	05/10/95	69.7	71	387	15.8	217	3.8	0.02	287	295	120	415	0
16:04:56	05/10/95	68.1	70	386	15.8	213	3.8	0.02	285	302	120	421	0
16:05:53	05/10/95	68.2	70	386	15.8	211	3.8	0.02	283	306	122	427	0
16:06:50	05/10/95	70.3	70	385	15.7	214	3.9	0.00	280	311	124	435	0
16:07:47	05/10/95	70.3	71	384	15.7	220	3.9	0.00	280	310	125	434	0
16:08:44	05/10/95	70.2	71	384	15.8	214	3.8	0.02	282	310	125	434	0
16:09:41	05/10/95	70.2	70	382	15.8	209	3.8	0.00	281	309	123	431	0
16:10:38	05/10/95	70.4	70	382	15.7	211	3.9	0.02	278	313	124	437	0
16:11:35	05/10/95	70.4	70	381	15.7	212	3.9	0.00	280	316	124	439	0
16:12:32	05/10/95	70.3	71	379	15.8	207	3.8	0.00	285	304	121	425	0
16:13:29	05/10/95	74.0	70	406	14.2	230	5.0	0.00	194	403	132	535	0
16:14:26	05/10/95	75.4	70	490	11.7	232	6.8	0.02	118	669	159	827	0
16:15:23	05/10/95	67.7	70	474	14.5	218	4.7	0.03	209	635	144	779	0
16:16:20	05/10/95	65.8	70	424	16.0	191	3.7	0.02	301	324	89	412	5
16:17:17	05/10/95	66.8	70	403	16.1	189	3.6	0.00	311	278	87	365	0
16:18:14	05/10/95	67.9	70	393	16.1	193	3.6	0.02	306	270	94	363	0
16:19:11	05/10/95	68.7	71	387	16.0	194	3.6	0.02	303	273	101	374	0
16:20:08	05/10/95	69.1	71	382	16.1	193	3.6	0.00	303	268	102	370	0
16:21:05	05/10/95	69.5	71	379	16.0	195	3.7	0.00	299	269	106	375	4
16:22:02	05/10/95	69.8	71	377	16.0	198	3.7	0.02	298	277	110	387	4

	TIME (HR: MN: SE)	DATE	COMB. EFFIC. %	TEMP AMB. (°F)	TEMP STACK (°F)	O2 (%) BY VOL	CO (ppm)	CO2 (ppm)			NO (ppm)	NO2 (ppm)	NOx (ppm)	SO2 (ppm)
	16:22:59	05/10/95	69.9	71	375	16.0	196	3.7	0.02	298	279	111	390	0
	16:23:56	05/10/95	70.2	71	372	16.0	196	3.7	0.02	297	277	112	389	0
3.5.2	16:24:53	05/10/95	68.9	71	372	15.9	200	3.8	0.02	289	287	115	401	0
	16:25:50	05/10/95	70.5	70	371	15.9	200	3.7	0.00	291	289	118	407	0
	16:26:47	05/10/95	70.4	70	370	15.9	199	3.7	0.02	293	284	117	400	0
	16:27:44	05/10/95	70.6	71	369	15.9	203	3.7	0.00	293	282	116	398	0
3.513	16:28:41	05/10/95	70.7	71	369	15.9	205	3.7	0.02	291	284	119	403	0
	16:29:38	05/10/95	70.6	70	369	15.9	205	3.7	0.00	292	282	118	400	0
0	16:30:35	05/10/95	70.6	70	366	16.0	204	3.7	0.02	297	275	117	391	0
	16:31:32	05/10/95	68.8	71	365	16.0	204	3.7	0.03	301	265	115	379	0
	16:32:29	05/10/95	70.4	71	365	16.0	205	3.6	0.02	303	261	114	374	4
	16:33:26	05/10/95	49.2	71	276	20.2	95	0.6	0.00	OVER	122	75	196	40
	08:06:25	05/11/95	0.0	71	70	21.0	0	0.0	0.00	OVER	0	0	0	0
	08:07:22	05/11/95	0.0	72	70	21.0	0	0.0	0.02	OVER	0	0	0	0
	08:08:19	05/11/95	0.0	72	69	20.9	0	0.0	0.00	OVER	0	0	0	0
	08:09:16	05/11/95	0.0	72	69	21.0	0	0.0	0.00	OVER	0	0	0	0
	08:13:55	05/11/95	63.3	72	426	16.1	270	3.6	0.06	310	274	88	361	7
	08:14:52	05/11/95	62.6	72	442	16.1	276	3.6	0.08	304	283	96	379	2
	08:15:49	05/11/95	62.6	71	445	16.0	278	3.7	0.09	299	290	104	393	4
	08:16:46	05/11/95	62.9	71	446	15.9	278	3.7	0.08	295	294	109	402	6
	08:17:43	05/11/95	61.0	71	449	15.9	283	3.7	0.09	291	308	114	421	0
0	08:18:40	05/11/95	60.9	70	447	15.9	282	3.7	0.10	294	304	117	420	0
	08:19:37	05/11/95	60.8	70	449	15.9	278	3.7	0.10	293	304	115	419	0
	08:20:34	05/11/95	60.8	70	447	15.9	276	3.7	0.09	295	303	115	418	0
	08:21:31	05/11/95	60.6	70	447	16.0	273	3.7	0.09	298	295	114	408	0
	08:22:28	05/11/95	60.6	69	446	16.0	273	3.7	0.10	298	295	116	410	0
	08:23:25	05/11/95	60.7	69	446	16.0	274	3.7	0.10	296	298	117	414	0
	08:38:40	05/11/95	66.2	72	412	15.8	270	3.8	0.03	283	318	100	418	0
50	08:39:37	05/11/95	62.7	72	442	15.7	283	3.9	0.09	276	343	112	455	0
	08:40:34	05/11/95	62.4	71	450	15.7	285	3.9	0.09	274	349	116	465	0
	08:41:31	05/11/95	64.0	71	452	15.7	288	3.9	0.05	274	351	120	470	0
	08:42:28	05/11/95	63.9	71	452	15.7	284	3.9	0.08	276	344	120	464	0
	08:43:25	05/11/95	62.0	70	451	15.7	282	3.9	0.08	276	345	120	465	0
	08:44:22	05/11/95	61.7	70	452	15.7	282	3.9	0.08	277	341	122	462	0
	08:45:19	05/11/95	63.6	70	453	15.7	280	3.9	0.06	279	335	120	455	0
	08:46:16	05/11/95	63.5	70	452	15.8	277	3.8	0.05	281	332	120	452	0
	08:47:13	05/11/95	63.5	71	452	15.7	276	3.9	0.08	280	330	120	449	0
	08:48:10	05/11/95	61.7	71	454	15.7	279	3.9	0.10	277	334	121	455	0
	08:49:07	05/11/95	61.7	71	455	15.7	276	3.9	0.08	277	339	121	460	0
	08:50:04	05/11/95	63.4	71	455	15.7	273	3.9	0.09	279	336	121	457	0
	08:51:01	05/11/95	61.6	71	455	15.7	271	3.9	0.09	279	332	120	451	0
	08:51:58	05/11/95	61.6	71	452	15.8	276	3.8	0.08	281	329	121	450	0
	08:52:55	05/11/95	61.9	71	453	15.7	270	3.9	0.09	277	332	119	450	0
	08:53:52	05/11/95	62.1	71	455	15.6	274	3.9	0.10	272	346	121	467	0
	08:54:49	05/11/95	62.0	71	455	15.7	273	3.9	0.08	274	348	123	470	0
	08:55:46	05/11/95	53.7	70	390	17.7	259	2.4	0.09	506	334	122	455	1
	08:56:43	05/11/95	0.0	70	211	20.7	30	0.2	0.05	OVER	37	26	63	20
	08:57:40	05/11/95	0.0	70	128	20.8	8	0.0	0.00	OVER	7	6	12	6
	08:58:37	05/11/95	0.0	70	92	20.9	6	0.0	0.00	OVER	5	4	9	6
100	09:05:07	05/11/95	66.3	71	513	14.3	340	4.9	0.08	198	576	137	712	0
	09:06:04	05/11/95	64.1	71	527	14.3	344	4.9	0.08	197	587	137	723	0
	09:07:01	05/11/95	65.5	71	531	14.2	344	5.0	0.09	196	591	139	729	0
	09:07:58	05/11/95	63.9	71	534	14.2	345	5.0	0.09	195	591	143	734	0
	09:08:55	05/11/95	65.3	71	537	14.2	343	5.0	0.08	194	597	145	742	0
	09:09:52	05/11/95	63.8	71	540	14.2	340	5.0	0.09	194	601	147	747	0
33	09:10:49	05/11/95	63.7	71	542	14.2	334	5.0	0.09	194	599	148	746	0
	09:11:46	05/11/95	63.8	71	544	14.1	330	5.1	0.09	191	603	149	752	0
	09:12:43	05/11/95	65.4	71	546	14.0	335	5.1	0.09	187	615	152	766	0
	09:13:40	05/11/95	65.2	70	545	14.1	335	5.1	0.08	190	612	154	765	0
	09:14:37	05/11/95	63.6	70	546	14.1	334	5.0	0.09	192	605	152	757	0
	09:15:34	05/11/95	63.7	70	545	14.1	334	5.1	0.09	191	602	152	754	0
	09:16:31	05/11/95	63.6	70	548	14.1	333	5.1	0.09	190	603	152	755	0
	09:17:28	05/11/95	63.6	69	549	14.0	329	5.1	0.09	188	611	154	765	0
	09:18:25	05/11/95	63.6	69	549	14.0	331	5.1	0.09	188	610	154	763	0
	09:19:22	05/11/95	63.6	69	549	14.0	329	5.1	0.08	188	609	154	763	0
140	09:20:19	05/11/95	63.8	69	549	14.0	324	5.1	0.09	188	611	155	766	0
	09:28:30	05/11/95	68.0	72	514	14.1	173	5.0	0.02	191	310	17	327	0
	09:29:27	05/11/95	64.5	72	680	12.0	348	6.6	0.09	124	740	127	866	0
	09:30:24	05/11/95	62.9	71	699	11.9	359	6.7	0.10	121	766	151	916	0

	TIME (HR: MN: SE)	DATE	COMB. EFFIC. %	TEMP AMB. (°F)	TEMP STACK (°F)	O2 (%) BY VOL	CO (ppm)	CO2 (ppm)			NO (ppm)	NO2 (ppm)	NOx (ppm)	SO2 (ppm)
140	09:31:21	05/11/95	64.9	71	703	11.9	351	6.7	0.10	121	771	152	922	0
	09:32:18	05/11/95	64.8	70	704	11.9	343	6.7	0.09	121	776	152	927	0
	09:33:15	05/11/95	63.8	70	708	11.8	342	6.7	0.09	120	780	154	933	0
	09:34:12	05/11/95	63.7	70	710	11.8	341	6.8	0.09	119	780	154	933	0
	09:35:09	05/11/95	62.5	70	711	11.8	335	6.7	0.10	120	782	154	935	0
2,4,3	09:36:06	05/11/95	63.5	70	710	11.9	326	6.7	0.09	121	783	155	937	0
	09:37:03	05/11/95	63.5	70	710	11.8	321	6.7	0.09	121	783	155	937	0
	09:38:00	05/11/95	63.5	70	712	11.8	316	6.7	0.10	120	781	155	935	0
	09:38:57	05/11/95	64.4	70	713	11.8	315	6.7	0.08	120	781	155	936	0
	09:39:54	05/11/95	63.5	70	712	11.8	312	6.7	0.10	120	785	155	940	0
	09:40:51	05/11/95	63.3	70	712	11.9	310	6.7	0.09	121	783	156	938	0
	09:41:48	05/11/95	63.4	70	715	11.8	307	6.7	0.09	120	782	156	938	0
	09:42:45	05/11/95	63.5	70	715	11.8	303	6.7	0.10	120	785	156	941	0
	09:43:42	05/11/95	63.4	70	715	11.8	300	6.7	0.09	120	784	156	940	0
	09:50:54	05/11/95	65.6	71	711	11.4	231	7.0	0.04	111	546	33	578	0
	09:51:51	05/11/95	64.1	70	837	9.8	368	8.2	0.11	81	899	151	105	0
	09:52:48	05/11/95	62.9	70	849	9.7	361	8.2	0.11	81	919	164	1080	0
	09:53:45	05/11/95	63.6	70	854	9.7	354	8.3	0.11	80	926	164	1092	0
	09:54:42	05/11/95	63.4	70	859	9.7	344	8.2	0.11	81	929	165	1090	0
175	09:55:39	05/11/95	63.3	70	862	9.7	341	8.2	0.11	81	929	165	1094	0
	09:56:36	05/11/95	63.2	70	864	9.7	334	8.2	0.13	81	933	165	1093	0
	09:57:33	05/11/95	62.3	70	869	9.7	334	8.3	0.10	80	933	165	1098	0
	09:58:30	05/11/95	63.1	70	871	9.7	332	8.3	0.11	80	936	165	1108	0
	09:59:27	05/11/95	63.1	71	869	9.7	334	8.3	0.10	80	934	165	1091	0
	10:00:24	05/11/95	62.2	71	870	9.7	332	8.2	0.11	81	930	165	1098	0
2,5,3	10:01:21	05/11/95	62.2	71	870	9.7	325	8.2	0.13	81	930	164	1095	0
	10:02:18	05/11/95	63.0	72	870	9.8	324	8.2	0.13	81	923	164	1084	0
	10:03:15	05/11/95	62.1	72	870	9.8	321	8.2	0.13	81	927	164	1096	0
	10:04:12	05/11/95	63.0	72	870	9.8	317	8.2	0.13	81	927	164	1091	0
	10:05:09	05/11/95	62.1	72	870	9.8	314	8.2	0.13	81	925	164	1080	0
	10:06:06	05/11/95	63.0	72	869	9.8	308	8.2	0.11	82	923	164	1088	0
	10:07:03	05/11/95	62.1	73	871	9.8	305	8.2	0.13	81	922	163	1086	0
	10:07:60	05/11/95	8.2	73	549	18.6	140	1.7	0.11	750	490	134	628	0
	10:08:57	05/11/95	0.0	73	294	20.7	17	0.2	0.04	OVER	40	16	56	21
140	10:09:54	05/11/95	0.0	73	167	20.8	9	0.2	0.02	OVER	14	4	18	8
	10:10:51	05/11/95	0.0	73	107	20.8	8	0.0	0.00	OVER	10	4	14	6
	10:22:45	05/11/95	63.3	73	725	11.7	263	6.8	0.11	118	768	127	894	0
	10:23:42	05/11/95	63.1	73	732	11.7	263	6.8	0.11	118	783	139	922	0
	10:24:39	05/11/95	63.0	73	732	11.7	258	6.8	0.11	118	783	141	923	0
	10:25:36	05/11/95	63.1	73	732	11.7	258	6.8	0.11	117	788	141	928	0
	10:26:33	05/11/95	63.2	73	729	11.7	259	6.8	0.11	118	791	142	932	0
	10:27:30	05/11/95	63.3	72	728	11.7	260	6.8	0.11	118	793	142	935	0
	10:28:27	05/11/95	63.3	72	728	11.7	257	6.8	0.11	117	793	142	935	0
	10:29:24	05/11/95	64.4	72	728	11.7	257	6.8	0.09	117	792	142	934	0
	10:30:21	05/11/95	63.4	72	726	11.7	256	6.8	0.11	117	793	142	935	0
	10:31:18	05/11/95	63.4	72	726	11.7	253	6.8	0.09	117	795	144	938	0
	10:32:15	05/11/95	63.4	71	725	11.7	254	6.8	0.09	117	795	144	938	0
	10:33:12	05/11/95	63.5	71	723	11.7	252	6.8	0.11	117	795	144	939	0
	10:34:09	05/11/95	62.6	71	723	11.6	252	6.9	0.10	116	798	145	943	0
	10:35:06	05/11/95	63.5	71	723	11.7	254	6.8	0.11	117	798	145	943	0
	10:36:03	05/11/95	63.5	71	723	11.7	252	6.8	0.11	117	797	145	942	0
	10:36:60	05/11/95	64.8	71	727	11.5	247	6.9	0.09	113	798	144	941	0
	10:37:57	05/11/95	63.9	72	729	11.5	243	7.0	0.11	112	799	144	942	0
	10:38:54	05/11/95	53.8	72	598	15.4	223	4.1	0.13	258	775	144	918	0
	10:55:40	05/11/95	72.7	73	274	17.1	47	2.9	0.00	410	62	5	66	0
100	10:56:37	05/11/95	63.8	73	542	14.2	253	5.0	0.11	194	572	94	665	0
	10:57:34	05/11/95	62.3	73	573	14.1	268	5.1	0.10	191	606	119	724	0
	10:58:31	05/11/95	60.9	73	575	14.1	264	5.1	0.15	189	605	127	732	0
	10:59:28	05/11/95	61.1	73	577	14.0	263	5.1	0.15	186	612	133	745	0
	11:00:25	05/11/95	62.4	73	575	14.0	267	5.1	0.11	188	605	137	741	0
	11:01:22	05/11/95	62.2	73	573	14.1	263	5.1	0.10	190	600	138	737	0
	11:02:19	05/11/95	60.7	73	572	14.1	262	5.0	0.15	192	592	139	731	0
	11:03:16	05/11/95	60.9	73	570	14.1	263	5.0	0.15	192	588	140	727	0
	11:04:13	05/11/95	61.0	73	570	14.1	259	5.1	0.15	191	587	141	727	0
	11:05:10	05/11/95	61.0	73	568	14.1	259	5.0	0.15	192	584	142	725	0
	11:06:07	05/11/95	62.6	73	569	14.1	254	5.1	0.10	191	586	142	728	0
	11:07:04	05/11/95	61.0	73	568	14.1	257	5.0	0.15	192	585	143	728	0
	11:08:01	05/11/95	63.2	73	573	13.9	259	5.2	0.10	182	597	144	741	0
	11:08:58	05/11/95	63.5	73	576	13.8	262	5.3	0.10	178	621	148	769	0

TIME (HR: MN: SE)	DATE	COMB. EFFIC. %	TEMP AMB. (°F)	TEMP STACK (°F)	O2 (%) BY VOL	CO (ppm)	CO2 (ppm)			NO (ppm)	NO2 (ppm)	NOx (ppm)	SO2 (ppm)
11:09:55	05/11/95	62.0	73	576	13.8	259	5.3	0.15	178	627	150	776	0
11:10:52	05/11/95	59.7	73	567	14.4	256	4.8	0.15	203	594	147	740	0
11:11:49	05/11/95	57.4	72	542	15.1	232	4.3	0.15	239	474	127	600	0
11:12:46	05/11/95	55.7	72	521	15.6	215	4.0	0.15	270	384	110	493	0
11:13:43	05/11/95	56.0	71	508	15.7	210	3.9	0.15	276	344	102	446	0
11:14:40	05/11/95	56.5	71	501	15.7	215	3.9	0.14	277	335	104	438	0
11:15:37	05/11/95	58.8	71	496	15.7	218	3.9	0.11	276	333	106	438	0
11:16:34	05/11/95	59.1	71	493	15.7	217	3.9	0.10	274	330	107	437	0
11:17:31	05/11/95	59.7	70	490	15.6	221	4.0	0.08	270	348	113	461	0
11:18:28	05/11/95	60.0	70	485	15.6	219	4.0	0.13	270	345	113	458	0
11:19:25	05/11/95	60.0	70	483	15.6	218	3.9	0.10	272	343	113	456	0
11:20:22	05/11/95	60.1	70	481	15.7	218	3.9	0.08	274	335	112	446	0
11:21:19	05/11/95	60.2	70	481	15.6	215	3.9	0.09	272	336	112	447	0
11:22:16	05/11/95	60.1	70	478	15.7	218	3.9	0.10	276	333	113	446	0
11:23:13	05/11/95	60.3	70	476	15.7	218	3.9	0.11	275	331	113	443	0
11:24:10	05/11/95	60.4	70	475	15.7	219	3.9	0.09	274	331	113	444	0
11:25:07	05/11/95	62.5	70	474	15.6	217	3.9	0.09	272	336	114	449	0
11:26:04	05/11/95	58.9	70	473	15.6	216	3.9	0.13	272	341	114	454	0
11:27:01	05/11/95	61.0	70	473	15.6	217	4.0	0.10	270	345	115	460	0
11:27:58	05/11/95	60.9	70	473	15.6	218	4.0	0.11	270	343	115	458	0
11:28:55	05/11/95	61.0	70	473	15.6	219	4.0	0.09	269	348	117	464	0
11:29:52	05/11/95	61.3	70	471	15.6	214	4.0	0.10	267	352	115	467	0
11:30:49	05/11/95	61.4	70	469	15.6	212	4.0	0.09	269	352	115	467	0
11:31:46	05/11/95	61.4	70	468	15.6	211	4.0	0.09	269	350	114	464	0
11:32:43	05/11/95	59.5	70	468	15.6	211	4.0	0.11	269	353	114	467	0
11:33:40	05/11/95	61.4	70	469	15.6	213	4.0	0.10	269	355	115	469	0
11:42:39	05/11/95	68.0	71	395	15.7	178	3.9	0.06	275	312	69	381	0
11:43:36	05/11/95	63.2	71	462	15.4	218	4.1	0.09	254	394	107	501	0
11:44:33	05/11/95	62.7	71	474	15.3	222	4.2	0.13	249	409	112	521	0
11:45:30	05/11/95	63.0	71	475	15.2	224	4.2	0.10	247	419	118	537	0
11:46:27	05/11/95	60.8	71	476	15.3	224	4.2	0.11	249	416	119	535	0
11:47:24	05/11/95	60.6	70	477	15.3	222	4.2	0.13	249	415	120	535	0
11:48:21	05/11/95	62.8	70	479	15.2	225	4.3	0.11	245	424	123	547	0
11:49:18	05/11/95	60.9	70	478	15.2	225	4.2	0.11	246	422	124	546	0
11:50:15	05/11/95	60.9	70	481	15.2	226	4.3	0.10	244	424	124	548	0
11:51:12	05/11/95	64.3	70	481	15.2	226	4.3	0.10	245	424	126	549	0
11:52:09	05/11/95	62.5	69	480	15.2	223	4.2	0.11	246	427	126	553	0
11:53:06	05/11/95	60.8	69	480	15.2	223	4.2	0.11	246	426	125	550	0
11:54:03	05/11/95	62.5	70	480	15.2	223	4.2	0.10	246	420	124	544	0
11:55:00	05/11/95	64.2	70	480	15.2	226	4.2	0.09	246	421	125	545	0
11:55:57	05/11/95	62.2	69	480	15.3	236	4.2	0.11	249	416	127	542	0
11:56:54	05/11/95	63.9	69	478	15.3	230	4.2	0.09	249	411	126	536	0
11:57:51	05/11/95	62.2	69	480	15.3	226	4.2	0.10	249	413	126	539	0
11:58:48	05/11/95	62.1	69	480	15.2	225	4.2	0.11	251	411	125	535	0
11:59:45	05/11/95	62.1	69	478	15.3	226	4.2	0.10	252	405	125	530	0
12:00:42	05/11/95	64.6	69	288	20.4	54	0.4	0.08	OVER	92	48	139	27
12:09:14	05/11/95	63.5	71	747	11.6	192	6.9	0.05	115	536	41	576	0
12:10:11	05/11/95	63.2	71	857	9.9	335	8.1	0.13	83	874	147	102	0
12:11:08	05/11/95	62.0	71	865	9.9	317	8.1	0.13	83	905	162	1061	0
12:12:05	05/11/95	62.8	70	866	9.9	303	8.1	0.11	83	912	164	1077	0
12:13:02	05/11/95	62.6	70	868	9.9	295	8.1	0.11	84	917	165	1085	0
12:13:59	05/11/95	61.7	70	869	9.9	288	8.1	0.13	84	910	164	1071	0
12:14:56	05/11/95	62.5	70	869	10.0	289	8.1	0.11	84	910	163	1073	0
12:15:53	05/11/95	62.4	70	870	10.0	289	8.1	0.11	84	908	163	1072	0
12:16:50	05/11/95	62.4	70	871	10.0	284	8.1	0.13	84	912	163	1070	0
12:17:47	05/11/95	62.4	71	872	10.0	278	8.1	0.13	84	909	162	1074	0
12:18:44	05/11/95	62.5	71	871	9.9	275	8.1	0.13	84	909	162	1071	0
12:19:41	05/11/95	61.5	72	875	9.9	270	8.1	0.14	84	911	163	1071	0
12:20:38	05/11/95	62.5	72	873	9.9	266	8.1	0.13	84	911	164	1073	0
12:21:35	05/11/95	61.5	72	873	9.9	271	8.1	0.13	84	911	163	1074	0
12:22:32	05/11/95	62.4	72	875	9.9	270	8.1	0.13	84	911	163	1073	0
12:23:29	05/11/95	42.2	73	742	15.4	232	4.1	0.13	255	842	162	1003	0
~~12:24:26~~	~~05/11/95~~	~~15.2~~	~~73~~	~~486~~	20.5	27	0.4	0.08	OVER	80	31	~~113~~	23
12:27:14	05/11/95	61.4	72	861	10.5	303	7.7	0.13	93	814	134	948	0
12:28:11	05/11/95	61.5	73	864	10.4	308	7.7	0.11	92	830	150	979	0

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Eng #2 175 RPM

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APPENDIX C

FUEL MEASUREMENT – MAY 10 AND 11, 1995

CONTENTS

		Page
C1.0	Fuel Flow Data Sheets	C–2
C2.0	Flow Meter Calibration Curves	C–8
C3.0	Corrected Engine Fuel Consumption	C–10
C4.0	Engine Fuel Flow Rates	C–12

APPENDIX C1.0

FUEL FLOW DATA SHEETS, MAY 10 AND 11, 1995

Data were extracted from raw data sheets as shown in Appendix B1.5 and reprinted here for clarity.

USCG M/V KINGS POINTER EMISSIONS TEST
Fuel Flow Data Sheet

Block: 1

Date: 10 May 1995

				Engine 4			Engine 2		
Run	RPM	Time & GPM	Time	Indicated Supply Gallons	Indicated Return Gallons	Net Fuel	Indicated Supply Gallons	Indicated Return Gallons	Net Fuel
1	50	Start	10:00:00	75.40	32.30		1202.65	755.60	
		End	10:10:00	77.85	32.90		1209.57	759.60	
		Net	10	2.45	0.60	1.85	6.92	4.00	2.92
		GPM	Indicated	0.25	0.06	0.19	0.69	0.40	0.29
		GPM	Actual	0.23	0.05	***0.18***	0.64	0.36	***0.28***
2	100	Start	10:24:00	82.12	33.68		1220.00	766.65	
		End	10:39:00	86.76	34.50		1231.37	774.16	
		Net	15	4.64	0.82	3.82	11.37	7.51	3.86
		GPM	Indicated	0.31	0.05	0.25	0.76	0.50	0.26
		GPM	Actual	0.29	0.05	***0.24***	0.70	0.46	***0.25***
3	140	Start	10:50:00	91.46	35.04		1240.78	779.60	
		End	11:05:00	98.04	35.77		1253.90	786.92	
		Net	15	6.58	0.73	5.85	13.12	7.32	5.80
		GPM	Indicated	0.44	0.05	0.39	0.87	0.49	0.39
		GPM	Actual	0.42	0.04	***0.38***	0.82	0.44	***0.38***
4	175	Start	11:15:00	104.05	36.10		1263.90	791.75	
		End	11:30:00	113.75	36.83		1279.87	798.85	
		Net	15	9.70	0.73	8.97	15.97	7.10	8.87
		GPM	Indicated	0.65	0.05	0.60	1.06	0.47	0.59
		GPM	Actual	0.62	0.04	***0.58***	1.01	0.43	***0.58***
5	0	Start	11:45:00	117.94	37.64		1291.11	806.33	
		End	12:00:00	121.49	38.51		1301.35	813.87	
		Net	15	3.55	0.87	2.68	10.24	7.54	2.70
		GPM	Indicated	0.24	0.06	0.18	0.68	0.50	0.18
		GPM	Actual	0.22	0.05	***0.17***	0.63	0.46	***0.17***

USCG M/V KINGS POINTER EMISSIONS TEST
Fuel Flow Data Sheet

Block: 2

Date: 10 May 1995

Run	RPM	Time & GPM	Time	Engine 4 Indicated Supply Gallons	Engine 4 Indicated Return Gallons	Engine 4 Net Fuel	Engine 2 Indicated Supply Gallons	Engine 2 Indicated Return Gallons	Engine 2 Net Fuel
1	0	Start	12:00:00	121.49	38.51		1301.35	813.87	
		End	12:15:00	125.08	39.37		1311.64	821.42	
		Net	15	3.59	0.86	2.73	10.29	7.55	2.74
		GPM	Indicated	0.24	0.06	0.18	0.69	0.50	0.18
		GPM	Actual	0.22	0.05	***0.17***	0.63	0.46	***0.17***
2	50	Start	12:30:00	128.76	40.22		1322.00	828.92	
		End	12:45:00	132.51	41.06		1332.47	836.45	
		Net	15	3.75	0.84	2.91	10.47	7.53	2.94
		GPM	Indicated	0.25	0.06	0.19	0.70	0.50	0.20
		GPM	Actual	0.23	0.05	***0.19***	0.64	0.46	***0.18***
3	140	Start	13:02:00	139.54	41.87		1346.70	844.77	
		End	13:17:00	146.05	42.58		1359.71	852.19	
		Net	15	6.51	0.71	5.80	13.01	7.42	5.59
		GPM	Indicated	0.43	0.05	0.39	0.87	0.49	0.37
		GPM	Actual	0.41	0.04	***0.37***	0.81	0.45	***0.36***
4	175	Start	13:30:00	153.72	43.09		1372.24	858.03	
		End	13:45:00	163.38	43.69		1388.13	865.00	
		Net	15	9.66	0.60	9.06	15.89	6.97	8.92
		GPM	Indicated	0.64	0.04	0.60	1.06	0.46	0.59
		GPM	Actual	0.62	0.03	***0.59***	1.01	0.42	***0.59***
5	100	Start	13:55:00	166.98	44.20		1396.80	870.24	
		End	14:10:00	171.52	45.00		1407.92	877.66	
		Net	15	4.54	0.80	3.74	11.12	7.42	3.70
		GPM	Indicated	0.30	0.05	0.25	0.74	0.49	0.25
		GPM	Actual	0.28	0.04	***0.24***	0.69	0.45	***0.24***

USCG M/V KINGS POINTER EMISSIONS TEST

Fuel Flow Data Sheet

Block: 3

Date: 10 May 1995

				Engine 4			Engine 2		
Run	RPM	Time & GPM	Time	Indicated Supply Gallons	Indicated Return Gallons	Net Fuel	Indicated Supply Gallons	Indicated Return Gallons	Net Fuel
1	100	Start	14:10:00	171.52	45.00		1407.92	877.66	
		End	14:25:00	176.04	45.78		1419.02	885.09	
		Net	15	4.52	0.78	3.74	11.10	7.43	3.67
		GPM	Indicated	0.30	0.05	0.25	0.74	0.50	0.24
		GPM	Actual	0.28	0.04	***0.24***	0.69	0.45	***0.23***
2	175	Start	14:56:00	190.08	47.24		1446.00	900.15	
		End	15:11:00	199.71	47.84		1461.82	907.21	
		Net	15	9.63	0.60	9.03	15.82	7.06	8.76
		GPM	Indicated	0.64	0.04	0.60	1.05	0.47	0.58
		GPM	Actual	0.62	0.03	***0.58***	1.00	0.43	***0.57***
3	140	Start	15:28:00	207.34	48.59		1476.90	915.43	
		End	15:43:00	213.80	49.29		1489.77	922.73	
		Net	15	6.46	0.70	5.76	12.87	7.30	5.57
		GPM	Indicated	0.43	0.05	0.38	0.86	0.49	0.37
		GPM	Actual	0.41	0.04	***0.37***	0.80	0.44	***0.36***
4	50	Start	15:55:00	216.89	49.91		1498.30	928.69	
		End	16:10:00	220.54	50.74		1508.56	936.18	
		Net	15	3.65	0.83	2.82	10.26	7.49	2.77
		GPM	Indicated	0.24	0.06	0.19	0.68	0.50	0.18
		GPM	Actual	0.23	0.05	***0.18***	0.63	0.46	***0.17***
5	0	Start	16:22:00	223.71	51.40		1517.00	942.15	
		End	16:37:00	227.29	52.24		1527.16	949.67	
		Net	15	3.58	0.84	2.74	10.16	7.52	2.64
		GPM	Indicated	0.24	0.06	0.18	0.68	0.50	0.18
		GPM	Actual	0.22	0.05	***0.17***	0.62	0.46	***0.17***

USCG M/V KINGS POINTER EMISSIONS TEST
Fuel Flow Data Sheet

Block: 4

Date: 11 May 1995

Run	RPM	Time & GPM	Time	Engine 4 Indicated Supply Gallons	Engine 4 Indicated Return Gallons	Engine 4 Net Fuel	Engine 2 Indicated Supply Gallons	Engine 2 Indicated Return Gallons	Engine 2 Net Fuel
1	0	Start	08:15:00	254.00	59.37		1612.66	1015.70	
		End	08:30:00	257.49	60.22		1622.74	1023.22	
		Net	15	3.49	0.85	2.64	10.08	7.52	2.56
		GPM	Indicated	0.23	0.06	0.18	0.67	0.50	0.17
		GPM	Actual	0.22	0.05	***0.17***	0.62	0.46	***0.16***
2	50	Start	08:40:00	259.91	60.78		1629.52	1028.22	
		End	08:55:00	263.55	61.63		1639.73	1035.71	
		Net	15	3.64	0.85	2.79	10.21	7.49	2.72
		GPM	Indicated	0.24	0.06	0.19	0.68	0.50	0.18
		GPM	Actual	0.23	0.05	***0.18***	0.63	0.46	***0.17***
3	100	Start	09:05:00	266.51	62.16		1646.95	1040.67	
		End	09:20:00	271.10	62.94		1657.98	1048.10	
		Net	15	4.59	0.78	3.81	11.03	7.43	3.60
		GPM	Indicated	0.31	0.05	0.25	0.74	0.50	0.24
		GPM	Actual	0.29	0.04	***0.24***	0.68	0.45	***0.23***
4	140	Start	09:30:00	275.32	63.41		1666.29	1052.98	
		End	09:45:00	281.89	64.08		1679.14	1060.23	
		Net	15	6.57	0.67	5.90	12.85	7.25	5.60
		GPM	Indicated	0.44	0.04	0.39	0.86	0.48	0.37
		GPM	Actual	0.42	0.04	***0.38***	0.80	0.44	***0.36***
5	175	Start	09:55:00	288.48	64.47		1689.44	1064.98	
		End	10:10:00	298.70	65.04		1705.60	1071.98	
		Net	15	10.22	0.57	9.65	16.16	7.00	9.16
		GPM	Indicated	0.68	0.04	0.64	1.08	0.47	0.61
		GPM	Actual	0.66	0.03	***0.63***	1.03	0.42	***0.60***

USCG M/V KINGS POINTER EMISSIONS TEST
Fuel Flow Data Sheet

Block: 5

Date: 11 May 1995

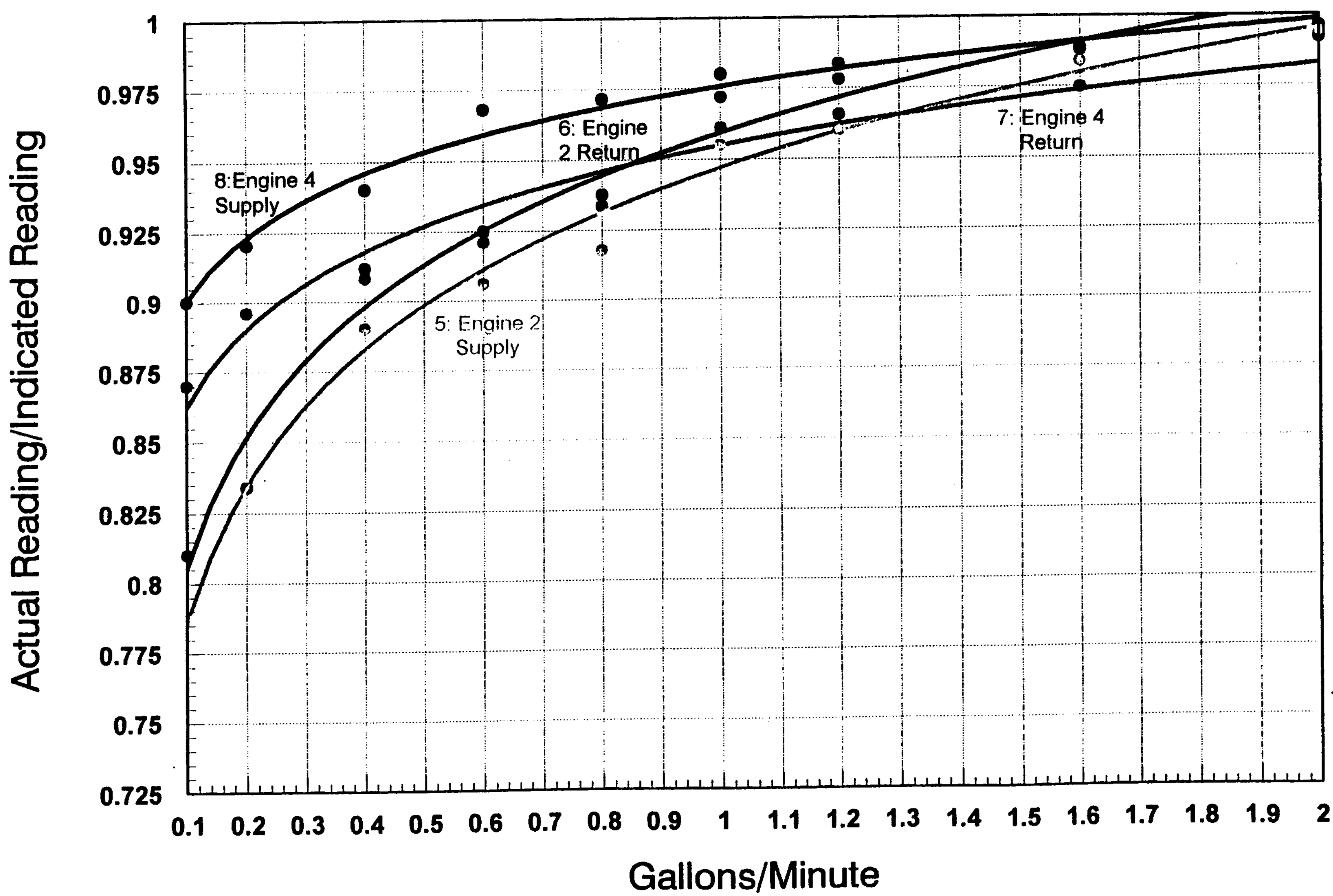
Run	RPM	Time & GPM	Time	Engine 4 Indicated Supply Gallons	Engine 4 Indicated Return Gallons	Engine 4 Net Fuel	Engine 2 Indicated Supply Gallons	Engine 2 Indicated Return Gallons	Engine 2 Net Fuel
1	140	Start	10:25:00	306.58	65.60		1719.80	1079.10	
		End	10:40:00	313.18	66.29		1732.58	1086.35	
		Net	15	6.60	0.69	5.91	12.78	7.25	5.53
		GPM	Indicated	0.44	0.05	0.39	0.85	0.48	0.37
		GPM	Actual	0.42	0.04	***0.38***	0.80	0.44	***0.36***
2	100	Start	10:55:00	318.00	67.00		1743.88	1093.67	
		End	11:10:00	322.55	67.73		1754.78	1101.06	
		Net	15	4.55	0.73	3.82	10.90	7.39	3.51
		GPM	Indicated	0.30	0.05	0.25	0.73	0.49	0.23
		GPM	Actual	0.28	0.04	***0.24***	0.67	0.45	***0.22***
3	0	Start	11:20:00	325.02	68.23		1761.63	1106.00	
		End	11:35:00	328.59	68.98		1771.72	1113.42	
		Net	15	3.57	0.75	2.82	10.09	7.42	2.67
		GPM	Indicated	0.24	0.05	0.19	0.67	0.49	0.18
		GPM	Actual	0.22	0.04	***0.18***	0.62	0.45	***0.17***
4	50	Start	11:45:00	331.08	69.47		1778.52	1118.37	
		End	12:00:00	334.82	70.19		1788.78	1125.74	
		Net	15	3.74	0.72	3.02	10.26	7.37	2.89
		GPM	Indicated	0.25	0.05	0.20	0.68	0.49	0.19
		GPM	Actual	0.23	0.04	***0.19***	0.63	0.45	***0.18***
5	175	Start	12:00:00	340.54	70.56		1798.13	1130.48	
		End	12:25:00	350.31	71.05		1813.88	1137.43	
		Net	15	9.77	0.49	9.28	15.75	6.95	8.80
		GPM	Indicated	0.65	0.03	0.62	1.05	0.46	0.59
		GPM	Actual	0.63	0.03	***0.60***	1.00	0.42	***0.58***

APPENDIX C2.0

FLOW METER CALIBRATION CURVES

M/V KINGS POINTER EMISSIONS TESTING

Brooks PD Flowmeter Calibrations S/N 8509-30971-4-



APPENDIX C3.0

CORRECTED ENGINE FUEL CONSUMPTION

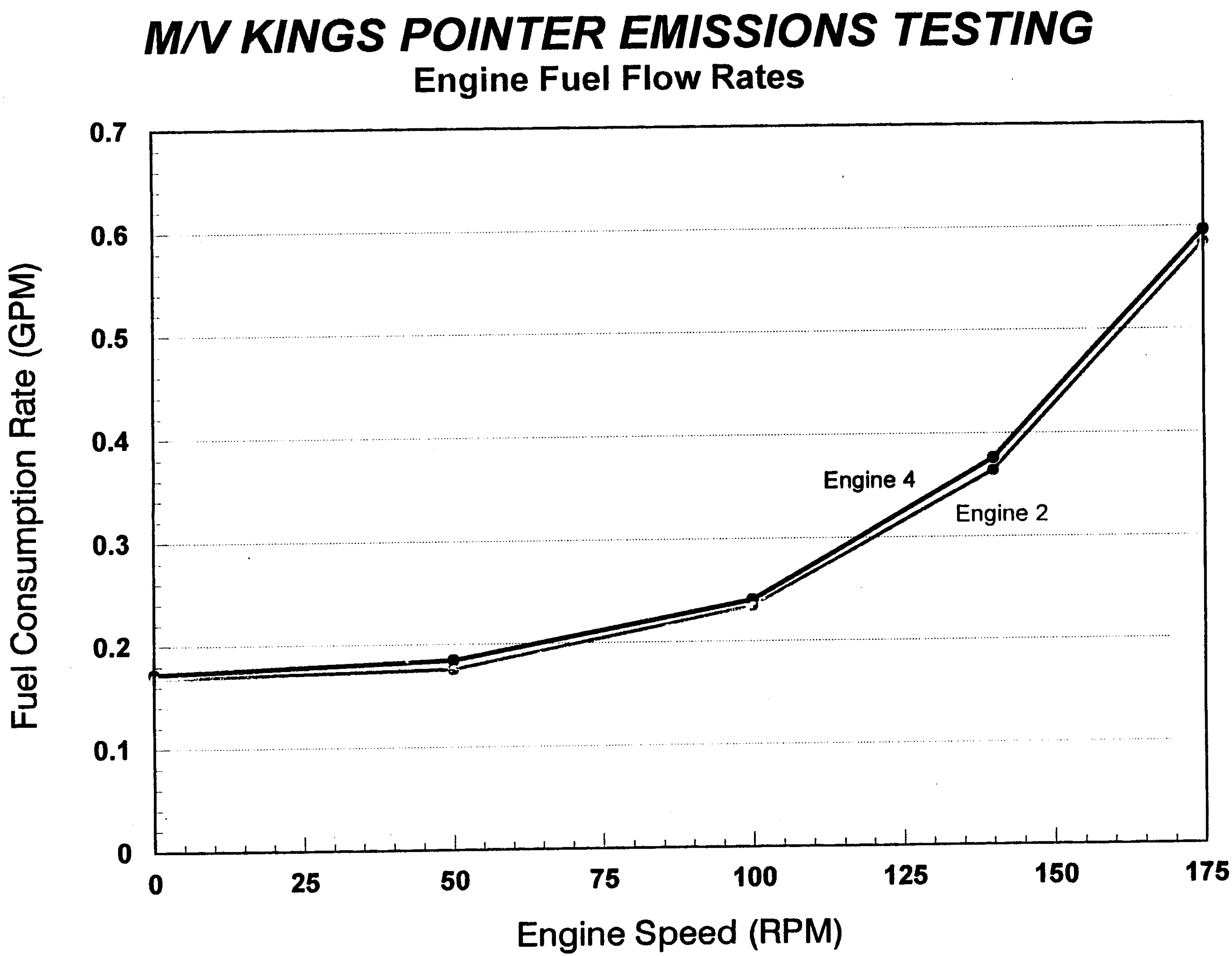
M/V KINGS POINTER EMISSIONS TEST

Summary Of Corrected Engine Fuel Consumption Rates

BLOCK No.	1		2		3		4		5		AVERAGE	
	Engine		Engine		Engine		Engine		Engine		Engine	
RPM	2	4	2	4	2	4	2	4	2	4	2	4
0	0.17	0.17	0.17	0.17	0.17	0.17	0.16	0.17	0.17	0.18	0.168	0.172
50	0.28	0.18	0.18	0.19	0.17	0.18	0.17	0.18	0.18	0.19	0.175	0.184
100	0.25	0.24	0.24	0.24	0.23	0.24	0.23	0.24	0.22	0.24	0.234	0.240
140	0.38	0.38	0.36	0.37	0.36	0.37	0.36	0.38	0.36	0.38	0.364	0.376
175	0.58	0.58	0.59	0.59	0.57	0.58	0.60	0.63	0.58	0.60	0.584	0.596

APPENDIX C4.0

ENGINE FUEL FLOW RATES



M/V KINGS POINTER EMISSIONS TESTING
Engine Fuel Flow Rates
Fuel Consumption Rate (GPM)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Engine 4
Engine 2
0
25
50
75
100
125
150
175
Engine Speed (RPM)