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Hazardous Air Pollutants from the Combustion of an Emulsified Heavy Fuel Oil in a Firetube Boiler

Prepared by:

C. Andrew Miller
U.S. Environmental Protection Agency
National Risk Management Research Laboratory
Research Triangle Park, NC 27711

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16. ABSTRACT The report gives results of measuring emissions of hazardous air pollutants (HAPs) from the combustion flue gases of a No. 6 fuel oil, both with and without an emulsifying agent, in a 2.5 million Btu/hr (732 kW) firetube boiler with the purpose of determining the impacts of the emulsifier on HAP emissions. The boiler flue gases were sampled and analyzed for both metal and organic HAPs, and the effects of the emulsification on criteria emissions such as carbon dioxide (CO), nitrogen oxides (NOx), and particulate matter (PM) were also measured. Measured in pounds per million British thermal units, the emulsified oil showed a decrease in the CO emission factor of 24%, a decrease of 35% in the NOx emission factor, and a decrease of 37% in the PM emission factor compared to emission factors measured from burning the base oil (i.e., the same oil without the emulsifying agent). Emissions of sulfur dioxide (SO2) and metals were essentially unchanged for the emulsified oil compared with the base oil. No polychlorinated dibenzodioxins or polychlorinated dibenzofurans were detected in the flue gases of either fuel. There was a notable shift in the particle size distribution toward smaller size ranges for the emulsified oil compared to the base oil, although it is currently unclear whether the reduction in total PM emissions also results in a reduction of smaller particles.

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Fuel Oil	Stationary Sources	21D
Combustion	Hazardous Air Pollutants (HAPs)	21B
Emulsions		07D
Fire Tube Boilers		13A
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FOREWORD

The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Risk Management Research Laboratory is the Agency's center for investigation of technological and management approaches for reducing risks from threats to human health and the environment. The focus of the Laboratory's research program is on methods for the prevention and control of pollution to air, land, water, and subsurface resources; protection of water quality in public water systems; remediation of contaminated sites and groundwater; and prevention and control of indoor air pollution. The goal of this research effort is to catalyze development and implementation of innovative, cost-effective environmental technologies; develop scientific and engineering information needed by EPA to support regulatory and policy decisions; and provide technical support and information transfer to ensure effective implementation of environmental regulations and strategies.

This publication has been produced as part of the Laboratory's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

E. Timothy Oppelt, Director
National Risk Management Research Laboratory

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ABSTRACT

Emissions of criteria and hazardous air pollutants (HAPs) were measured from the combustion flue gases of a #6 fuel oil, both with and without an emulsifying agent, in a 2.5×10^6 Btu/hr firetube boiler, with the purpose of determining the impacts of the emulsifier on HAP emissions. The flue gases of the boiler were sampled and analyzed for both metal and organic HAPs, and the effects of the emulsification on criteria emissions such as carbon monoxide (CO), nitrogen oxides (NO_x), and particulate matter (PM) were also measured. Measured in pounds per million British thermal units (Btu), the emulsified oil showed a decrease in the CO emission factor of 24%, a decrease of 35% in the NO_x emission factor, and a decrease of 37% in the PM emission factor compared to emission factors measured from burning the base oil (i.e. the same #6 oil without the emulsifying agent). Emissions of sulfur dioxide (SO_2) and metals were essentially unchanged for the emulsified oil compared to the base oil. Emissions of volatile organic HAPs from the emulsified oil were 9% lower than for the base oil, and semivolatile emissions were 29% lower for the emulsified oil compared to the base oil. For both volatile and semivolatile organic compounds, the emission factors were on the order of 1 pound per trillion Btu. No polychlorinated dibenzodioxins or polychlorinated dibenzofurans were detected in the flue gases of either oil. There was a notable shift in the particle size distribution toward smaller size ranges for the emulsified oil compared to the base oil, although it is currently unclear whether the reduction in total particulate emissions results in an overall reduction in emissions of smaller (< 2.5 μm) particles. Additional work is planned to provide quantitative information on the differences in size distributions and the total mass emissions for the different particle size ranges.

PREFACE

The Control Technology Center (CTC) was established by EPA's Office of Research and Development (ORD) and Office of Air Quality Planning and Standards (OAQPS) to provide technical assistance to state and local air pollution control agencies. Three levels of assistance can be accessed through the CTC. First, a CTC HOTLINE has been established to provide telephone assistance on matters relating to air pollution control technology. Second, more in-depth engineering assistance can be provided when appropriate. Third, the CTC can provide technical guidance through publication of technical guidance documents, development of personal computer software, and presentation of workshops on control technology matters.

The technical guidance projects, such as this one, focus on topics of national or regional interest that are identified through contact with state and local agencies. In this case, the CTC became interested in examining the emissions of hazardous air pollutants (HAPs) from the combustion of a heavy fuel oil, both with and without an emulsifying agent, in a small industrial/commercial boiler, based on a request from a state agency.

In late 1994, the CTC received a request from the producer of a heavy oil/water emulsion to provide information regarding the potential for HAP emissions from the combustion of the emulsified oil. A state agency had requested the producer to provide such information, and the producer approached EPA regarding the possibility of testing the oil, both with and without the emulsifier, to provide the HAP emissions data requested by the state agency.

Related work to characterize HAP emissions from the combustion of #2, #5, and #6 fuel oils had been conducted earlier at EPA's National Risk Management Research Laboratory, Air Pollution Prevention and Control Division (APPCD), formerly the Air and Energy Engineering Research Laboratory. With this background, APPCD was asked by the CTC to conduct similar tests on the emulsified fuel oil and the base oil without the emulsifying agent. These tests were conducted in early 1995, and the results are the subject of this report.

ACKNOWLEDGMENTS

Portions of this work were conducted under EPA Contract 68-D4-0005 with Acurex Environmental Corporation. The author would like to acknowledge the following Acurex staff for their efforts: Jeff Ryan (now with EPA's Air Pollution Prevention and Control Division), responsible for the sampling and analytical portion of the project; and Tony Lombardo, who led the operation and maintenance of the North American boiler. The author also acknowledges the contributions of Charles Rogers of Industrial Fuel Company who provided the fuels and analyses of the fuels for these tests.

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1. INTRODUCTION

1.1 Hazardous Air Pollutants

The emissions of air toxics or hazardous air pollutants (HAPs) have been an issue of increasing concern over the last few years, particularly since the passage of the 1990 Clean Air Act Amendments (CAAAs)[1] which mandated regulation of HAPs under Title III from a wide range of sources. Title III of the CAAAs lists 189 compounds and compound classes as HAPs, and requires application of maximum achievable control technology (MACT) to a nonutility source that emits over 10 tons/year* of any one HAP, or 25 tons/year of any combination of HAPs. In addition to the requirements of the CAAAs at the Federal level, limits on emissions of HAPs have also been set by some states. States are also requesting increasing amounts of information regarding the potential for HAP emissions prior to allowing an operating permit for fuel combustion or other processes. Because the emissions of HAPs have become a regulatory issue only recently, there is much less information available regarding the characterization of HAP emissions from stationary sources than is the case for the criteria pollutants such as carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), and particulate matter (PM).

A further complication in characterization of HAPs is the large number and variety of compounds that have been identified as HAPs under the CAAAs. Of the 189 compounds and compound classes listed as hazardous under Title III of the CAAAs, 11 are metals. Also included are radionuclides (composed of both gaseous and metal compounds; e.g., radon and uranium), asbestos, fine mineral fibers, and acids such as hydrochloric acid (HCl), hydrofluoric acid (HF), and hydrogen sulfide (HS). Most of the remainder of the 189 HAPs are organic. Many of these organic compounds are nitrogenated or chlorinated organics, and are often associated with the production of pesticides, herbicides, or chemical production byproducts.

In the case of many sources such as chemical production facilities, the characterization is relatively straightforward, since the emissions are primarily fugitive vapor emissions from the production of a limited number of chemical compounds. In such cases, the types of chemicals being released are usually known, and characterization is a matter of determining quantity and location of the emissions. In other cases, characterization is more difficult. For instance, hydrocarbon combustion processes will as a matter of course result in the emission of trace quantities of products of incomplete combustion (PICs) such as benzene, toluene, and polycyclic aromatic hydrocarbons (PAHs), even during efficient combustion. Because of the large volumes of flue gas produced during the combustion process, however, even HAP

* See Appendix A for conversion factors to metric units.

concentrations in the parts per million (ppm) level can result in annual mass emissions that are greater than the 10 or 25 ton/year limits specified under Title III.

1.2 HAPs from Combustion Sources

Combustion sources can emit a wide range of HAPs during operation. The types and amounts of HAP emissions can vary widely, depending on the type of fuel used and the conditions under which the fuel is combusted. Many of the fuels in use in industry contain trace levels of metals, including metals that are listed as HAPs under Title III of the CAAAs. For example, coal naturally contains most of the listed metals in trace quantities less than 0.01% by weight. Fuel oils, and particularly heavy fuel oils such as #6 oil, also contain trace quantities of metals. During the combustion process, these metals are released from the fuel into the gases produced during combustion and, without adequate controls, can be released to the atmosphere from the combustor stack. Since the metal contents of the fuels are typically on the order of parts per million, the resulting concentrations of metals in the flue gases are very low. However, because of the large quantities of fuels combusted in many processes, the total mass of these metals can be on the order of tons per year. For instance, a fuel that contains 100 ppm of a metal can result in 10 tons/year of metal emissions into the atmosphere if the fuel were burned at an average rate of 22,830 lb/hr, and if 100% of the metal in the fuel exited the combustor via the stack. Although this level of fuel usage may seem very high, it is the required fuel flow for a typical steam power plant rated at 41.7 MWe running at full load using a #6 fuel oil. Thus, the potential for combustion processes to exceed the regulatory level of HAP emissions can be high for even relatively small industrial sources.

In addition to the emissions of toxic metals from the fuels, organic compounds can also be emitted from fuel combustion processes. The high temperatures and high levels of chemical species found in a combustion system provide an ideal environment for chemical reactions. While the vast majority of reactions between oxygen (O_2) and the hydrocarbon fuel result in the formation of carbon dioxide (CO_2) and water (H_2O), some of the reactions that take place result in the formation of trace quantities of other species such as benzene, toluene, or formaldehyde, all of which are listed as HAPs under Title III. While the levels of these compounds that are produced during combustion are very low, the example given above illustrates that low levels of compounds can result in a relatively high total mass of emissions. In addition, the complex chemical and physical processes that occur in the combustion environment make it impossible to determine *a priori* the amounts or the species that will be emitted from a combustion process.

1.3 Emulsified Fuel Oils

Emulsions have been used for many years as a means of reducing the emissions of criteria pollutants from the combustion of fuel oils. A number of studies have shown the ability of emulsions of water suspended in oil to reduce the emissions from combustion sources[2-4]; however, the impacts of oil/water emulsions on particular pollutants vary. For heavy fuel oils, oil/water emulsions tend to reduce particulate, but in general have had a smaller effect on either CO or NO_x when operating conditions are kept constant.[2] With distillate oils, particulates and NO_x have been shown to be reduced when using an oil/water emulsion compared to using the same oil without emulsification.[3] However, the use of an emulsifier results in improved secondary atomization of the fuels, often allowing operation at a reduced stoichiometric ratio, and also tends to reduce the peak combustion temperature. Both of these effects result in lower NO_x emissions, and the improved atomization can also result in lower CO emissions.

The key disadvantage to the use of emulsions in the past has been the ability of the water to remain in suspension during storage. One method of avoiding this problem has been to mix the oil and water immediately prior to feeding the mixture into the boiler. However, this requires additional fuel and water handling equipment, as well as a system to mix the two liquids. The additional expenses associated with this equipment have not usually been considered worth the resulting reductions in NO_x emissions. As an alternative to separate storage of the oil and water, emulsifying agents that result in a reduced rate of oil/water separation have been developed, allowing "premixed" emulsified oils to maintain their properties for extended periods of time when properly stored. This approach eliminates the need for additional handling and mixing equipment, and utilizes existing fuel handling systems, thereby reducing the cost of use. In the present tests, a "premixed" oil/water emulsion of a #6 fuel oil was used in comparison to the base, nonemulsified oil.

1.4 Project Objective

The objective of this project is to evaluate the emissions of HAPs from the combustion of an emulsified fuel oil and compare those emissions to the same oil without the emulsifying agent, both being burned in the same unit under similar conditions.* This information will provide guidance regarding the potential for increase in HAP emissions due to the use of water/residual oil emulsions for reducing criteria pollutant emissions, and will also provide information in addition to previous tests of HAP emissions from the combustion of fuel oils conducted in the same unit.[5] This will allow both fuel users and pollution control agency officials to make informed decisions regarding the impacts on air emissions from the combustion of water/residual oil emulsions.

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* The emulsified fuel was prepared and supplied by Industrial Fuel Company of Hickory, North Carolina.

The work described in this report was conducted by the Air Pollution Technology Branch (formerly the Combustion Research Branch) of EPA's Air Pollution Prevention and Control Division (APPCD) of the National Risk Management Research Laboratory (NRMRL) in Research Triangle Park, NC, and supported by EPA's Control Technology Center.

2. EXPERIMENTAL SETUP

2.1 Equipment

The tests were performed on APPCD's North American package boiler (NAPB) which is capable of firing natural gas or #2 through #6 fuel oils. The boiler is of a three-pass firetube "Scotch" marine-type design built in 1967, model 5-360H-D, and shown schematically in Figure 2-1. The burner is a North American model 6121-2.5H6-A65 rated at 2.5 x 10^6 Btu/hr, and has a ring-type natural gas burner and an air-atomizing center nozzle oil burner capable of firing #2 through #6 oils. The boiler has 300 ft^2 of heating surface and generates up to 2400 lb/hr of saturated steam at pressures up to 15 psig. Heat is extracted from the steam through a heat exchanger to an industrial cooling water system that simulates the

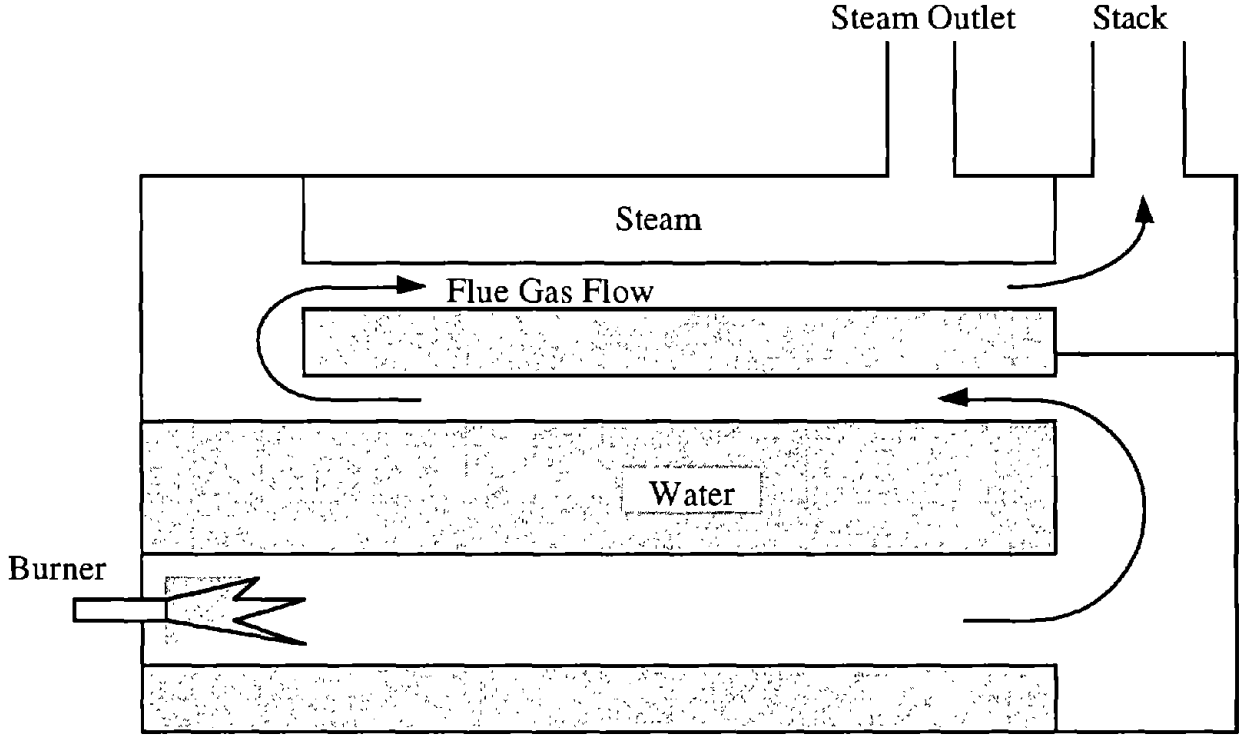

Figure 2-1. Schematic of the North American package boiler. The boiler is a three-pass firetube "Scotch" marine-type boiler capable of burning natural gas or fuel oils.

boiler load. Oil temperature can be adjusted using an electric heater to maintain proper oil viscosity, and both fuel and atomizing air pressures are variable to ensure adequate oil atomization. The NAPB is fully instrumented with continuous emission monitors (CEMs) for NO_x, CO, CO_2, O_2, and SO_2. A computerized data acquisition system was used to record CEM measurements as well as steam and flue gas temperatures.

The flue gases from the unit pass through a manifold to an air pollution control system (APCS) consisting of a natural-gas-fired secondary combustion chamber, an acid gas scrubber, and a fabric filter to ensure proper removal of pollutants generated during tests designed to mimic poor combustion conditions. During the tests reported here, the APCS was operated to provide a constant draft to the NAPB to minimize changes in the induced draft. Although this type of boiler normally operates under forced draft only, the imposition of an induced draft due to the APCS was not felt to introduce any significant effects on boiler emissions.

2.2 Test Matrix

The test matrix was chosen to evaluate the effects of using an emulsified fuel on HAP emissions. The same #6 fuel oil was used in both tests, one with the emulsifier and the other without. The ultimate analyses of the fuels are given in Table 2-1, and Table 2-2 presents the trace element concentrations of the

Table 2-1. Ultimate analyses of the base #6 fuel oil and the emulsified oil used in the test program. Elemental concentrations are given in dry percent by weight, and viscosity values are in centistokes (cSt).

	#6 Fuel Oil (without emulsifier)	Emulsified #6 Fuel Oil
Water(1)	0.70	9.00
Carbon (2)	85.20	77.83
Hydrogen (2)	7.16	10.16
Nitrogen (2)	0.24	0.24
Sulfur (2)	2.13	1.70
Ash (2)	0.040	0.096
Oxygen (2,3)	5.23	10.07
Viscosity, cSt		
@100° F	1964	2281
@210° F	47.24	63.38 (4)
Heat of Combustion, Btu/lb (ref. to 77° F)	18,243	16,604

(1) Karl Fischer water
(2) Values are on a dry basis. Water percentage is given for reference only.
(3) Oxygen values are calculated by difference
(4) Due to the water content of the emulsified oil, the viscosity at 210° F is approximate

Table 2-2. Trace element content of the base #6 fuel oil used in the test program, in μg/g. The emulsified oil was not analyzed for metals since no metals were in the emulsifying agent.

	#6 Fuel Oil (without emulsifier)
Antimony	< 1.2
Arsenic	< 0.6
Beryllium	< 0.002
Cadmium	< 0.03
Chromium	< 0.06
Lead	< 0.6
Mercury	< 0.05
Manganese	< 0.01
Nickel	65.0
Sodium (1)	51.6
Vanadium (1)	486

(1) Sodium and vanadium are not listed as HAPs under Title III

oil without emulsifier (referred to as the base oil). No trace element concentration analyses were conducted on the emulsified oil, since the producer of the emulsified oil verified that no metals were included in the emulsifier.

Table 2-1 shows that the fuels have relatively high sulfur contents, and very low ash contents. The addition of the water in the emulsified oil significantly impacts the heating value, reducing it by 9%, equal to the increase in water content of the emulsified oil compared to the base oil. A greater flow of emulsified oil is then required to maintain the same heating rate as for the base oil. In addition, the combustion air flow also changes between the two fuels, due to the change in input rate of combustible content of the emulsified oil and to changes in the level of excess air used with the emulsified oil (operating changes will be discussed below).

The amounts of metals in the base oil indicate very low levels of all metals except nickel, sodium, and vanadium. Of these three, only nickel is listed as a HAP under Title III. These results are not unexpected, given the very low ash levels of the two oils. The trace element concentrations of the emulsified oil will be even less, since the metals will be diluted by the presence of the water.

The tests were conducted following the instructions of the oil/water emulsion producer. The proper procedure for setting the combustion conditions was to begin with the base oil, set conditions to obtain the desired level of O_2 in the stack, and measure the smoke number. The fuel was then switched to the emulsified oil, and the excess air level was reduced until the same smoke number as was measured with

the base fuel was obtained. This resulted in a lower stoichiometric ratio for the emulsified oil than for the base oil. This condition represents the baseline condition for the emulsified oil. No other combustion conditions were tested. For the base oil, the baseline condition was a firing rate of 2 x 10^6 Btu/hr, a nominal excess air level of 20% (stoichiometric ratio of 1.2), 5 psig outlet steam pressure, 48 psig atomizing air pressure, and 74 psig oil pressure. The same firing rate, steam pressure, and atomizing air pressure were used for both oils. For the base oil, the oil feed temperature averaged 236 °F, and for the emulsified oil, the feed temperature averaged 253 °F.

Because of constraints on sampling locations, different sampling procedures were conducted during different test runs. Sampling was done for metals, organics, and polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Test runs were scheduled to minimize changes in test conditions, and duplicate test runs were also conducted to provide a measure of the repeatability of the test results. Table 2-3 shows the test matrix, including the sampling activities conducted during each test run.

Table 2-3 Test matrix used for sampling HAPs. For each test run, the number of samples taken for that test run is given.

Test Run	Date	Fuel	Metals	Volatile Organics	Semivolatile Organics	PCDDs/PCDFs
1	3/7/95	Base	2			
2	3/8/95	Base		1		2
3	3/8/95	Base	2			
4	3/9/95	Base			1	1
5	3/9/95	Base	1	1		
6	3/10/95	Base			1	1
7	3/10/95	Base			1	1
8	3/14/95	Emulsified	2			
9	3/14/95	Emulsified				2
10	3/15/95	Emulsified		1	2	
11	3/15/95	Emulsified	2	1		
12	3/16/95	Emulsified			1	1
13	3/16/95	Emulsified			1	1

2.3 Sampling and Analysis

The current program used different methods to sample and analyze for four major categories of HAPs: volatile organics, semivolatile organics, PCDDs/PCDFs, and metals. Table 2-4 lists the sampling and analytical procedures used in the test program. Duplicate samples were collected during selected test runs to provide a measure of the sampling precision. Sample probes were collocated in the stack, using the

Table 2-4. Sampling and analytical methods used in the test program.

Compound Class	Sampling Method[1]	Analytical Method
Volatile Organics	SW-846 Method 0030 (VOST)	SW-846 Methods 5040 and 8240
Semivolatile Organics	SW-846 Method 0010 (Modified Method 5)	SW-846 Method 8270
Polychlorinated Dioxins and Furans	40 CFR Part 60 Method 23[2]	Modified SW-846 Method 8280
Metals and Particulate Matter	SW-846 Method 0060[3]	SW-846 Method 0060[3]

(1) SW-846 sampling and analytical methods for VOCs and semivolatile organics can be found in Reference 6.
(2) Method 23 is found in Reference 7.
(3) Method 0060 is an SW-846 method identical to the unpublished Method 29, Draft Multi-Metals Train, 40 CFR Part 60, and following conventional usage, is referred to as Method 29 in the text. Method 0060 is found in Reference 8.

same axial location, and with the radial location being determined by the point of average duct velocity. In addition, field blanks were collected for each type of emissions sample to permit evaluation of potential sampling contamination.

Extractive sampling locations and locations of the CEM probes on the NAPB are shown in the schematic in Figure 2-2. The CEM data collected were recorded using a computerized data acquisition system for later retrieval and analysis of the data.

2.4 Quality Assurance

The project was conducted according to an APPCD Level III Quality Assurance (QA) Project Plan, which was prepared to document the test objectives, procedures used, data quality objectives, and data quality indicator goals for the test program. A QA Level III plan is used for technology development, and is less rigorous than the QA procedures required for regulatory standard setting or enforcement. However, the sampling and analysis procedures used in these tests were exactly the same as those required under the more rigorous QA levels. In this series of tests, more samples were taken than Level III requires, providing for an increased level of QA. A discussion of QA-related measurements and calculations is given in Appendix B.

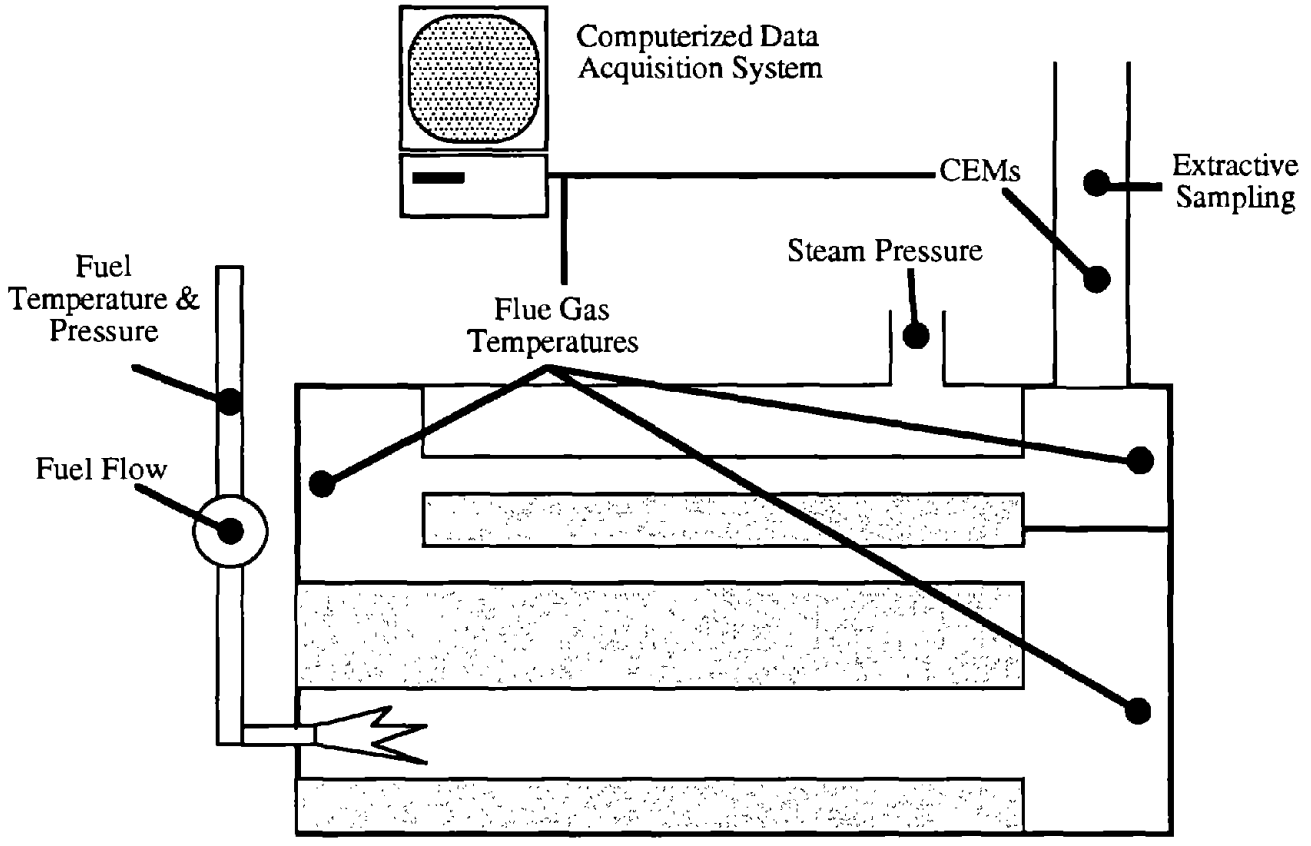

Figure 2-2. Location of CEM, temperature, and sampling probes on the North American package boiler. Flue gas temperatures and CEM measurements are automatically recorded on the computerized data acquisition system.

3. RESULTS

3.1 Criteria Pollutant Emissions

As noted in the Introduction, one of the primary reasons emulsified oils are used is to reduce emissions of criteria pollutants. Emissions of CO, NO_x, and SO_2 were measured during each of the test runs using CEM equipment, and the data from the CEMs were collected using a computerized data acquisition system. PM samples were collected during stack sampling for each of the test runs for which metals were sampled. In addition, smoke number readings were taken during each test to determine whether the recommendations of the emulsified oil supplier were being followed. The average smoke number reading when using the base #6 oil was 6.13, and the average was 5.95 when using the emulsified oil. Because the combustion air was reduced to bring the smoke numbers of the two fuels together, the average excess air levels (and hence the O_2 concentrations of the flue gases) for the emulsified oil were lower than for the base oil. The base oil stack gases had an average O_2 concentration of 4.5%, measured on a dry basis,

while the emulsified oil stack gases had an average O_2 concentration of 3.1%, again measured on a dry basis. These values correspond to average excess air levels of 24% for the base oil and 15% for the emulsified oil.

Table 3-1 and Figure 3-1 show the average measurements of CO, NO_x, and SO_2 for the base oil and for the emulsified oil for 12 of the 13 runs (CEM data for run 1 were lost due to damage to a data disk). Table 3-1 also includes the average PM and smoke number readings. The CO, NO_x, and SO_2 values are the averaged values of the individual run average CEM readings. NO_x data for runs 9 and 12, and SO_2 data for runs 12 and 13 were not included in the calculation of the averages due to CEM failures. Figure 3-2 presents the average PM and smoke number readings for the base and emulsified oils. As expected, the emulsified oil showed significant reductions in CO, NO_x, and PM, with SO_2 values remaining approximately the same. CO emissions from the emulsified oil were lower than the base oil by 22%, NO_x emissions were 35% lower for the emulsified fuel than for the base fuel, and PM emissions were 31% lower for the emulsified fuel than for the base fuel. Because the emulsification does not impact the amount of sulfur in the oil (except to add moisture and reduce O_2 in the flue gas), little change was expected. Although there was a slight decrease in the concentration of SO_2 in the measured flue gas of the emulsified oil, the amount of change was not considered to be significant, nor was it considered to be due to the use of the emulsified oil. Also shown in Figure 3-1 are the standard deviations measured from the individual runs.

Table 3-1. Average emissions of criteria pollutants, and average smoke number readings from the two oils tested. CO, NO_x, and SO_2 values are in ppm corrected to 3% O_2, dry conditions. PM is in g/dry standard m^3 (at 77° F, 1 atm).

	Base #6 Fuel Oil (without emulsifier)	Emulsified #6 Fuel Oil
CO	23	18
NO_x	320	220
SO_2	990	960
PM	0.23	0.16
Smoke No.	6.13	5.95

Figures 3-3 through 3-8 present the values of heat input, CO, NO_x, SO_2, PM, and smoke number respectively, for 12 of the 13 runs. These plots indicate the variability in the data across the runs. Included in Figure 3-5 are the average NO_x CEM readings for runs 9 and 12, which were not included in the overall averages due to CEM problems. The CEM NO_x data showed an unacceptable drift in measurements during runs 9 and 12, and post-test calibrations of the NO_x analyzer failed. Figure 3-6 includes the average SO_2 CEM readings for runs 12 and 13, which were also excluded from the overall average due to CEM problems. In this case, no anomalies were noted in the CEM data, but post-test

calibration checks failed for these runs. In Figures 3-4 through 3-6, the error bars denote the standard deviations of the CEM measurements taken during the test runs. CEM data were logged every 30 seconds during the tests during runs 2 through 13.

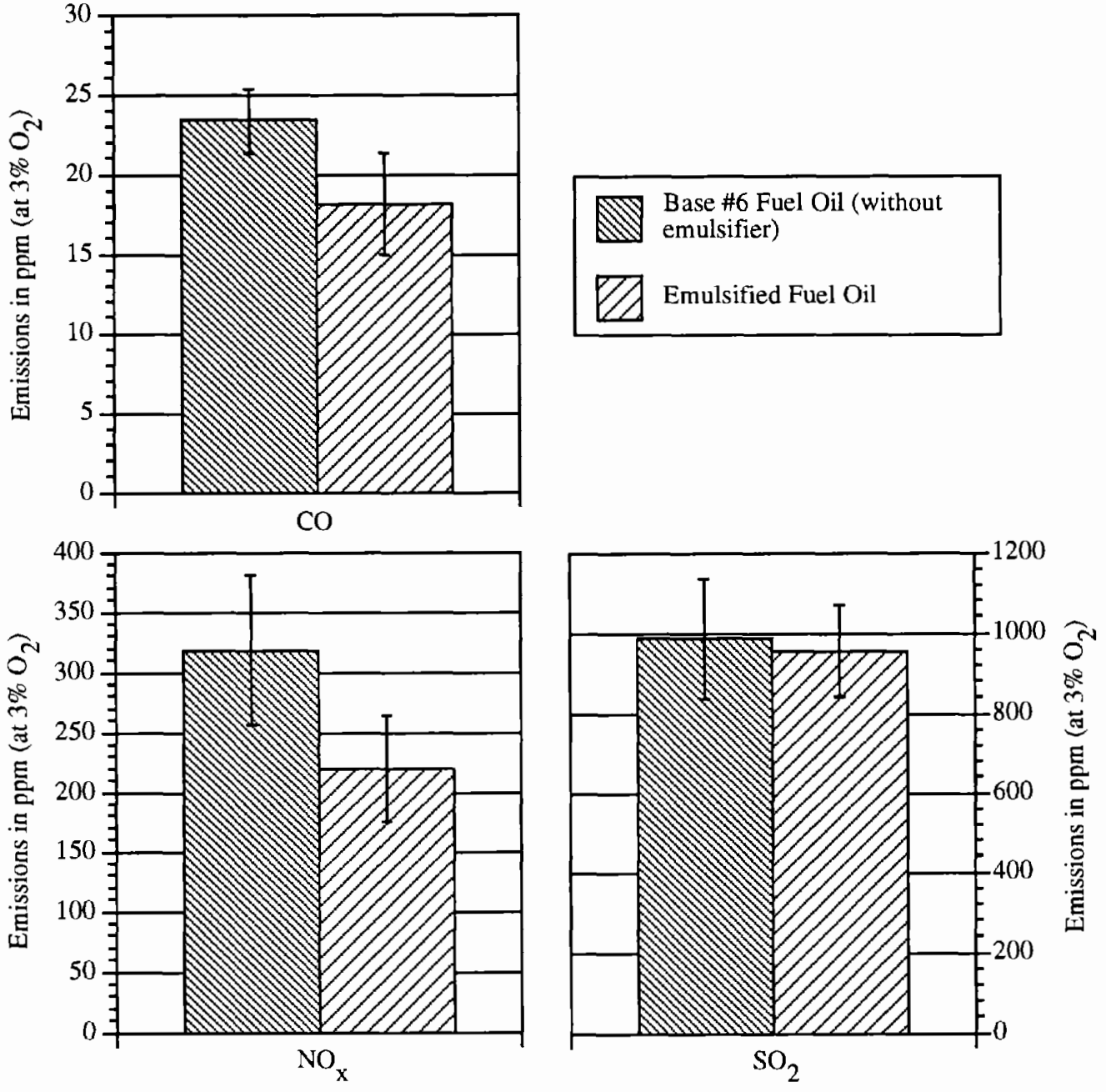

Figure 3-1. Average emissions of CO, NO_x, and SO_2 for the base and emulsified fuel oils. The presented values are the overall averages of the average run concentrations for each oil, and the error bars measure the standard deviations for each overall average.

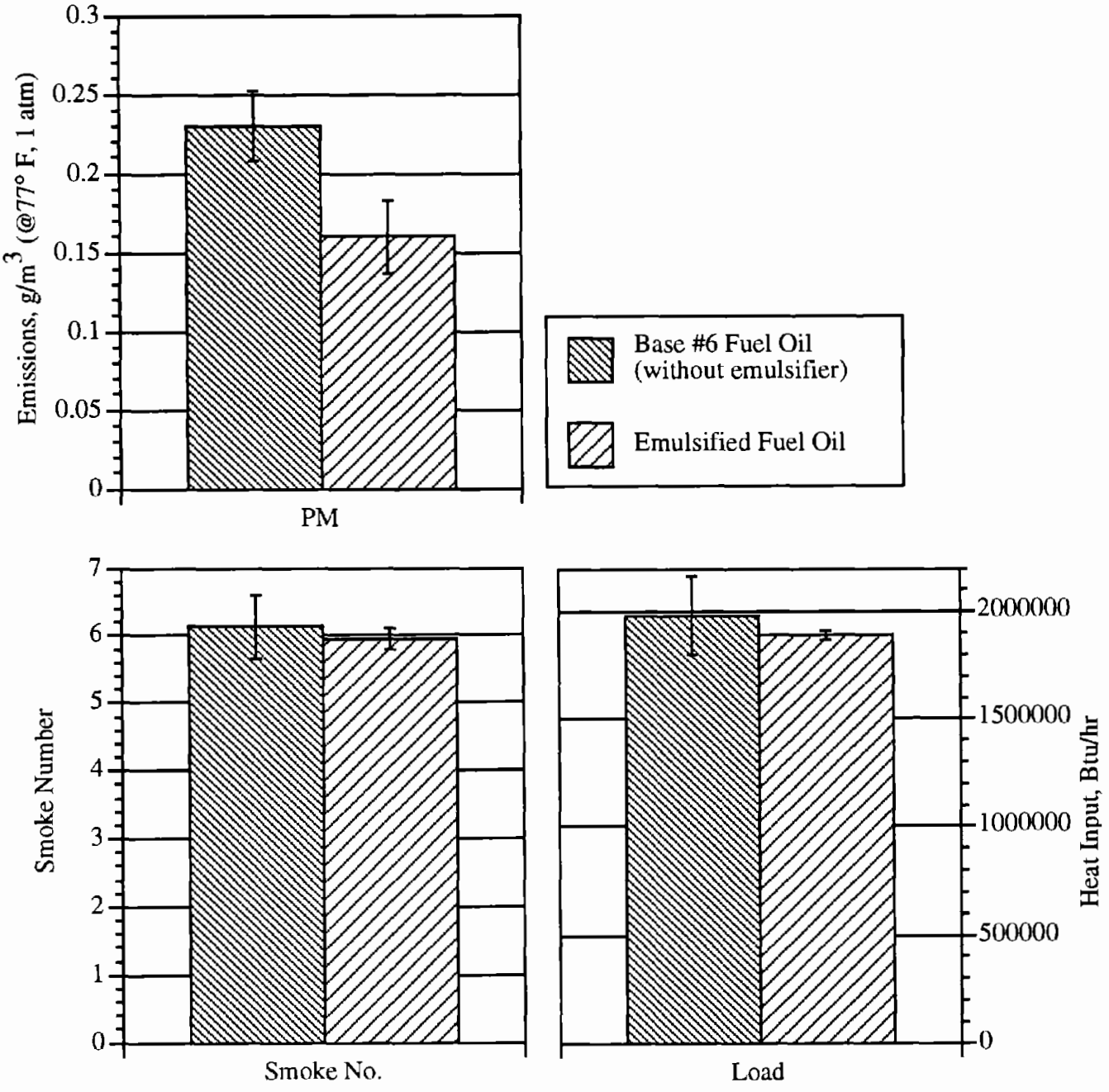

Figure 3-2 Average concentrations of PM and average smoke numbers and heat inputs for the base oil and emulsified oil. Error bars are the standard deviations for each average.

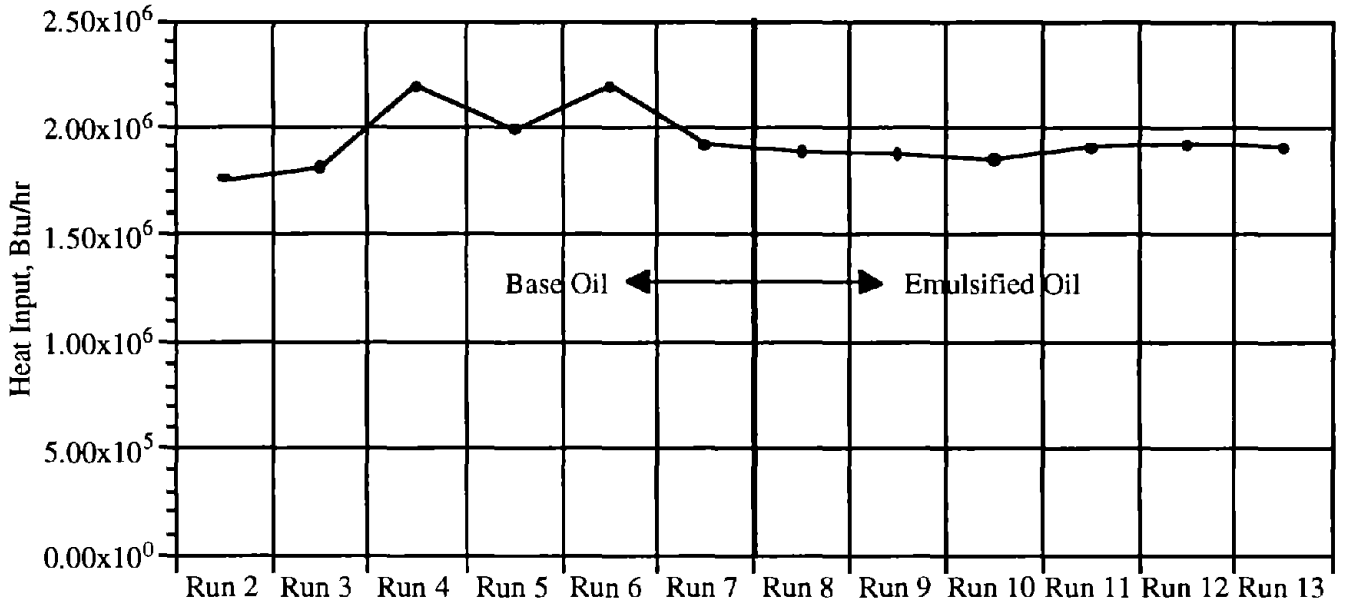

Figure 3-3. Average heat input rate for 12 of the 13 runs. Runs 2–7 were conducted using the base #6 oil, and runs 8–13 with the emulsified oil.

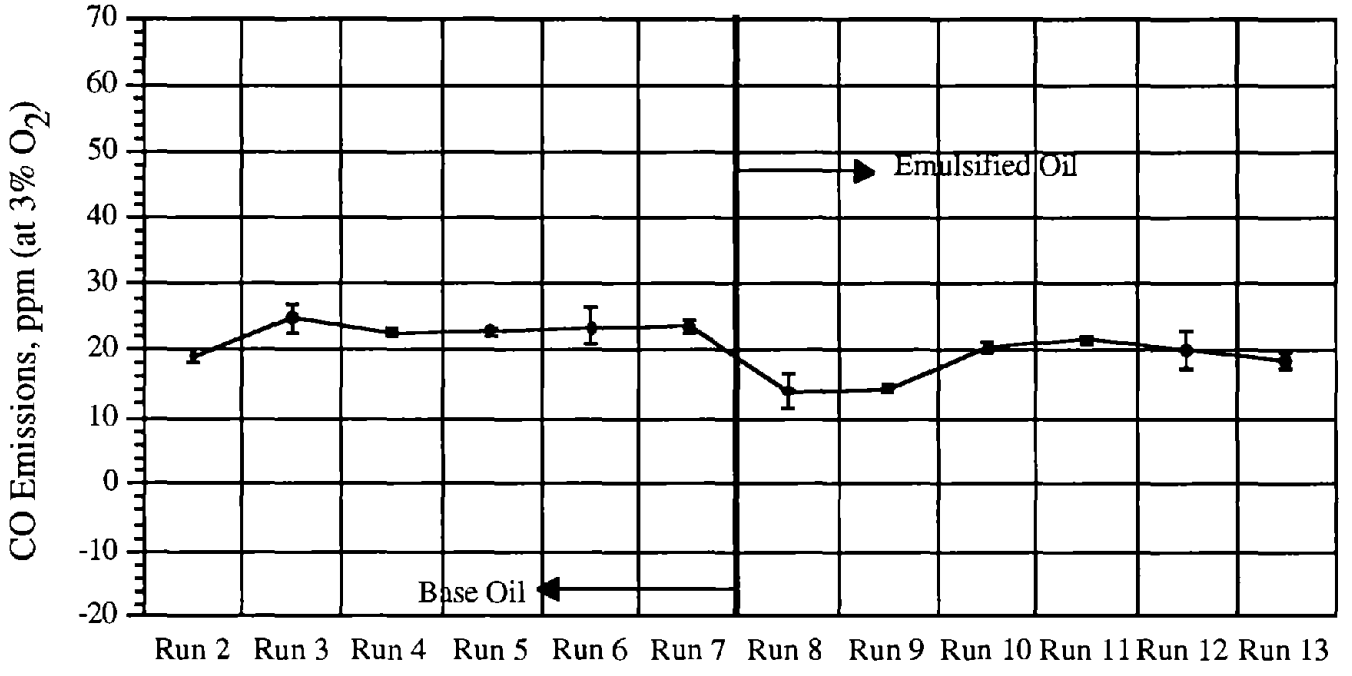

Figure 3-4. Average CO emissions for 12 of the 13 runs. Runs 2-7 were conducted using the base #6 oil, and runs 8-13 with the emulsified oil. The error bars show the standard deviation of the CEM measurements for each run.

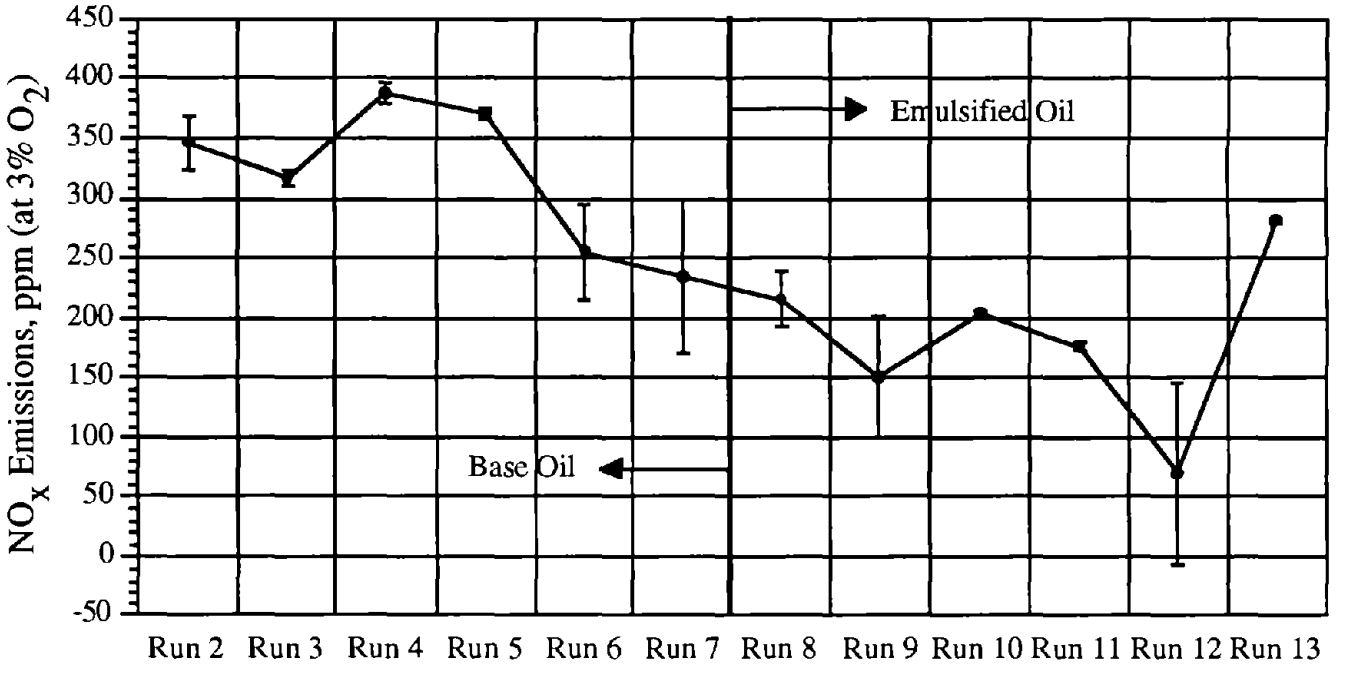

Figure 3-5. Average NO_x emissions for 12 of the 13 runs. Runs 2-7 were conducted using the base #6 oil, and runs 8-13 with the emulsified oil. The error bars show the standard deviation of the CEM measurements for each run.

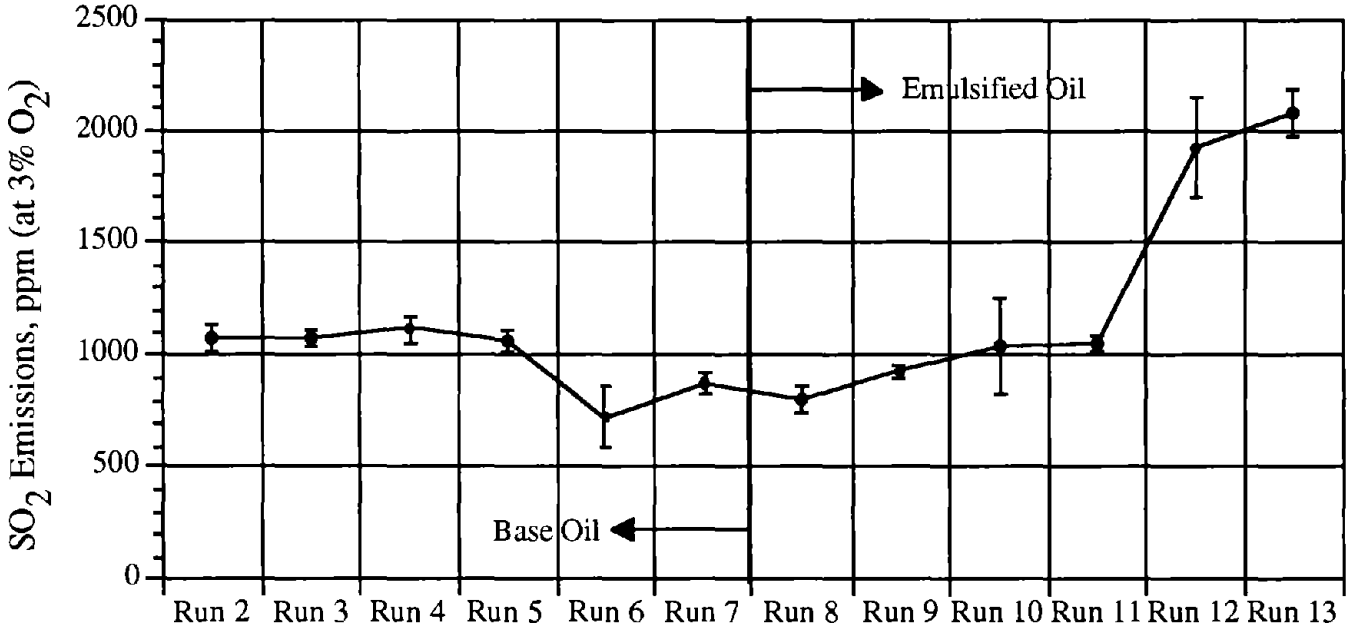

Figure 3-6. Average SO_2 emissions for 12 of the 13 runs. Runs 2-7 were conducted using the base #6 oil, and runs 8-13 with the emulsified oil. The error bars show the standard deviation of the CEM measurements for each run.

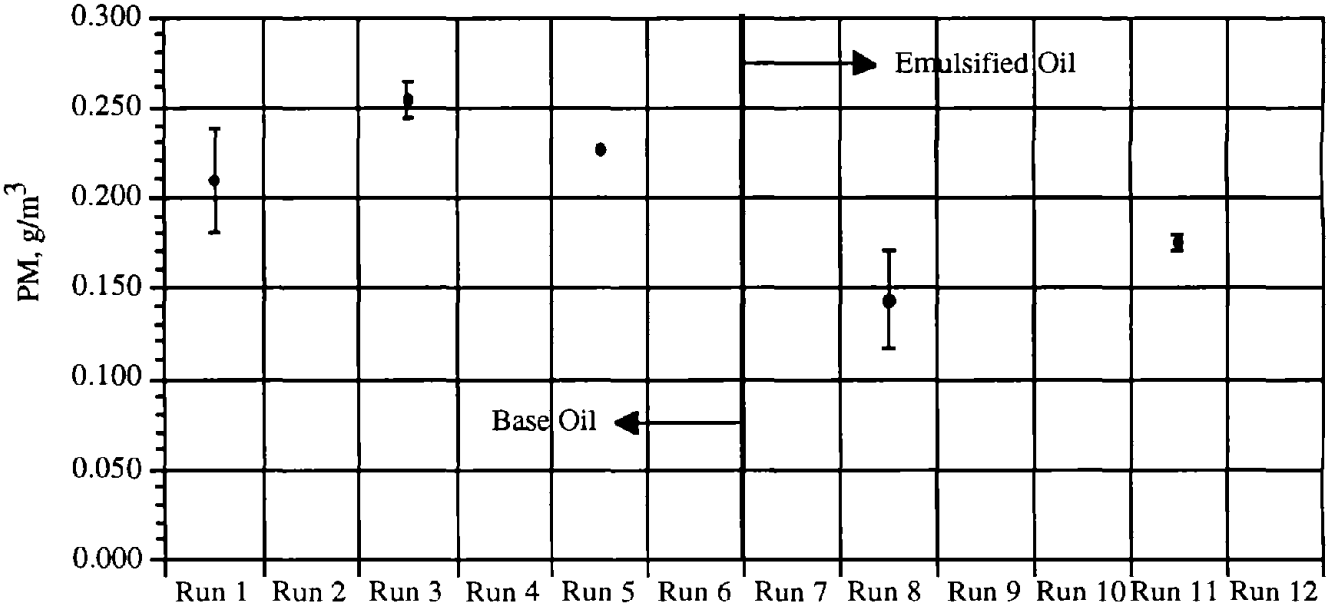

Figure 3-7. PM emissions for runs 1, 3, 5, 8, and 11. Runs 1, 3, and 5 were conducted using the base #6 oil, and runs 8 and 11 with the emulsified oil. The error bars show the standard deviation of the measurements for each run.

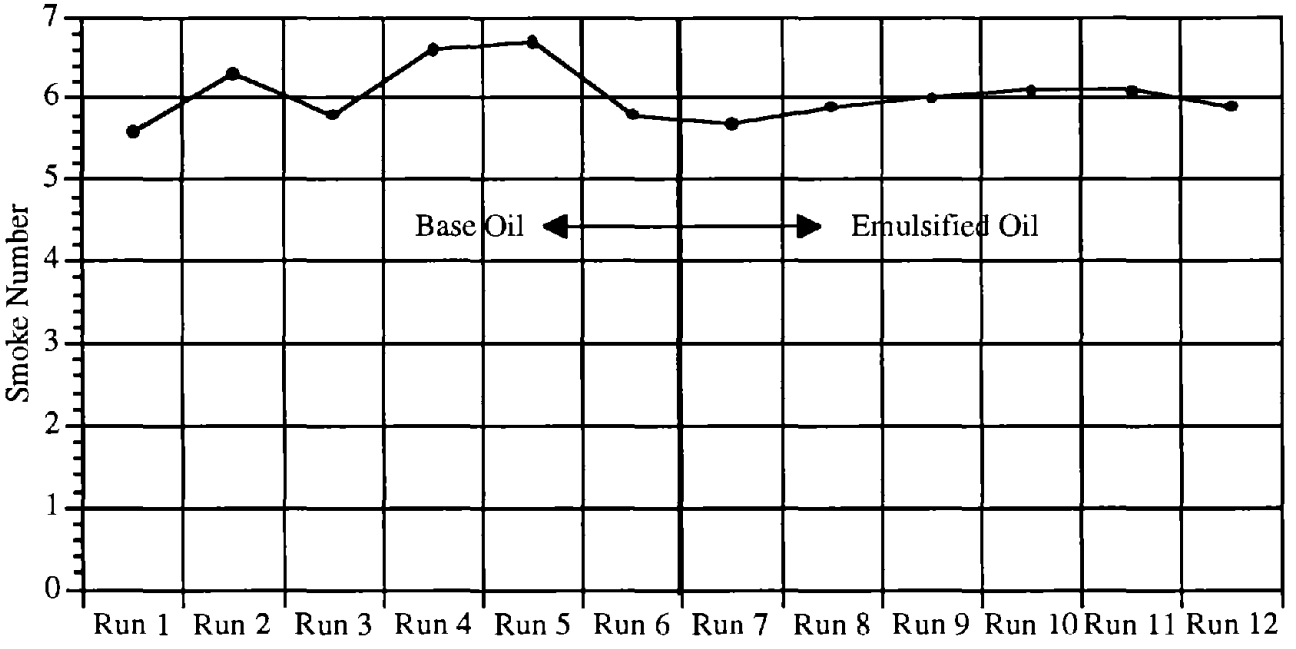

Figure 3-8. Smoke numbers for 12 of the 13 runs. Runs 1–6 were conducted using the base #6 oil, and runs 7–12 with the emulsified oil.

Table 3-2 and Figure 3-9 present the emission factors for the same four criteria pollutants in pounds per million British thermal units. The percent changes between the base and emulsified oil emission factors are somewhat different than the percent changes comparing the emissions based on concentrations. The differences are due to changes in the fuel and gas flow rates from the base to the emulsified fuel tests, and because the emission factor averages are taken from a smaller data set. As was the case for calculating the average concentration above, the average NO_x emission factor for the emulsified oil did not include runs 9 and 13, and the average SO_2 emission factor did not include runs 12 and 13 due to CEM problems. Emission factors for PM were calculated using only data from runs 1, 2, and 3 for the base oil and runs 7, 11, and 12 for the emulsified oil due to lack of sample volume data for the remaining runs.

Table 3-2. Average emission factors for criteria pollutants from the two fuels tested, in $lb/10^6$ Btu, at 3% O_2, dry conditions.

	Base #6 Fuel Oil (without emulsifier)	Emulsified #6 Fuel Oil
CO	0.019	0.014
NO_x	0.28	0.18
SO_2	1.9	1.7
PM	0.18	0.11

When comparing emission factors for these pollutants, the emulsified oil showed slightly greater, but consistent, reductions on a percentage basis than when comparing flue gas concentrations. The average CO emission factor was 24% lower for the emulsified oil compared with the base oil, the average NO_x emission factor was 35% lower for the emulsified oil compared to the base oil, and the average PM emission factor was 38% lower for the emulsified oil compared to the base oil. The average SO_2 emission factor was 9% lower for the emulsified oil compared to the base oil. As noted before, this difference is not attributed to the emulsified oil, but rather is due to changes in the sulfur content of the as fired fuel. As seen in Figure 3-6, there was relatively little variation in the average SO_2 value for each of the runs, with the exception of runs 11 and 12, indicating that the change in fuel did not have a significant impact on the SO_2 emissions.

3.1.1 PM Size Distribution

In addition to reducing the total mass of particulate, tests indicated that distribution of particle sizes also changed when firing the emulsified oil. This is due to the secondary atomization of the fuel by the water. The particle size distribution data were taken from a differential mobility particle sizer (DMPS) and from a cascade impactor that collects particulate in discrete size ranges. Total PM was also measured using the Method 29 filter. The total mass of PM captured in the Method 29 train did not correlate with the total

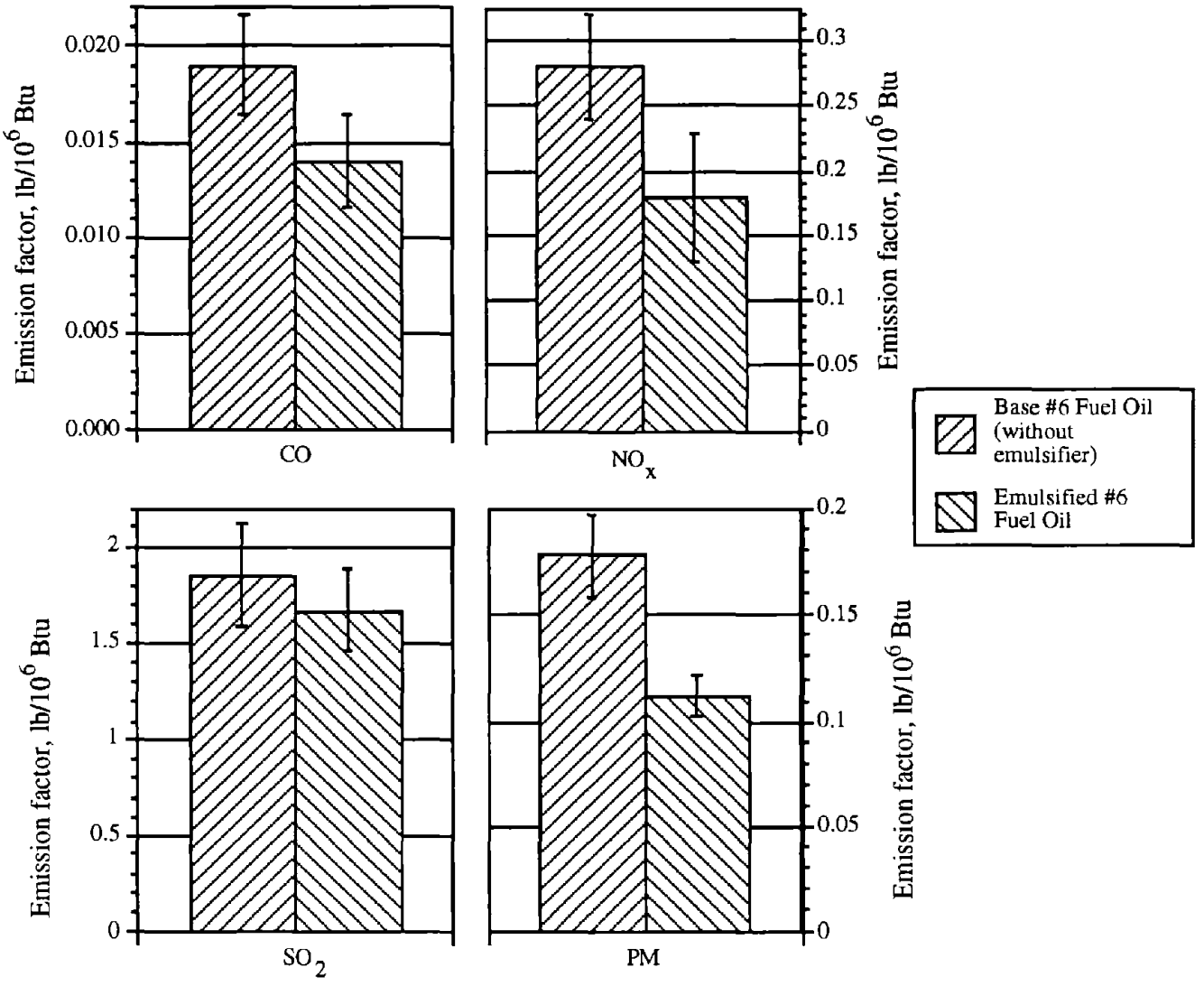

Figure 3-9. Average emission factors for CO, NO_x, SO_2, and PM for the base oil and the emulsified oil.

mass of the PM captured in the cascade impactor. Review of the data and collection procedures indicated that the total mass data from the Method 29 samples were good, while the mass values from the cascade impactor measurements were questionable. However, the trends in particle size distributions as a percentage of total mass measured by the cascade impactor were determined to be adequate, based on the data from the DMPS. In both cases, a shift was seen in the particle size distributions toward smaller sizes when using the emulsified oil as compared to the base oil. It is not clear, however, how the mass emissions of these smaller particles differed between the two oils. Additional study is required to quantify the actual mass emissions of the different particle size ranges for the two oils.

3.2 Metal HAP Emissions

Concentrations of 10 metal compounds were also sampled during the test program, using an EPA Method 29 sampling train. Concentrations of antimony, arsenic, beryllium, cadmium, chromium, lead, manganese, nickel, selenium, and vanadium were measured for both the base oil and the emulsified oil. Because the emulsifier did not contain any metals, the only source of metals in the stack gases was the oil itself, neglecting any erosion or residues from earlier testing. However, the previous operations of the NAPB were conducted using natural gas, which did not leave any metallic residues. Therefore, it is clear that the only source of metals in the present tests is from the fuels or from erosion of metal surfaces. However, there was no indication that such erosion was occurring during the testing. From Table 2-2, it is seen that the only metals of measurable quantity in the oil were nickel, sodium, and vanadium. Of these three, only nickel is listed as a HAP under Title III of the CAAAs.

Duplicate samples were taken during runs 1 and 3 using the base oil, and during runs 8 and 11 using the emulsified oil to allow an evaluation of the measurements' precision. A measure of the precision of the data is the relative percent difference (RPD), given by:

$$RPD = \frac{(C_1 - C_2)}{(C_1 + C_2)/2} \times 100\% \qquad \text{(Eq. 3-1)}$$

where C_1 is the largest and C_2 is the smallest of the two values being compared. The RPD allows the precision of duplicate samples taken during a single test run to be quantified.Table 3-3 shows the RPDs for the duplicate Method 29 samples for each of the 10 metals sampled. In general, runs 3 and 11 had the best correlation between the duplicate samples, with RPD values below 10% for all metals except antimony and cadmium in the case of run 11, and for all metals except for antimony, arsenic, beryllium, and selenium in the case of run 3. All metals in run 1 had RPDs over 10%, except for chromium, and only chromium and selenium had RPDs less than 10% in run 8.

Table 3-3 Relative percent differences for the duplicate Method 29 samples for each of the 10 metals. The values are calculated from the measured concentrations in grams per cubic meter. Nickel and vanadium concentrations from sample A of run 8 were not considered reliable, and were not included in these or other calculations.

Run	Sb	As	Be	Cd	Cr	Pb	Ni	Mn	Se	V
1	134	30.8	27.1	17.0	5.64	72.2	50.4	41.3	13.8	53.5
3	133	35.8	21.2	2.04	8.57	0.36	4.40	6.64	23.3	3.65
8	58.1	32.0	19.0	11.8	0.45	19.7	-	12.0	4.69	-
11	180	8.11	4.01	11.1	0.15	3.91	5.59	1.64	7.65	9.44

Because the RPD values for runs 1 and 11 are higher than the data quality indicator (DQI) goals (see Appendix B), it may be more reliable to compare the results from runs 3 and 11 only. Emission factors measured from runs 3 and 11 are presented in Table 3-4. These values generally show a slight increase in the metals emission factors for the emulsified oil compared to the base oil. However, except for antimony, the differences in emission factors between the base and emulsified oils were within ±21%. This indicates that there were no significant differences in emissions between the two oils, given the fluctuations in metal content of the fuels and errors associated with measurement and analysis. Even when using data from all runs, the metals emission factors were nearly identical for the two oils. Except for antimony, the metals emission factors ranged from a 9.4% increase in selenium from the base oil emission factor to the emulsified oil emission factor, to a 4.6% decrease in arsenic from the base oil emission factor to the emulsified oil emission factor. Since the data from runs 3 and 11 are more reliable, these are presented in Table 3-4 and Figure 3-10.

A further check on the data is to estimate the maximum emission factors using the as-received energy contents and contents of trace metals in the oils. Estimates of the maximum emission factor for metals can be calculated by assuming that the total mass of these metals entering the boiler in the fuel exits the boiler in the stack flue gases. In this study, only nickel and vanadium were found to be at levels above the detection limits in the as-fired base oil, so only for these metals can estimates be made of the maximum emission factors. Some differences are expected between the calculated emission factor based on the trace metal contents and the measured emission factor, due to the relatively low levels being measured, analytical accuracy, and the variability in the samples. In some systems, there is also retention of the metals in ash that is deposited within the boiler.

Table 3-4. Average measured emission factors for the 10 metals sampled, in lb/10^{12} Btu. Only data from runs 3 and 11 for the base and emulsified oils, respectively, are presented. Note that lead and vanadium are not listed as HAPs under Title III of the CAAAs.

	Base Oil (data from run 3 only)	Emulsified Oil (data from run 11 only)
Antimony	77.5	156
Arsenic	5.07	4.51
Beryllium	0.174	0.187
Cadmium	4.07	4.24
Chromium	19.7	20.9
Lead	161	135
Manganese	20.0	24.1
Nickel	5190	5620
Selenium	15.5	16.4
Vanadium	25,300	27,600

For nickel, the maximum emission factor based on the nickel contents of the oils was found to be 3560 lb/10^{12} Btu for the base oil and 3910 lb/10^{12} Btu for the emulsified oil, and for vanadium the maximum possible emission factor was calculated to be 26,600 lb/10^{12} Btu for the base oil and 29,300 lb/10^{12} Btu for the emulsified oil. These values are quite close to the measured values given in Table 3-4, with the measured emission factors for nickel being 146% of the calculated emission factors for the base oil and 144% for the emulsified oil. For vanadium, the measured emission factor for the base oil was 95% of the calculated emission factor, and for the emulsified oil, the measured emission factor was 94% of the calculated emission factor. The values of over 100% most likely indicate fluctuations in the nickel levels between the fuel tested and the fuel actually burned in the boiler. However, the fact that both the base and emulsified oils showed nearly identical percentages indicates that there are no significant differences in how these two metals behaved in the combustion environment when comparing the base and emulsified oils.

For the metal emission results in general, the results followed the expected pattern and showed no significant differences between the base oil and the emulsified oil, as seen in Figure 3-10. Although there was a relatively large difference in the antimony emission factors between the two fuels, the data for antimony showed a much larger scatter than was present in the other metals. Because there was no metal

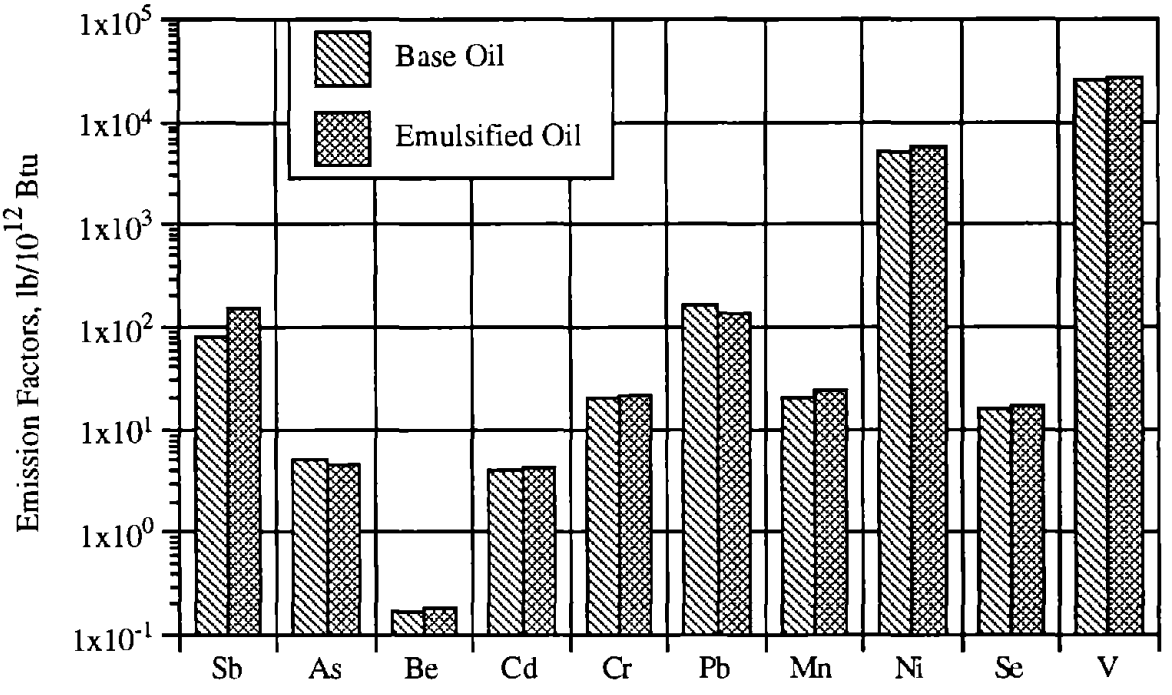

Figure 3-10. Average measured emission factors for 10 metals sampled for the base oil and the emulsified oil. Data from runs 3 and 11 only are used to calculate the averages.

added in the emulsifying agent, it was expected that the two fuels would show essentially the same total emissions of metals per unit of energy.

3.2.1 Metal Size Distribution

As was done for total PM emissions, some metal emissions were also sampled to determine the effects of the oil/water emulsion on size distribution. Each sample of particulate collected by size fraction was analyzed to determine the amount of chromium, nickel, and vanadium in the size fraction. As in the case with the total PM size distributions, the mass values measured for the total nickel and vanadium samples were not consistent with the total mass of nickel and vanadium measured in the size-segregated samples. While the trends indicated a shift toward smaller particles for the emulsified oil compared to the base oil, quantification of that shift remains to be determined.

3.3 Organic HAP Emissions

Emissions of organic compounds are usually less well defined as those of metal compounds. This is because the total mass of metals remains constant in the combustion process, and any metal entering the system via the fuel must exit either in the flue gas or in one of the ash streams such as bottom ash. While many toxic organic compounds are present in hydrocarbon fuels, they are also created and/or destroyed in the combustion process. The total emission of these compounds is often highly dependent on the combustion conditions and the mixing processes within the combustor. This can result in measurements of organic compounds that vary significantly between test runs.

3.3.1 Volatile Organic HAP Emissions

In the current set of tests, four sample tubes were collected for each oil type. Table 3-5 shows each volatile organic compound (VOC) detected during the testing and the number of times it was detected in the four sample tubes, as a function of the oil type. The samples were analyzed for a total of 45 VOCs, of which 24 were listed as HAPs under Title III of the CAAAs. As can be seen in Table 3-5, 17 compounds were detected, with all compounds but one being detected multiple times.

Because several of these compounds are present in laboratory and field environments, the sampled mass of each compound was compared to the amount of that compound measured in two field blanks. These blanks were prepared in the same way as a regular sample, but without having an actual flue gas sample drawn into them. For all but four compounds, the field blanks showed levels of volatile organic HAPs of the same order of magnitude or greater than one or more of the sample tubes. The field blanks showed no indication of 2-butanone, carbon disulfide, styrene, or 1,1,1-trichloroethane. However, because 1,1,1-trichloroethane was measured in only one sample tube and because of its highly chlorinated

Table 3-5. Volatile organic compounds detected for each oil during combustion testing, with the number of times the compound was detected (out of four sample tubes for each oil).

	Base Oil	Emulsified Oil
Acetone	1	4
Benzene	4	3
Bromodichloromethane	2	2
Bromomethane	2	2
2-Butanone	1	2
Carbon Disulfide	3	3
Chloroform	2	2
Chloromethane	2	1
Dichlorodifluoromethane	3	4
Ethylbenzene	2	2
Styrene	1	3
Toluene	4	4
1,1,1-Trichloroethane	1	0
Trichlorofluoromethane	3	2
Xylene (m,p)	2	2
o-xylene	2	2

nature, the measurement was not considered to be highly reliable. These results indicate that a number of the VOCs measured in the sample tubes may have been the result of sample contamination and not due to the presence of a particular compound. However, for benzene, ethyl benzene, toluene, and m,p xylenes, one or more samples showed levels of volatile organic HAPs significantly higher (a factor of 3 or more) than what was present in the field blanks. The detected levels of the remaining compounds were nearly all less than 2 times higher than the field blanks, with most of the samples being either at or below the levels seen in the field blanks. Table 3-6 presents the ratio of the field blanks to the average detected mass of each compound in the base oil and emulsified oil samples.

Of the remaining three compounds, 2-butanone and styrene were detected in only one of four VOST tubes for the base oil. 2-butanone was detected in two of four tubes for the emulsified oil, and carbon disulfide was detected in three of four tubes for both fuels. Styrene was detected in three of four tubes in the emulsified oil. Since each run produced a pair of tubes, RPD values can be calculated to evaluate the precision of the duplicates. Table 3-7 presents the RPD for benzene, 2-butanone, carbon disulfide, ethyl benzene, styrene, toluene, and m,p xylenes.

These results show that there is significant variability in the data, making the reliability of the quantitative emissions data questionable. On a qualitative basis, the two oils were very similar in the compounds detected and in the levels measured. Even given the variability in the data, if the assumption is

Table 3-6. Ratio of mass of volatile organic compound detected in the field blanks to the average detected mass in the samples, for the base and emulsified oils.

	Base Oil	Emulsified Oil
Acetone	18.4	8.40
Benzene	6.36	7.27
Bromodichloromethane	19.1	19.8
Bromomethane	7.53	3.79
2-Butanone	0.00	0.00
Carbon Disulfide	0.00	0.00
Chloroform	18.4	17.8
Chloromethane	66.5	1.08
Dichlorodifluoromethane	12.3	10.4
Ethylbenzene	6.23	3.11
Styrene	0.00	0.00
Toluene	19.4	8.50
1,1,1-Trichloroethane	0.00	0.00
Trichlorofluoromethane	14.1	21.2
Xylene (m,p)	1.93	3.10
o-xylene	6.42	5.92

Table 3-7. Relative percent differences between VOST tube measurements for three volatile organic compounds.

	Run 1	Run 2	Run 3	Run 4
Benzene	5.23%	17.9%	3.76%	200.%
2-Butanone	NA	200.%	200.%	200.%
Carbon Disulfide	200.%	21.14%	30.2%	200.%
Ethyl Benzene	200.%	200.%	200.%	200.%
Styrene	200.%	NA	102.%	200.%
Toluene	141.%	24.8%	177.%	42.9%
Xylene (m,p)	200.%	200.%	200.%	200.%

*NA - Not applicable (all data for the run were below the detection limit)

made that all measurements were accurate, the total VOC emission factor was on the order of 5 lb/10^{12} Btu for both oils, which is very small compared to the metals emission factors.

Table 3-8 presents the emission factors for the 7 VOCs listed above, both in terms of average detected emissions and incorporating the measurements which were less than the method detection limit. The measurements which incorporate samples that measured below the detection limit are typically less than the values reported for the average detected emissions, since the detected values are almost always higher than

Table 3-8. Emission factors of volatile organic compounds, in lb/10^{12} Btu. The Average Detected Value figures do not include measurements below the method detection level. The Average (All Readings) figures include measurements below the method detection level. Averages for compounds that had measurements below the detection level are calculated using the method detection level, and are indicated as being "less than" the given value.

	Average Detected Value		Average (All Readings)	
	Base Oil	Emulsified Oil	Base Oil	Emulsified Oil
Benzene	0.971	0.684	0.958	< 0.582
2-Butanone	0.867	1.44	< 0.518	< 0.857
Carbon Disulfide	1.71	0.880	< 1.36	< 0.729
Ethyl Benzene	0.177	0.278	< 0.294	< 0.278
Styrene	0.354	0.368	< 0.390	< 0.345
Toluene	1.56	2.81	1.54	2.81
Xylene (m,p)	0.475	0.230	< 0.443	< 0.254

the listed method detection limit (although some samples had measureable concentration levels slightly below the listed method detection limit). The values calculated using measurements below the detection limit are all given as being "less than" the listed value.

Although the compounds listed in Table 3-8 are reported with lower than desireable reliability concerning the absolute quantities, it is likely that these volatile organic HAPs are present in the flue gases. For instance, both benzene and toluene were measured in the flue gases repeatedly and at consistent levels significantly greater than levels measured in the field blanks. Additionally, previous studies have indicated their presence in the flue gas of oil combustion systems,[9,10] and it is likely that they are present in the flue gases of the two oils tested in this study. Even neglecting any contamination by the analysis procedures, however, neither of these compounds was present in levels exceeding 3 lb/10^{12} Btu.

3.3.2 Semivolatile Organic HAP Emissions

Flue gas samples were also analyzed for semivolatile organic HAPs using a Modified Method 5 sampling train and standard EPA analysis methods. As was the case for the volatile organic HAPs, the measurements in some cases varied significantly between samples. Three samples were taken of base oil flue gases and four samples of emulsified oil flue gases, with two of those four being taken during a single test run. The flue gases were analyzed for 105 semivolatile compounds, of which 45 were listed as HAPs under Title III of the CAAAs. Included in the 105 compounds were 17 PAHs, which are listed as a single HAP under Title III. Of the 105 compounds, only 15 were detected at least once in the 7 samples. The semivolatile organic compounds detected and the number of times they were detected are presented in Table 3-9. Dibenzofuran was the only compound detected solely in the flue gases of the emulsified oil,

while 7 of the 15 compounds detected were found only in the flue gases of the base oil. Naphthalene and dibutyl phthalate were the only two compounds detected in every sample.

The emissions of semivolatile organic compounds were dominated by phthalates. However, the phthalates were also found in the field blanks in high concentrations, indicating that the majority of the phthalates measured in the samples were from contamination during analytical procedures rather than actual presence in the flue gases (phthalates are common laboratory contaminants). Of the remaining compounds, benzyl alcohol was the major semivolatile organic emission from the base oil, and phenol constituted almost the entire semivolatile emissions from the emulsified oil. Emission factors for the semivolatile compounds for the two oils are presented in Table 3-9 and Figure 3-11. Table 3-9 and Figure 3-11 present two sets of emission factors, the first calculated by assuming that compounds with concentrations below the detection limit are at zero concentration, and the second calculated by assuming

Table 3-9. Semivolatile organic compounds detected for each oil during combustion testing, with the number of times the compound was detected (out of three sample trains for the base oil and four sample trains for the emulsified oil).

	Base Oil	Emulsified Oil
Benzo(a)anthracene	2	0
Benzo(g,h,i)perylene	2	0
Benzyl alcohol	2	0
Benzyl butyl phthalate	1	1
Bis(2ethylhexyl)phthalate	2	2
Chrysene	2	0
Dibenz(a,h)anthracene	2	0
Dibenzofuran	0	4
Dibutyl phthalate	3	4
Diethyl phthalate	1	4
Di-N-octyl phthalate	2	3
3-methylcholanthrene	1	0
3&4-methyl phenol	1	0
Naphthalene	3	4
Phenol	1	2

Table 3-10. Average semivolatile organic emission factors in lb/10^{12} Btu. In columns 2 and 3, emission factors were calculated using the detection levels for samples in which the concentration was below the detection value. In columns 4 and 5, emission factors were assumed to be zero if the concentration was below detection value. Some compounds in Table 3-8 are not shown here due to high field blank levels of those compounds.

	Calculated using detection level		Calculated using zero	
	Base Oil	Emulsified Oil	Base Oil	Emulsified Oil
Benzo(a)anthracene	0.16	0.16	0.10	0
Benzyl alcohol	7.58	13.5	2.47	0
Chrysene	0.14	0.15	0.08	0
Dibenz(a,h)anthracene	0.36	0.43	0.20	0
Dibenzofuran	0.66	0.10	0	0.06
3-methylcholanthrene	0.03	0	0.03	0
3&4-methyl phenol	5.50	7.14	0.08	0
Phenol	5.58	5.56	0.47	2.37

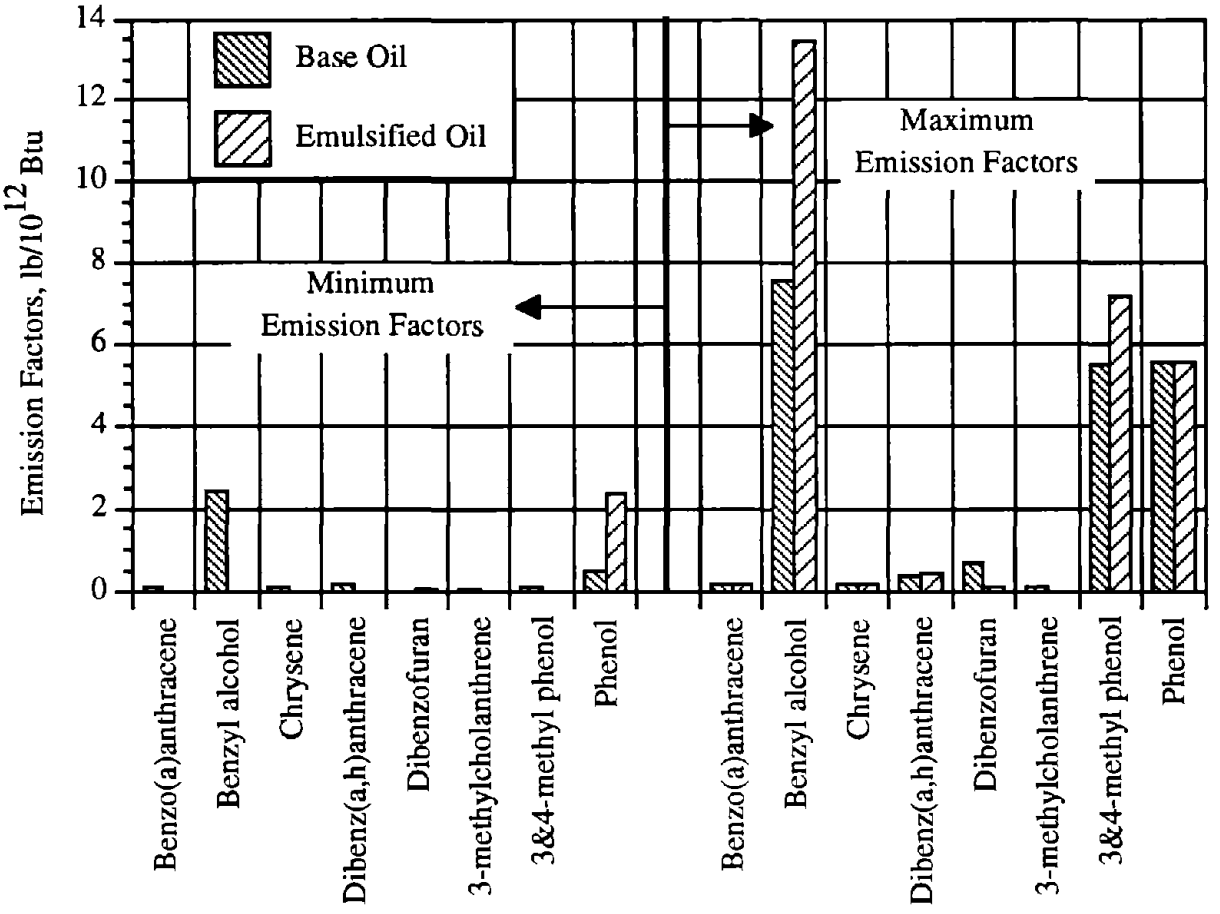

Figure 3-11. Average semivolatile emisson factors for the base and emulsified oils The bars on the left half of the figure assume compounds at concentrations below the detection limits are at zero concentration, and the bars on the right half of the figure assume compounds at concentrations below the detection limits are at the detection limit concentration.

that compounds with concentrations below the detection limit are at the detection limit. In this way, Table 3-10 and Figure 3-11 present the bounds on the emission factors for these compounds, with the minimum being the zero concentration assumption and the maximum being the detection limit concentration assumption.

3.3.3 Dioxin and Furan Emissions

The final organic compounds for which the flue gases were analyzed were PCDDs and PCDFs. In all cases for both the base oil and emulsified oil, the levels of PCDDs and PCDFs were below the method detection levels.

4. DISCUSSION

Based on the knowledge of the emulsified oil, there were only three areas that were considered to have potential for significant changes when using the emulsified oil compared to the base oil. These areas were operational factors (e.g., boiler efficiency), emissions of criteria pollutants, and emissions of organic compounds. Because no metals were being introduced into the oil from the emulsifier, it was expected that there would be no change in metal emissions. However, because the emulsification process results in secondary atomization and the formation of finer fuel droplets, it was expected that particulate sizes could shift toward smaller particle size ranges which are more difficult to collect.

4.1 Operational Factors

Relatively little difference was noted between the base and the emulsified oils during operation. The major difference was the O_2 level to which the unit was controlled. However, once this was set, little or no further adjustment was necessary to operate the boiler. While the water content of the flue gases was higher when using the emulsified oil compared to the base oil, no adverse effects were noted during the operation of the unit. These comparisons were only made during short term operation of the boiler, and no information was collected on any long term operational effects of using the emulsified oil.

4.2 Criteria Pollutant Emissions

The emulsified oil showed reductions in the CO emission factor of 24% compared with the base oil, in the NO_x emission factor of 36% compared with the base oil, and in the PM emission factor of 37% when using the emulsified oil compared with the base oil. These reductions were consistent across the test runs, and are the result of the finer fuel droplets and secondary atomization characteristic of the emulsified oil, allowing improved vaporization and oxidation of the hydrocarbon fuels, and the lower excess air level

used during operation with the emulsified oil. Some reduction of NO_x may also be due to the presence of higher amounts of water in the flame zone, thereby reducing the peak flame temperature and the associated formation rate of NO_x. However, the major factor influencing NO_x levels was the lower amount of excess air used during combustion.

No long term reduction of SO_2 would be expected from using the emulsified oil, since the amount of sulfur being input to the boiler via the fuel would be essentially the same for a given total heat load. If any change is noticed in total SO_2 emissions, it would be expected that there may be a slight increase due to combustion efficiency losses caused by higher levels of water in the fuel. Such an increase is not expected to be significant, however. The major factor influencing SO_2 emissions will remain the fuel's as-fired concentration of sulfur per unit energy.

The distribution of particle sizes showed a discernable shift toward smaller sizes in the emulsified oil compared to the base oil. It is not known whether or not the total mass of the smaller particulate emissions increased. This may be an area for concern, based on recent studies that have indicated a link between adverse health effects and ambient levels of small (< 2.5 μm) particulate.[11] Impacts of these studies and their implications for emissions controls are currently being evaluated.

4.3 Metal Emissions

As with SO_2, no significant change in total uncontrolled emissions of metals would be expected over long term operation using the emulsified oil. For sources with particulate control, the impact of using emulsified oil on metals emissions is not as clear. While the absolute mass of particulate emissions will be significantly reduced by the control device, the shift in particle sizes noted for the emulsified oil compared with the base oil may result in an increase in the fine particulate fraction, which is less efficiently controlled by standard particulate control systems. In instances where the metals are concentrated in the fine particulate fraction, the emissions of those metals may not significantly decrease when using the emulsified oil for the same controlled source. Additional work is required to allow a quantification of this effect. In addition, a slight increase in metal emissions may result due to a reduction in the thermal efficiency of the boiler due to the increased water in the flue gas during operation with the emulsified oil. The major factor influencing the total emissions of metals will be the oil's trace metal content per unit energy.

4.4 Organic HAP Emissions

Emissions of organic compounds were 9% higher when using the emulsified fuel oil compared with the base oil. The VOC emission factors from both oils were the same order of magnitude as the emission

factors for the sampled semivolatile organics, and one or more orders of magnitude lower than for the metals. Emission factors for semivolatile compounds were 29% lower for the emulsified oil than for the base oil. Emissions of chlorinated dioxins and furans did not change, with neither fuel having detectable quantities of PCDDs or PCDFs in the flue gases. The lower levels of organic compound emissions are likely due to the secondary atomization generated by the emulsification of the oil. For both oils, the level of total organic emissions is very low and, although the percentage change values may seem significant, the total mass of organic compounds emitted for both fuels remains very low. For both the base and emulsified oils, the organic emissions were dominated by the semivolatile organics, and were approximately four orders of magnitude less than the emissions of vanadium and three orders of magnitude lower than the emission rate of nickel.

5. CONCLUSIONS

The emulsified oil showed lower emissions of CO, NO_x, PM, and organic HAPs compared to the base #6 oil. No significant change was noted in emissions of SO_2 or total metals.

For the boiler tested, operating at its full load capacity of 2.5×10^6 Btu/hr for a full year, the total annual emissions of organic compounds would be 0.035 lb/year for the base oil and 0.025 lb/year for the emulsified oil. This compares with 308 lb/year of combined vanadium and nickel emissions for the base oil and 335 lb/year of combined vanadium and nickel emissions for the emulsified oil. For both oils, the emissions of HAPs are well below the 10 tons/year threshold defined by Title III of the CAAAs for a major source.

A potential drawback to the use of the emulsified oil is the indicated shift of the distribution of particulate sizes toward the smaller size ranges. Additional work remains to quantify this aspect of the emissions.

6. REFERENCES

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APPENDIX A. ENGLISH ENGINEERING TO METRIC CONVERSIONS

$kW = Btu/hr \times 3413$

$°C = (°F - 32) \div 1.8$

$m^2 = ft^2 \div 10.764$

$cm = in. \times 2.54$

$kg = lb \div 2.2046$

$kPa = psi \times 6.893$

$tonne = ton \times 0.9072$

$\mu g/MJ = lb/10^{12}\ Btu \times 0.430$

APPENDIX B. QUALITY EVALUATION REPORT

This project was conducted under an approved APPCD Level III Quality Assurance (QA) Project Plan. The plan set forth the operating, sampling, and analysis procedures to be used during the testing, as well as the data quality indicator (DQI) goals for the project. The DQI goals for the project are shown in Table B-1.

Table B-1. Data quality indicator goals for the project.

Measurement	Bias	Precision	Accuracy	Completeness
VOCs	50-150%	< 30%	NA	>70
Semivolatiles	18-120%	< 15%	NA	>70
Metals	75-125%	< 10%	NA	>70
PCDDs/PCDFs	25/40-130%	< 30%	NA	>70
O_2	NA	<15% RSD*	< ±3%	>90
CO_2	NA	<15% RSD	< ±3%	>90
CO	NA	<15% RSD	< ±3%	>90
NO_x	NA	<15% RSD	< ±3%	>90
THC	NA	<15% RSD	< ±3%	>90
SO_2	NA	<15% RSD	< ±3%	>90
Fuel Flow	NA	± 10% RSD	±10%	>90
Temperature	NA	± 10% RSD	±10%	>90

*Relative standard deviation

B.1 CEM Data

The CEM data were for the most part of high quality and met the DQI goals. However, the SO_2 analyzer did not meet the post-test calibration goals of ±3% deviation from full scale for runs 7 through 13. Noticeable differences were noted for runs 12 and 13, and these data were not used in the calculations of the average SO_2 emissions. For runs 7 through 11, the CEM data appeared to be good for the majority of the test runs, but drifted lower toward the end of the runs. For these runs, only the data judged to be measured prior to the onset of analyzer drift were used in the calculation of the averages. The NO_x analyzer also displayed periodic problems, resulting in post-test calibrations of the midspan point that typically showed a drift toward lower values. However, the one post-test calibration of the high range calibration point did not show this drift. On average, the difference between the pre-test check and the post-test check of the midpoint calibration was 5.5% of full scale. During runs 8 and 11, the NO_x analyzer had periods of signal loss, resulting in negative concentration measurements. Data from these runs were not used in calculating the average emission factors. The CO analyzer showed differences within 3% of full scale for all tests.

B.2 Duplicate Samples

Duplicate sampling trains were used during several runs to help evaluate the precision of the results. One pair of duplicate samples were collected for the semivolatile organic compounds, two pairs for the dioxin and furans, and four pairs for the metals.

For the semivolatile organic compounds the only compound detected at levels above the field blank during the use of duplicate sampling trains was dibenzofuran. The measurements of dibenzofuran for the duplicate trains resulted in a relative percent difference of 53.6%. All PCDD/PCDF samples collected were below the method detection level. Therefore the RPD values were not calculated for these duplicates. For the metals, two pairs of duplicate measurements were made for the base oil and two for the emulsified oil. The calculated RPD values for each of these pairs of measurements are shown in Table 3-3, and a short discussion of the metals data quality is given in Section 3.

B.3 Duplicate Tests

Duplicate tests were conducted for all measurements. The test matrix in Table 2-3 shows the duplicate tests for metals, VOCs, semivolatile organic compounds, and PCDDs/PCDFs. Duplicate tests were conducted for VOCs from the base oil and the emulsified oil, and triplicate tests were conducted for the semivolatile organic compounds from the base oil and the emulsified oil. Four tests were conducted for the PCDDs/PCDFs for the base oil, and three tests were conducted for PCDDs/PCDFs for the emulsified oil.

B.3.1 Criteria Pollutants

Figures 3-1 and 3-2 present the averages and standard deviations for the CEM, PM, smoke number, and load measurements for the tests. Standard deviations for the individual runs for CO, NO_x, SO_2, and PM are given in Figures 3-4 through 3-8, respectively.

B.3.2 Metals

For the metals tests, runs 1, 3, and 5 provided triplicate tests of the base oil, and runs 8 and 11 were duplicates for the emulsified oil. Table B-2 present the averages and standard deviations for each metal for the base oil and the emulsified oil. This table presents the fluctuation between the different test runs as a measure of the test repeatability.

B.3.3 Volatile Organic Compounds

Runs 2 and 5 were duplicate tests of the base oil volatile organic compounds and runs 10 and 11 were duplicate tests of the emulsified oil volatile organic compounds emissions. Table B-3 shows the results from these tests as a measure of the experimental repeatability of the VOC measurements.

Table B-2. Average metal emission factors for each run and the standard deviation between the runs.

	Base Oil				Emulsified Oil		
	Run 1 Average	Run 3 Average	Run 5	Standard Deviation	Run 8 Average	Run 11 Average	Standard Deviation
Antimony	211	38.8	38.1	99.6	30.0	78.2	34.1
Arsenic	1.62	2.53	2.27	0.471	1.78	2.26	0.340
Beryllium	0.0741	0.0869	0.0884	0.00785	0.0790	0.0934	0.0102
Cadmium	1.96	2.04	2.19	0.117	1.79	2.12	0.235
Chromium	10.6	9.83	10.1	0.383	9.94	10.5	0.372
Lead	60.9	80.5	69.3	9.81	59.1	67.5	5.92
Nickel	2040	2590	2670	342	2200	2810	433
Manganese	8.14	10.0	10.6	1.28	10.7	12.1	0.986
Selenium	5.73	7.76	7.73	1.17	6.97	8.22	0.889
Vanadium	10,100	12,600	13,000	1560	10,600	13,800	2240

Table B-3. Average volatile organic compound emission factors in $lb/10^{12}$ Btu and the relative percent differences between the runs. Measurements below the detection limit were assumed to be zero.

	Base Oil			Emulsified Oil		
Averages	Run 2	Run 5	RPD	Run 10	Run 11	RPD
Dichlordifluoromethane	0.0392	0.0437	10.9%	0.0224	0.0328	37.9%
Chloromethane	0.0095	0.0302	104%	ND*	0.0057	200%
Bromomethane	ND	0.0122	200%	0.0374	0.0185	67.7%
Trichlorofluoromethane	0.0203	0.0098	69.6%	0.0060	0.0051	16.0%
Carbon disulfide	0.0947	0.0813	15.3%	0.0306	0.0597	64.4%
Acetone	ND	0.131	200%	0.185	0.238	24.9%
Methylene chloride	6.78	4.05	5.04%	6.26	4.65	29.6%
Chloroform	0.0786	0.0335	80.6%	0.0359	0.0396	9.9%
2-Butanone	ND	0.0434	200%	0.0700	0.0661	5.8%
1,1,1-Trichloroethane	0.0073	ND	200%	ND	ND	NA†
Benzene	0.0522	0.0449	15.0%	0.0322	0.0304	5.6%
Bromodichloromethane	0.0137	0.0068	66.7%	0.0062	0.0068	10.2%
Toluene	0.0942	0.0621	41.0%	0.0692	0.181	89.5%
Ethylbenzene	0.0112	0.0066	51.9%	0.0211	0.0062	110%
Xylene (m,p)	0.0421	0.0053	155%	0.0176	0.0051	111%
o-xylene	0.0123	0.0022	139%	0.0062	0.0055	11.3%
Styrene	0.0176	ND	200%	0.0194	0.0110	55.1%

*ND - Compound below detection limit

†NA - Not applicable

B.3.4 Semivolatile Organic Compounds

Runs 4, 6, and 7 were triplicate tests of the base oil semivolatile organic compounds and runs 10, 12, and 13 were triplicate tests of the emulsified oil semivolatile organic compounds emissions. Table B-4 shows the results of these measurements and the standard deviation of each compound's emission factor as a measure of the test repeatability.

Table B-4. Average emission factors for semivolatile organic compounds, in lb/10^{12} Btu, and the standard deviations of the triplicate runs. Compounds that were measured below the detection level are assumed to be zero in this case.

	Base Oil				Emulsified Oil			
Compound	Run 4	Run 6	Run 7	Standard Deviation	Run 10	Run 12	Run 13	Standard Deviation
Phenol	643	0	0	371	0	3410	1570	1700
Benzyl alcohol	3020	337	0	1660	0	0	0	0
3&4-methyl phenol	112	0	0	64.5	0	0	0	0
Naphthalene	194	170	798	356	184	473	248	152
Dibenzofuran	0	0	0	0	23.9	78.4	22.5	31.9
Chrysene	51	60.6	0	32.6	0	0	0	0
Benzo(a)anthracene	74.2	55.9	0	38.7	0	0	0	0
3-methylcholanthrene	43.8	0	0	25.3	0	0	0	0
Dibenz(a,h)anthracene	212	58.3	0	110	0	0	0	0
Benzo(g,h,i)perylene	197	59.4	0	101	0	0	0	0

B.3.5 PCDDs/PCDFs

Duplicate tests were conducted for PCDDs/PCDFs during runs 2, 4, 6, and 7 for the base oil and during runs 9, 12, and 13 for the emulsified oil. All measurements were below the method detection limit.

B.4 Blanks

B.4.1 Volatile Organic Compounds

Of the 45 target VOCs, 13 were detected in the field blanks, and 9 on both field blanks. Table B-5 shows the detected amounts of the 13 compounds. As noted in Section 3, these high levels of blank contamination resulted in a significant loss of data quality for the VOC measurements. However, the levels of those compounds such as benzene and toluene that were detected in the samples were not high, even when disregarding the possibility of any sample contamination. Nevertheless, the values reported in Section 3 do not include any of the compounds listed in Table B-5.

Table B-5. Volatile organic compounds detected in the field blanks, in ng.

Compound	Detected Concentration, ng	
	Blank 1	Blank 2
Acetone	86.6	35.8
Benzene	15.7	ND*
Bromodichloromethane	5.11	4.08
Bromomethane	2.77	4.16
Chloroform	26.0	22.3
Chloromethane	7.45	23.1
Dichlorodifluoromethane	15.5	4.24
Ethylbenzene	ND	2.74
Methylene chloride	3520	2700
Trichlorofluoromethane	4.26	3.94
Toluene	61.6	15.3
M,P-xylene	ND	2.26
o-xylene	ND	2.31

*ND - Not Detected

B.4.2 Semivolatile Organic Compounds

The MM5 field blanks showed the presence of 7 of the 105 target compounds, indicating that at least some of their presence was due to either previous contamination of the sampling train or contamination during the extraction and analysis procedures. The eight compounds detected in the field blank are shown in Table B-6. None of these compounds were reported as detected in Section 3.

Table B-6. Semivolatile organic compounds detected in the field blanks.

Compound	Detected Concentration, µg/ml
Acetophenone	8.73
Benzyl butyl phthalate	2.23
Bis(2-ethylhexyl)phthalate	170
Dibutyl phthalate	34.0
Diethyl phthalate	17.9
Di-N-octyl phthalate	810
Naphthalene	2.72

B.5 Matrix Spikes

Matrix spikes were used to evaluate the ability of the analytical procedures to accurately measure known concentrations of materials. Matrix spikes were performed for the semivolatile compounds and for

the metals. No matrix spikes were performed for the VOCs or PCDDs/PCDFs. The percent recovery is calculated as:

$$\text{Recovery} = \frac{(\text{Measured Concentration})}{(\text{Known Concentration})} \times 100\% \qquad \text{(Eq. B-1)}$$

B.5.1 Semivolatile Organic Compounds

Two matrix spikes were done for PAHs, and the recoveries of these spikes are shown in Table B-7. The recoveries ranged from 80% to 126%, and had relative percent differences (RPDs) from 0 to 14.9%. The RPD is a measure of the recovery precision, and in each case was well below the DQI goal of < 30%.

Table B-7. Spike recoveries and relative percent differences for the matrix spikes of PAHs.

Target Compound	First Spike Recovery, %	Second Spike Recovery, %	RPD
Acenaphthene	104	101	2.12
Acenaphthylene	104	106	1.41
Anthracene	102	107	3.54
Benzo(a)anthracene	126	124	1.41
Benzo(b)fluoranthene	90	89	0.71
Benzo(k)fluoranthene	108	112	2.83
Benzo(ghi)perylene	98	107	6.36
Benzo(a)pyrene	93	93	0.00
Chrysene	92	101	5.66
Debenz(a,j)acridine	114	116	0.71
Dibenz(a,h)anthracene	80	91	7.78
Fluoranthene	122	124	1.41
Fluorene	115	109	4.24
Ideno(1,2,3-cd)pyrene	83	80	2.12
Naphthalene	117	109	5.66
Phenanthrene	90	111	14.9
Pyrene	111	98	9.19

B.5.2 Metals Matrix Spikes

For the metals, a National Institute of Standards and Technology (NIST) standard fly ash containing known concentrations of metals was used as the matrix spike. The standard used was NIST SRM 1633b fly ash. For the first spike, 1.05 g of the NIST sample was used, and 0.116 g of the NIST sample was used for the second spike. Because the concentrations of each metal were the same for both spikes, the total mass of each metal was approximately a factor of ten lower for the second spike than for the first. This resulted in measurements of antimony and cadmium being below the method detection level for the

second spike. In Table B-8, the percent recoveries of the spiked metals are presented as a percentage of the spike input concentration.

Table B-8. Percent recoveries of metal matrix spikes. The first sample was spiked with 1.05 g of NIST SRM 1633b sample, and the second with 0.116 g of the same sample.

Metal	First Spike Recovery, %	Second Spike Recovery, %	Relative Percent Difference
Antimony	80.2	ND†	NA*
Arsenic	84.3	91.5	8.19
Beryllium	NA	NA	NA
Cadmium	125	ND	NA
Chromium	79.5	97.5	20.3
Lead	85.1	89.8	5.37
Manganese	73.4	125	52.2
Nickel	98.3	120	19.6
Selenium	108	241	76.2
Vanadium	83.1	109	26.9

*NA - Not applicable
†ND - Not detected

B.6 Completeness

Completeness goals were met for all measurements except for the CEM data for run 1. In this case, the data were collected, but were lost when the disk containing the data was damaged prior to backup.

APPENDIX C. DATA SHEETS

NALCO

ANALYTICAL LABORATORY REPORT

From:
Industrial Fuel Co.
Wilmington, NC

Sample Marked:
Virgin No. 6 Oil

Analysis No. CS 375756
Date Sampled 11/ 4/93
Date Received 11/ 9/93
Date Completed 11/15/93
Date Printed 11/15/93

<< FUEL OIL ANALYSIS >>

% Ash- Calculated	0.02
Pour Point (Deg. F)	30
Viscosity at 122 Deg. F	261 SSF
Specific Gravity (API at 60 F)	10.4
Sediment (%)	0.6
Water (%)	Trace < 0.05%
Asphaltenes by Hexane Extraction (%)	13.
BTU's per Pound (as received)	18160

ICAP Analysis of Oil

Sulfur (% S)	2.0
Vanadium (ppm V)	290
Nickel (ppm Ni)	70
Phosphorus (ppm P)	29
Calcium (ppm Ca)	29
Zinc (ppm Zn)	24
Sodium (ppm Na)	12
Iron (ppm Fe)	10
Aluminum (ppm Al)	7

The following were < 5 ppm or not detected:

Ag	B	Ba	Cd	Co	Cr	Cu	K	Li	Mg	Mn
Mo	Pb	Sb	Si	Sn	Sr	Ti				

Form 738 (8-89)

Analytical Laboratory Locations:
NALCO CHEMICAL COMPANY
ONE NALCO CENTER ◻ NAPERVILLE, ILLINOIS 60563-1198
POST OFFICE BOX 87 ◻ SUGAR LAND, TEXAS 77487-0087

Quali-Trak™

NALCO

ANALYTICAL LABORATORY REPORT

From:
Industrial Fuel Co.
Wilmington, NC

Sample Marked:
Virgin No. 6 Oil

Analysis No. CS 377800
Date Sampled 12/ 1/93
Date Received 12/ 6/93
Date Completed 12/29/93
Date Printed 12/29/93

<< FUEL OIL ANALYSIS >>

% Ash- Calculated	0.02
Pour Point (Deg. F)	30
Viscosity at 122 Deg. F	308 SSF
Specific Gravity (API at 60 F)	10.8
Sediment (%)	0.6
Water (%)	Trace < 0.05%
Asphaltenes by Hexane Extraction (%)	10.
BTU's per Pound (as received)	18160

ICAP Analysis of Oil

Sulfur (% S)	2.0
Vanadium (ppm V)	250
Nickel (ppm Ni)	59
Sodium (ppm Na)	26
Aluminum (ppm Al)	9
Calcium (ppm Ca)	8
Iron (ppm Fe)	7

The following were < 5 ppm or not detected:

Ag	B	Ba	Cd	Co	Cr	Cu	K	Li	Mg	Mn
Mo	P	Pb	Sb	Si	Sn	Sr	Ti	Zn		

Form 738 (8-89)

Analytical Laboratory Locations:
NALCO CHEMICAL COMPANY
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POST OFFICE BOX 87 ◻ SUGAR LAND, TEXAS 77487-0087

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NALCO

ANALYTICAL LABORATORY REPORT

From:
Industrial Fuel Co.
Wilmington, NC

Sample Marked:
Virgin #6 Oil Tank

Analysis No. CS 388036
Date Sampled 4/ 7/94
Date Received 4/11/94
Date Completed 4/26/94
Date Printed 4/26/94

<< FUEL OIL ANALYSIS >>

% Ash- Calculated	0.02
Pour Point (Deg. F)	30
Viscosity at 122 Deg. F	268 SSF
Specific Gravity (API at 60 F)	10.0
Sediment (%)	10.
Water (%)	1.0
BTU's per Pound (as received)	18120

ICAP Analysis of Oil

Sulfur (% S)	2.0
Vanadium (ppm V)	390
Nickel (ppm Ni)	69
Barium (ppm Ba)	46
Tin (ppm Sn)	17
Aluminum (ppm Al)	8
Sodium (ppm Na)	7
Calcium (ppm Ca)	6
Iron (ppm Fe)	5

The following were < 5 ppm or not detected:

Ag	B	Cd	Co	Cr	Cu	K	Li	Mg	Mn	Mo
P	Pb	Sb	Si	Sr	Ti	Zn				

Form 738 (8-88)

Analytical Laboratory Locations:
NALCO CHEMICAL COMPANY
ONE NALCO CENTER ▫ NAPERVILLE, ILLINOIS 60563-1198
POST OFFICE BOX 87 ▫ SUGAR LAND, TEXAS 77487-0087

QualiTrak™

NALCO

ANALYTICAL LABORATORY REPORT

From:
Industrial Fuel Co.
Wilmington, NC

Sample Marked:
Emulsified #6 Oil

Analysis No. CS 388037
Date Sampled 4/ 7/94
Date Received 4/11/94
Date Completed 4/26/94
Date Printed 4/26/94

<< FUEL OIL ANALYSIS >>

% Ash- Calculated	0.02
Pour Point (Deg. F)	30
Viscosity at 122 Deg. F	334 SSF
Specific Gravity (API at 60 F)	10.3
Sediment (%)	1.0
Water (%)	0.4
BTU's per Pound (as received)	16630

ICAP Analysis of Oil

Sulfur (% S)	1.8
Vanadium (ppm V)	320
Nickel (ppm Ni)	66
Tin (ppm Sn)	45
Barium (ppm Ba)	8
Aluminum (ppm Al)	6
Calcium (ppm Ca)	5

The following were < 5 ppm or not detected:

Ag	B	Cd	Co	Cr	Cu	Fe	K	Li	Mg	Mn
Mo	Na	P	Pb	Sb	Si	Sr	Ti	Zn		

Form 738 (8-89)

Analytical Laboratory Locations:
NALCO CHEMICAL COMPANY
ONE NALCO CENTER ◻ NAPERVILLE, ILLINOIS 60563-1198
POST OFFICE BOX 87 ◻ SUGAR LAND, TEXAS 77487-0087

Quali-Trak™

NALCO

ANALYTICAL LABORATORY REPORT

From:
Industrial Fuel Co.
Wilmington, NC

Sample Marked:
Virgin No. 6 Oil Tank

Analysis No. CS 390949
Date Sampled 5/ 6/94
Date Received 5/11/94
Date Completed 5/23/94
Date Printed 5/23/94

<< FUEL OIL ANALYSIS >>

% Ash- Calculated	0.02
Pour Point (Deg. F)	30
Viscosity at 122 Deg. F	318 SSF
Specific Gravity (API at 60 F)	10.2
Sediment (%)	0.4
Water (%)	Trace < 0.05%
BTU's per Pound (as received)	18230

ICAP Analysis of Oil

Sulfur (% S)	2.5
Vanadium (ppm V)	350
Nickel (ppm Ni)	77
Sodium (ppm Na)	20
Aluminum (ppm Al)	8
Iron (ppm Fe)	6
Calcium (ppm Ca)	6
Silica (ppm Si)	5

The following were < 5 ppm or not detected:

Ag	B	Ba	Cd	Co	Cr	Cu	K	Li	Mg	Mn
Mo	P	Pb	Sb	Sn	Sr	Ti	Zn			

Form 738 (8-89)

Analytical Laboratory Locations:
NALCO CHEMICAL COMPANY
ONE NALCO CENTER ◻ NAPERVILLE, ILLINOIS 60563-1198
POST OFFICE BOX 87 ◻ SUGAR LAND, TEXAS 77487-0087

Quali-Trak™

NALCO

ANALYTICAL LABORATORY REPORT

From:
Industrial Fuel Co.
Wilmington, NC

Sample Marked:
Virgin #6 Oil Tank

Analysis No. CS 393403
Date Sampled 6/ 2/94
Date Received 6/ 6/94
Date Completed 6/13/94
Date Printed 6/13/94

<< FUEL OIL ANALYSIS >>

% Ash- Calculated	0.03
Pour Point (Deg. F)	30
Viscosity at 122 Deg. F	283 SSF
Specific Gravity (API at 60 F)	10.7
Sediment (%)	0.4
Water (%)	Trace < 0.05%
BTU's per Pound (as received)	18180

ICAP Analysis of Oil

Sulfur (% S)	1.7
Vanadium (ppm V)	340
Nickel (ppm Ni)	75
Calcium (ppm Ca)	31
Zinc (ppm Zn)	26
Phosphorus (ppm P)	25
Sodium (ppm Na)	20
Iron (ppm Fe)	11
Aluminum (ppm Al)	9
Magnesium (ppm Mg)	8
Silica (ppm Si)	7

The following were < 5 ppm or not detected:
Ag B Ba Cd Co Cr Cu K Li Mn Mo
Pb Sb Sn Sr Ti

Form 738 (8-89)

Analytical Laboratory Locations:
NALCO CHEMICAL COMPANY
ONE NALCO CENTER ◻ NAPERVILLE, ILLINOIS 60563-1198
POST OFFICE BOX 87 ◻ SUGAR LAND, TEXAS 77487-0087

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NALCO

ANALYTICAL LABORATORY REPORT

From:
Industrial Fuel Co.
Wilmington, NC

Sample Marked:
Emulsified No. 6 Oil

Analysis No. CS 393404
Date Sampled 6/ 2/94
Date Received 6/ 6/94
Date Completed 6/13/94
Date Printed 6/13/94

<< FUEL OIL ANALYSIS >>

% Ash- Calculated	0.02
Pour Point (Deg. F)	30
Viscosity at 122 Deg. F	332 SSF
Specific Gravity (API at 60 F)	10.5
Sediment (%)	7.2
Water (%)	0.4
BTU's per Pound (as received)	16700

ICAP Analysis of Oil

Sulfur (% S)	1.6
Vanadium (ppm V)	320
Nickel (ppm Ni)	71
Phosphorus (ppm P)	24
Calcium (ppm Ca)	23
Zinc (ppm Zn)	20
Iron (ppm Fe)	8
Aluminum (ppm Al)	7
Sodium (ppm Na)	6

The following were < 5 ppm or not detected:

Ag	B	Ba	Cd	Co	Cr	Cu	K	Li	Mg	Mn
Mo	Pb	Sb	Si	Sn	Sr	Ti				

Form 738 (8-89)

Analytical Laboratory Locations:
NALCO CHEMICAL COMPANY
ONE NALCO CENTER ◻ NAPERVILLE, ILLINOIS 60563-1198
POST OFFICE BOX 87 ◻ SUGAR LAND, TEXAS 77487-0087

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ANALYTICAL LABORATORY REPORT

From:
Industrial Fuel Co.
Wilmington, NC

Sample Marked:
Industrial Fuel Co.
EMULSIFIED # 6 OIL

Analysis No. CS 390950
Date Sampled 5/ 6/94
Date Received 5/11/94
Date Completed 5/23/94
Date Printed 5/23/94

<< FUEL OIL ANALYSIS >>

% Ash- Calculated	0.02
Pour Point (Deg. F)	25
Viscosity at 122 Deg. F	321 SSF
Specific Gravity (API at 60 F)	10.2
Sediment (%)	7.2
Water (%)	0.4
BTU's per Pound (as received)	16680

ICAP Analysis of Oil

Sulfur (% S)	1.9
Vanadium (ppm V)	330
Nickel (ppm Ni)	72
Sodium (ppm Na)	9
Aluminum (ppm Al)	7

The following were < 5 ppm or not detected:

Ag	B	Ba	Ca	Cd	Co	Cr	Cu	Fe	K	Li
Mg	Mn	Mo	P	Pb	Sb	Si	Sn	Sr	Ti	Zn

Form 738 (8-89)

Analytical Laboratory Locations:
NALCO CHEMICAL COMPANY
ONE NALCO CENTER □ NAPERVILLE, ILLINOIS 60563-1198
POST OFFICE BOX 87 □ SUGAR LAND, TEXAS 77487-0087

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NALCO

ANALYTICAL LABORATORY REPORT

From:
Industrial Fuel Co.
Wilmington, NC

Sample Marked:
Emulsified No.6 Oil

Analysis No. CS 383060
Date Sampled 2/ 9/94
Date Received 2/15/94
Date Completed 3/ 9/94
Date Printed 3/ 9/94

<< FUEL OIL ANALYSIS >>

% Ash- Calculated	0.02
Pour Point (Deg. F)	30
Viscosity at 122 Deg. F	339 SSF
Specific Gravity (API at 60 F)	10.1
Sediment (%)	8.0
Water (%)	0.4
BTU's per Pound (as received)	16540

ICAP Analysis of Oil

Sulfur (% S)	1.7
Vanadium (ppm V)	290
Nickel (ppm Ni)	74
Phosphorus (ppm P)	14
Zinc (ppm Zn)	10
Calcium (ppm Ca)	10
Iron (ppm Fe)	7
Aluminum (ppm Al)	6
Lead (ppm Pb)	3
Sodium (ppm Na)	3
Tin (ppm Sn)	2
Silica (ppm Si)	2
Magnesium (ppm Mg)	1
Potassium (ppm K)	1
Chromium (ppm Cr)	1
Copper (ppm Cu)	1
Boron (ppm B)	1
Molybdenum (ppm Mo)	1
Antimony (ppm Sb)	1
Cobalt (ppm Co)	0
Titanium (ppm Ti)	0
Silver (ppm Ag)	0
Manganese (ppm Mn)	0

Form 738 (8-89)

Analytical Laboratory Locations:
NALCO CHEMICAL COMPANY
ONE NALCO CENTER ◻ NAPERVILLE, ILLINOIS 60563-1198
POST OFFICE BOX 87 ◻ SUGAR LAND, TEXAS 77487-0087

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NALCO

ANALYTICAL LABORATORY REPORT

From:
Industrial Fuel Co.
Wilmington, NC

Sample Marked:
Emulsified No.6 Oil

Analysis No. CS 383060
Date Sampled 2/ 9/94
Date Received 2/15/94
Date Completed 3/ 9/94
Date Printed 3/ 9/94

Cadmium (ppm Cd)	0
Lithium (ppm Li)	0
Strontium (ppm Sr)	0
Barium (ppm Ba)	0

Form 738 (8-89)

Analytical Laboratory Locations:
NALCO CHEMICAL COMPANY
ONE NALCO CENTER ◻ NAPERVILLE, ILLINOIS 60563-1198
POST OFFICE BOX 87 ◻ SUGAR LAND, TEXAS 77487-0087

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NALCO

ANALYTICAL LABORATORY REPORT

From:
Industrial Fuel Co.
Wilmington, NC

Sample Marked:
Emulsified No. 6 Oil

Analysis No. CS 377801
Date Sampled 12/ 1/93
Date Received 12/ 6/93
Date Completed 12/29/93
Date Printed 12/29/93

<< FUEL OIL ANALYSIS >>

% Ash- Calculated	0.02
Pour Point (Deg. F)	30
Viscosity at 122 Deg. F	349 SSF
Specific Gravity (API at 60 F)	10.7
Sediment (%)	9.2
Water (%)	0.4
Asphaltenes by Hexane Extraction (%)	12.
BTU's per Pound (as received)	16560

ICAP Analysis of Oil

Sulfur (% S)	1.6
Vanadium (ppm V)	240
Nickel (ppm Ni)	57
Sodium (ppm Na)	18
Aluminum (ppm Al)	8
Calcium (ppm Ca)	7
Phosphorus (ppm P)	6
Iron (ppm Fe)	6

The following were < 5 ppm or not detected:

Ag	B	Ba	Cd	Co	Cr	Cu	K	Li	Mg	Mn
Mo	Pb	Sb	Si	Sn	Sr	Ti	Zn			

Form 738 (8-89)

Analytical Laboratory Locations:
NALCO CHEMICAL COMPANY
ONE NALCO CENTER ◻ NAPERVILLE, ILLINOIS 60563-1198
POST OFFICE BOX 87 ◻ SUGAR LAND, TEXAS 77487-0087

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NALCO

ANALYTICAL LABORATORY REPORT

From:
Industrial Fuel Co.
Wilmington, NC

Sample Marked:
Emulsified No. 6 Oil

Analysis No. CS 375757
Date Sampled 11/ 4/93
Date Received 11/ 9/93
Date Completed 11/15/93
Date Printed 11/15/93

<< FUEL OIL ANALYSIS >>

% Ash- Calculated	0.02
Pour Point (Deg. F)	30
Viscosity at 122 Deg. F	341 SSF
Specific Gravity (API at 60 F)	20.1
Sediment (%)	0.2
Water (%)	8.0
Asphaltenes by Hexane Extraction (%)	14.
BTU's per Pound (as received)	16510

ICAP Analysis of Oil

Sulfur (% S)	1.8
Vanadium (ppm V)	270
Nickel (ppm Ni)	65
Phosphorus (ppm P)	26
Calcium (ppm Ca)	25
Zinc (ppm Zn)	20
Iron (ppm Fe)	9
Sodium (ppm Na)	7
Aluminum (ppm Al)	6

The following were < 5 ppm or not detected:

Ag	B	Ba	Cd	Co	Cr	Cu	K	Li	Mg	Mn
Mo	Pb	Sb	Si	Sn	Sr	Ti				

Form 738 (6-89)

Analytical Laboratory Locations:
NALCO CHEMICAL COMPANY
ONE NALCO CENTER ◻ NAPERVILLE, ILLINOIS 60563-1198
POST OFFICE BOX 87 ◻ SUGAR LAND, TEXAS 77487-0087

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TEST CONDITION SUMMARY

TEST RUN ----->		M23-1	M29-1	M23-2	M29-2	MM5-1	M23-3	M29-3	M23-4
TEST DATE ----->		3-6-95	3-7-95	3-8-95	3-8-95	3-9-95	3-9-95	3-9-95	3-10-95
Target Test Conditions:									
Fuel		High S #6	#6	#6	#6	#6	#6	#6	#6
Target FR	MBtu/hr	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Target SR		1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Actual Test Conditions:									
Fuel Feed	GPH	13.92	12.08	11.77	13.37	13.45	13.47	13.47	13.85
	Lb/hr	104.8	89.0	86.7	98.5	99.1	99.2	99.2	102.0
Firing Rate (FR)	MBtu/hr	1.982	1.635	1.593	1.810	1.820	1.822	1.822	1.874
Stoichiometric Ratio	(SR)	1.23	1.29	1.31	1.21	1.27	1.25	1.25	1.26
Exhaust Gas Compositon:									
Oxygen	Dry %	4.06	4.80	5.06	3.78	4.50	4.32	4.32	4.35
Carbon Dioxide	Dry %	15.02	14.89	14.95	15.04	15.02	15.02	15.02	14.65
Moisture	%	10.21	9.93	10.40	11.30	10.37	8.78	9.02	9.02
Dry Mol. Wt.		30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.5
Exhaust Gas Flow:	SCFM	434.13	385.02	385.00	374.20	424.71	409.11	409.11	424.67
	DSCFM	416.76	369.61	346.50	336.78	382.24	368.20	368.20	382.20

TEST CONDITION SUMMARY

TEST RUN ----->		MM5-2	M23-5	MM5-3	M29-4	M23-6	M29-5	MM5-4	MM5-5
TEST DATE ----->		3-10-95	3-10-95	3-10-95	3-14-95	3-14-95	3-15-95	3-15-95	3-16-95
Target Test Conditions:									
Fuel		#6	#6	#6	Emulsified #6	Emulsified #6	Emulsified #6	Emulsified #6	Emulsified #6
Target FR	MBtu/hr	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Target SR		1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Actual Test Conditions:									
Fuel Feed	GPH	13.85	13.41	13.41	14.05	13.96	14.21	14.63	14.62
	Lb/hr	102.0	98.8	98.8	103.5	102.8	104.7	107.8	107.7
Firing Rate (FR)	MBtu/hr	1.874	1.815	1.815	1.902	1.889	1.923	1.980	1.978
Stoichiometric Ratio	(SR)	1.26	1.21	1.21	1.21	1.23	1.20	1.14	1.24
Exhaust Gas Compositon:									
Oxygen	Dry %	4.35	4.72	4.72	3.76	4.04	3.54	2.60	4.18
Carbon Dioxide	Dry %	14.65	14.80	14.80	14.96	15.04	15.10	15.16	14.64
Moisture	%	9.15	8.90	8.56	10.73	10.34	11.64	12.06	10.88
Dry Mol. Wt.		30.5	30.5	30.5	30.5	30.6	30.6	30.5	30.5
Exhaust Gas Flow:	SCFM	424.67	410.84	410.84	382.36	387.96	365.68	361.97	398.83
	DSCFM	382.20	369.75	369.75	344.12	349.17	329.12	325.77	358.94

TEST CONDITION SUMMARY

TEST RUN ----->		M23-7	MM5-6	M23-8	M23-9	M23-10
TEST DATE ----->		3-16-95	3-16-95	3-16-95	3-24-95	3-28-95
Target Test Conditions:						
Fuel		Emulsified #6	Emulsified #6	Emulsified #6	Emulsified #6	Emulsified #6
Target FR	MBtu/hr	2.0	2.0	2.0	2.0	2.0
Target SR		1.2	1.2	1.2	1.0	1.2
Actual Test Conditions:						
Fuel Feed	GPH	14.62	14.76	14.76	NA	NA
	Lb/hr	107.7	108.7	108.7	NA	NA
Firing Rate (FR)	MBtu/hr	1.978	1.997	1.997	NA	NA
Stoichiometric Ratio	(SR)	1.24	1.23	1.23	NA	NA
Exhaust Gas Compositon:						
Oxygen	Dry %	4.18	4.06	4.06	NA	NA
Carbon Dioxide	Dry %	14.64	15.02	15.02	NA	NA
Moisture	%	11.53	11.42	10.61	NA	NA
Dry Mol. Wt.		30.5	30.6	30.6	NA	NA
Exhaust Gas Flow:	SCFM	398.83	410.72	410.72	NA	NA
	DSCFM	358.94	369.64	369.64	NA	NA

NORTH AMERICAN BOILER HAP OIL TEST DATA SHEET

DATE: 3/7/95

RUN NO. _____ START TIME: 1415 END TIME: _____ FUEL: #6 LS By: _____

	PRESSURE					TEMPERATURES						CEM's						
TIME	FUEL DELIVERY	STEAM	STACK DRAFT	ATOMIZING AIR	MANIFOLD DRAFT	FUEL DELIVERY	FUEL RETURN	HEAT EXCHGR IN	HEAT EXCHGR OUT	STACK	SMOKE NO.	OPACITY	CO	O2	CO2	NO	SO2	Remarks
14:15	75	4.5	0.4	45	1.7	250	180	90	175	441	6	-2.0	30	3.7	15.1	280	725	
14:46	75	4.5	0.4	44	1.7	225	165	88	174	451	5	-2.0	27	4.7	14.9	283	625	
15:02	74	4.5	0.4	44	1.7	225	165	81	174	448	7	-2.0	26	5.3	14.9	282	612	
15:16	74	4.5	0.1	45	1.8	225	165	91	175	444	7	-1.8	25	5.1	14.9	281	N/A	
15:36	74	4.5	0.2	42	1.8	220	185	89	174	447	6	-2.0	26	5.1	14.9	266	N/A	
15:50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(Switching Burners) NAPB WENT DOWN
15:54	74	4.5	0.2	42	1.8	215	158	88	183	425	7	-1.9	34	5.4	14.8	276	N/A	
16:07	74	4.5	0.2	42	1.8	220	180	86	175	441	8	-2.0	26	4.8	14.9	278	482	
16:20	74	4.5	0.2	42	1.8	225	180	89	175	442	6	-2.1	26	4.9	14.8	277	483	
16:33	74	4.5	0.2	42	1.8	225	180	88	175	445	5	-1.9	26	4.6	14.9	279	541	
16:45	74	4.5	0.2	42	1.8	225	185	87	175	445	5	-1.9	26	4.4	14.9	279	564	
18:09	74	4.5	0.2	42	1.8	250	180	85	176	446	6	-1.9	24	6.0	14.8	278	404	
	STOP																	

OIL METER START: 55143.02

OIL METER END: 55179.03

OIL METER TIME: 2:58.52

Page 1

NORTH AMERICAN BOILER HAP OIL TEST DATA SHEET

DATE: 3/8/95

RUN NO. _____ START TIME: 9:26 END TIME: _____ FUEL: #6 LS By: _____

	PRESSURE					TEMPERATURES						CEM's						
TIME	FUEL DELIVERY	STEAM	STACK DRAFT	ATOMIZING AIR	MANIFOLD DRAFT	FUEL DELIVERY	FUEL RETURN	HEAT EXCHGR IN	HEAT EXCHGR OUT	STACK	SMOKE NO.	OPACITY	CO	O2	CO2	NO	SO2	Remarks
9:26	76	4.5	0.4	42	1.5	275	200	84	168	447	6	-2.1	18	4.2	15.1	298	990	
9:42	75	4.5	0.4	43	1.6	265	200	83	168	449	6	-2.1	16	4.9	15.0	296	978	
9:52	75	4.5	0.3	43	1.6	220	180	84	167	439	5	-2.2	16	5.6	14.9	294	905	
10:03	75	4.5	0.3	43	1.7	215	185	83	166	442	6	-2.3	15	4.6	15.0	298	973	
10:18	75	4.5	0.2	43	1.7	220	186	84	167	443	7	-2.1	17	4.4	15.0	321	999	
10:33	75	4.5	0.3	43	1.7	250	185	84	169	444	7	-2.1	18	4.3	15.0	318	984	
10:49	75	4.5	0.3	43	1.7	225	185	84	169	445	6	-2.1	17	4.6	15.0	319	965	
11:07	75	4.5	0.2	43	1.6	210	180	85	170	445	7	-2.1	16	5.6	14.8	320	918	
11:26	74	4.5	0.2	43	1.7	210	185	85	171	433	6	-2.1	16	5.9	14.8	301	916	
	74	4.5	0.1	43	1.7	225	180	85	171	442		-2.2	16	6.3	14.7	315	896	
12:02	74	4.5	0.1	43	1.7	235	175	85	171	448	6	-2.2	17	4.9	14.9	308	979	
1284	74	4.5	0.1	43	1.7	210	175	85	170	446		-2.1	17	4.8	14.9	287	963	
12:37	STOP																	

OIL METER START: 56239.01
OIL METER END: 58275.75
OIL METER TIME: 307.16

NORTH AMERICAN BOILER HAP OIL TEST DATA SHEET

DATE: 3/8/95

RUN NO._____ START TIME 13:28 END TIME_____ FUEL #6 LS By_____

	PRESSURE					TEMPERATURES						CEM's						
TIME	FUEL DELIVERY	STEAM	STACK DRAFT	ATOMIZING AIR	MANIFOLD DRAFT	FUEL DELIVERY	FUEL RETURN	HEAT EXCHGR IN	HEAT EXCHGR OUT	STACK	SMOKE NO.	OPACITY	CO	O2	CO2	NO	SO2	Remarks
13:28	74	4.5	1.4	45	0.4	200	175	87	169	484	5	-2.2	31	4.9	14.9	264	945	NEW BURNER
13:55	74	4.5	1.5	46	0.45	225	180	87	170	490	6	-2.1	26	3.1	15.0	249	1048	
14:15	74	4.5	1.4	46	0.6	210	180	87	171	485	7	-2.2	24	4.1	15.0	303	1010	ADJUST O/C
14:40	74	4.5	1.4	46	0.6	230	180	87	170	495	6	-2.2	23	4.8	15.0	304	955	
14:50	74	4.5	1.4	46	0.6	225	180	86	170	499	6	-2.2	23	4.0	15.0	305	1002	
15:21	74	4.5	1.4	46	0.6	220	180	92	171	499	6	-2.1	22	4.1	15.0	304	991	
15:30	74	4.7	1.4	46	0.6	220	185	86	171	502	6	-2.1	22	3.6	15.0	307	1031	
15:56	74	4.5	1.4	44	0.7	230	185	86	171	499	8	-2.1	20	4.6	15.0	309	958	ADJUST O/C

OIL METER START: 56288.00

OIL METER END:_____

OIL METER TIME:_____

NORTH AMERICAN BOILER HAP OIL TEST DATA SHEET

DATE: 3/9/95

RUN NO.: _____ START TIME: 9:29 END TIME: 12:41 FUEL: #6 LS By: BOES, DOT, CE

	FUEL				PRESSURE			TEMPERATURES						CEM's						
TIME	TIME	VOL (GAL)	FUEL DELIVERY	STEAM	STACK DRAFT	ATOMIZING AIR	MANIFOLD DRAFT	FUEL DELIVERY	FUEL RETURN	HEAT EXCHGR IN	HEAT EXCHGR OUT	STACK	SMOKE NO.	OPACITY	CO	O2	CO2	NO	SO2	Remarks
9:29	2'18"	.5	74	0	0.3	44	1.5	240	180	59	113	487	6	-2.4	19	4.6	15.0	363	950	
9:50	2'10"	.5	74	4.5	0.3	43	1.5	275	185	60	157	495	6	-2.4	20	4.9	15.0	368	988	
10:20	2'16"	.5	74	4.8	0.2	43	1.5	225	180	59	160	497	6	-2.5	21	4.3	15.0	354	1076	
10:46	2'15"	.5	74	4.9	0.2	43	1.5	235	170	66	161	502	6	-2.4	22	4.3	15.0	354	1086	
11:15	2'16"	.5	74	4.9	0.2	43	1.5	230	170	60	160	501	6	-2.3	21	4.7	15.0	346	999	
11:33	2'11"	.5	74	4.9	0.2	43	1.5	205	190	61	161	502	6	-2.5	21	4.9	15.0	346	1027	
11:56	2'13"	.5	74	4.9	0.2	43	1.5	230	180	65	161	504	6	-2.5	21	4.9	15.0	338	700	
12:09	2'19"	.5	74	4.9	0.2	43	1.5	215	170	66	161	504	5	-2.5	21	5.0	15.1	341	977	
12:41	2'10"	.5	74	4.9	0.2	43	1.5	265	190	61	163	506	6	-2.6	21	4.3	15.1	335	982	

OIL METER START: 57479.11

OIL METER END: 57522.40

OIL METER TIME: 3°13'8"

NORTH AMERICAN BOILER HAP OIL TEST DATA SHEET

DATE: 3/9/95

RUN NO. _____ START TIME 13:18 END TIME _____ FUEL #6 LS By _____

	FUEL		PRESSURE					TEMPERATURES						CEM's					
TIME	TIME	VOL (GAL)	FUEL DELIVERY	STEAM	STACK DRAFT	ATOMIZING AIR	MANIFOLD DRAFT	FUEL DELIVERY	FUEL RETURN	HEAT EXCHGR IN	HEAT EXCHGR OUT	STACK	SMOKE NO.	OPACITY	CO	O2	CO2	NO	SO2	Remarks
13:18	2'16"	.5	74	4.9	0.2	43	1.5	226	185	62	163	509	5.5	-2.4	22	4.4	15.1	293	935	
13:30	2'15"	.5	74	4.9	0.2	43	1.5	230	190	72	16.3	511	6.0	-2.5	22	4.3	15.1	256	1058	
13:45	2'15"	.5	74	4.9	0.2	43	1.5	226	180	71	163	510	7	-2.5	21	4.6	15.1	213	977	
14:03	2'15"	.5	74	4.9	0.2	43	1.5	260	195	64	165	513	6	-2.5	22	5.3	15.0	216	893	
14:31	2'10"	.5	74	4.9	0.2	43	1.5	265	205	73	166	513	6	-2.6	21	4.5	15.1	209	778	
15:09	2'15"	.6	74	4.9	0.2	43	1.5	225	180	71	164	515	6	-1.7	21	4.6	15.0	156	733	
15:45	2'13"	.5	74	4.9	0.2	43	1.5	240	175	71	166	520	8	-2.1	22	4.1	15.1	105	597	
16:05	2'12"	.5	74	4.9	0.2	43	1.5	265	200	71	168	518	8	-2.0	22	4.7	15.0	53	441	
16:18	2'12"	.5	74	4.9	0.2	43	1.5	265	200	74	167	518	7	-2.0	22	4.7	15.0	0	476	

OIL METER START: 57538.10

OIL METER END: 57579.21

OIL METER TIME: 3°03'11"

NO_x analyzer stoped working because of a clogged capillary tube.

NORTH AMERICAN BOILER HAP OIL TEST DATA SHEET

DATE: 3/10/95

RUN NO. _____ START TIME 9:32 END TIME _____ FUEL #6 CS By _____

	FUEL		PRESSURE					TEMPERATURES						CEM's						
TIME	TIME	VOL (GAL)	FUEL DELIVERY	STEAM	STACK DRAFT	ATOMIZING AIR	MANIFOLD DRAFT	FUEL DELIVERY	FUEL RETURN	HEAT EXCHGR IN	HEAT EXCHGR OUT	STACK	SMOKE NO.	OPACITY	CO	O2	CO2	NO	SO2	Remarks
9:32	2'18"	.5	74	4.5	0.2	42	1.6	215	175	~~154~~ 57	154	511	6	—	19	5.0	14.7	663	329	
10:00	2'11"	.5	74	4.5	0.2	42	1.6	220	175	65	160	515	6	—	21	4.4	14.7	252	728	
10:29	2'10"	.5	74	4.9	0.2	42	1.6	220	180	59	157	516	9	—	23	5.6	14.9	242	674	Reset equip.
10:57	2'12"	.5	74	4.5	0.1	42	1.5	225	185	62	158	518	7	-2.2	23	3.8	14.8	242	736	
11:20	2'10"	.5	74	4.5	0.2	42	1.5	260	195	62	157	523	6	-2.1	22	4.7	14.8	240	712	
11:55	2'12"	.5	74	4.5	0.2	42	1.5	230	185	63	156	527	6	-2.3	23	3.9	14.8	232	778	
12:11	2'16"	.5	74	4.5	0.2	43	1.5	215	175	63	157	530	7	-2.4	22	4.5	14.8	234	802	

OIL METER START: 58710.30

OIL METER END: 58747.80

OIL METER TIME: 2°42'30"

NORTH AMERICAN BOILER HAP OIL TEST DATA SHEET

DATE: 3/10/95

RUN NO. ___ START TIME 13:00 END TIME ___ FUEL #6 CS By ___

	FUEL		PRESSURE					TEMPERATURES					SMOKE	CEM's						
TIME	TIME	VOL (GAL)	FUEL DELIVERY	STEAM	STACK DRAFT	ATOMIZING AIR	MANIFOLD DRAFT	FUEL DELIVERY	FUEL RETURN	HEAT EXCHGR IN	HEAT EXCHGR OUT	STACK	NO.	OPACITY	CO	O2	CO2	NO	SO2	Remarks
13:00	2'11"	.5	75	4.5	0.2	43	1.5	270	180	72	162	523	7	-2.7	25	4.7	14.8	168	855	
13:26	2'11"	.5	74	4.5	0.2	43	1.5	260	175	66	159	531	6	-2.5	22	4.4	14.8	49	836	
13:40	2'13"	.5	74	4.5	0.2	43	1.5	240	165	79	161	532	6	-1.5	22	4.5	14.8	246	810	
13:52	2'12"	.5	74	4.5	0.2	43	1.5	250	170	65	159	533	6	-1.2	21	4.6	14.8	243	784	
14:02	2'15"	.5	74	4.5	0.2	43	1.5	255	180	74	159	531	5	-1.9	21	5.5	14.7	243	765	
14:11	2'12"	.5	74	4.5	0.2	43	1.5	235	170	78	161	531	5	-2.0	20	5.7	14.7	247	734	

OIL METER START: 58755.70

OIL METER END: 58772.40

OIL METER TIME: 1°14'43"

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NORTH AMERICAN BOILER HAP OIL TEST DATA SHEET

DATE: 3/14/95 RUN NO. _____ START TIME: 9:46 END TIME: _____ FUEL: #6 emulsified By: _____

	FUEL		PRESSURE					TEMPERATURES						CEM's						
TIME	TIME	VOL (GAL)	FUEL DELIVERY	STEAM	STACK DRAFT	ATOMIZING AIR	MANIFOLD DRAFT	FUEL DELIVERY	FUEL RETURN	HEAT EXCHGR IN	HEAT EXCHGR OUT	STACK	SMOKE NO.	OPACITY	CO	O2	CO2	NO	SO2	Remarks
7:47	2'03"	.5	74	7	.03	46	1.6	250	180	76	110	460	6	.160	16	1.4	150	230	819	
10:21	2'15"	.5	74	9	.2	46	1.6	250	160	87	111	458	5	-.175	15	1.74	15.12	218	684	
10:42	2'5"	.5	74	4	.2	46	1.5	250	170	80	138	450	6	-.227	15	1.91	15.11	242	850	
10:55	2'4"	.5	74	4	.2	46	1.5	250	170	85	169	452	6	-.175	15	1.79	15.12	246	877	
11:06	2'4"	.5	74	4	.2	46	1.5	265	165	78	172	453	5	-.168	15	1.75	1511	246	826	
11:22	2'5"	.5	74	4	.2	46	1.5	265	165	80	171	454	6	-.018	15	1.74	15.1	242	850	
11:56	2'11"	.5	74	4	.2	46	1.5	255	145	79	171	454	6	-.177	15	2.19	15.07	224	926	

OIL METER START: 64286.51

OIL METER END: 84301.64

OIL METER TIME: _____

2 ½ hrs

Page 1

NORTH AMERICAN BOILER HAP OIL TEST DATA SHEET

DATE: 3/14/94

RUN NO. _____ START TIME 13:30 END TIME _____ FUEL #6 emusified BY Ric

TIME	FUEL TIME	FUEL VOL (GAL)	PRESSURE FUEL DELIVERY	PRESSURE STEAM	PRESSURE STACK DRAFT	PRESSURE ATOMIZING AIR	PRESSURE MANIFOLD DRAFT	TEMPERATURES FUEL DELIVERY	TEMPERATURES FUEL RETURN	TEMPERATURES HEAT EXCHGR IN	TEMPERATURES HEAT EXCHGR OUT	TEMPERATURES STACK	SMOKE NO.	CEM's OPACITY	CEM's CO	CEM's O2	CEM's CO2	CEM's NO	CEM's SO2	Remarks
1330	2'05"	.5	74	4	.02	46	1.5	250	160	76	162	445	5	-.174	17	2.26	15.08	220	889	
1341	2'7"	.5	74	4	.01	46	1.5	255	150	77	169	448	5	-.165	15	2.56	15.07	208	877	
1355	2'7"	.5	74	4	.01	46	1.5	235	150	80	172	453	5	-.180	15	1.58	15.10	186	953	
1405	2'3"	.5	73	4	.3	46	1.4	265	160	82	172	462	5	-.178	15	2.03	15.10	173	948	
1424	2'5"	.5	72	4.5	.3	46	1.4	255	155	88	174	461	5	-.158	14	2.74	15.05	152	931	
1442	2'4"	.5	72	4.5	.3	46	1.4	265	160	86	173	465	6	-.195	14	2.10	15.10	131	958	
1500	2'4"	.5	72	4.5	.3	46	1.4	265	155	84	175	463	6	-.209	15	2.56	15.03	110	949	
1522	2'6"	.5	72	4.5	.3	46	1.4	255	155	81	175	463	6	-.215	14	2.22	15.08	89	987	
1547	2'7"	.5	72	4.5	.5	46	1.2	260	155	88	175	471	6	-.177	15	2.43	15.06	246	955	

OIL METER START: 64371.4

OIL METER END: 64406.32

OIL METER TIME: 2:30:08

NO_x capillary became plugged again

NORTH AMERICAN BOILER HAP OIL TEST DATA SHEET

DATE: 3/15/95 RUN NO. _____ START TIME 9:40 END TIME _____ FUEL #6 emulsified By DR

	FUEL		PRESSURE					TEMPERATURES						CEM's						
TIME	TIME	VOL (GAL)	FUEL DELIVERY	STEAM	STACK DRAFT	ATOMIZING AIR	MANIFOLD DRAFT	FUEL DELIVERY	FUEL RETURN	HEAT EXCHGR IN	HEAT EXCHGR OUT	STACK	SMOKE NO.	OPACITY	CO	O2	CO2	NO	SO2	Remarks
9:42	2'4"	.5	74	4.5	.1	46	1.6	260	150	79	172	458	6	.180	17	3.82	15.11	199	1735	
9:58	2'11"	.5	73	4.5	.1	46	1.6	205	140	81	173	461	6	.169	19	3.47	15.13	201	1763	
10:18	2'6"	.5	74	4.5	.1	46	1.6	255	155	78	171	462	5	.178	19	3.62	15.15	199	1007	
10:40	2'7"	.5	74	4.5	.1	46	1.5	250	160	78	172	461	6	.179	20	3.24	15.13	199	865	
11:00	2'9"	.5	74	4.5	.1	46	1.5	260	155	78	172	466	6	.176	20	3.40	15.17	198	915	
11:22	2'5"	.5	74	4.5	.1	46	1.5	260	160	81	171	466	6	.179	21	3.39	15.17	196	928	
11:56	2'9"	.5	74	4.5	.1	46	1.5	215	125	83	172	468	6	.178	21	3.36	15.14	194	921	

OIL METER START: 65573.83

OIL METER END: 65609.5

OIL METER TIME: 2:30:38

NORTH AMERICAN BOILER HAP OIL TEST DATA SHEET

DATE: 3/15/95

RUN NO. _____ START TIME 12:35 END TIME _____ FUEL #6 emulsified BY _____

	FUEL		PRESSURE					TEMPERATURES						CEM's						
TIME	TIME	VOL (GAL)	FUEL DELIVERY	STEAM	STACK DRAFT	ATOMIZING AIR	MANIFOLD DRAFT	FUEL DELIVERY	FUEL RETURN	HEAT EXCHGR IN	HEAT EXCHGR OUT	STACK	SMOKE NO.	OPACITY	CO	O2	CO2	NO	SO2	Remarks
12:37	2'4"	.5	74	4.5	.1	46	1.5	260	155	85	173	471	6	.176	22	2.92	15.18	186	1025	
12:49	2'3"	.5	74	4.5	.1	46	1.5	255	165	79	171	470	6	.174	21	2.93	15.19	183	1034	
13:25	2'4"	.5	74	4.5	.1	46	1.5	250	175	78	172	471	6	.182	23	2.87	15.15	178	1044	
13:48	2'2"	.5	74	4.5	.1	46	1.5	260	170	82	172	473	7	.179	22	2.76	15.16	183	1056	
14:24	2'5"	.5	74	4.5	.1	46	1.5	270	160	84	173	473	6	.181	21	2.94	15.20	177	1110	
14:51	2'5"	.5	74	4.5	.1	46	1.5	240	155	82	173	479	6	.184	23	2.27	15.24	166	1124	
15:12	2'7"	.5	74	4.5	.1	46	1.5	230	155	85	173	479	6	.203	21	2.66	15.21	119	1100	
15:29	2'3"	.5	74	4.5	.1	46	1.5	270	165	85	173	482	6	.214	22	2.42	15.23	94	1079	

OIL METER START: 65618.33

OIL METER END: 65659.32

OIL METER TIME: 3:00:27

NORTH AMERICAN BOILER HAP OIL TEST DATA SHEET

DATE: 3/16/95

RUN NO. _____ START TIME 8:27 END TIME 11:29 FUEL #6 emuls. fuel BY ELA

TIME	FUEL TIME	FUEL VOL (GAL)	PRESSURE FUEL DELIVERY	STEAM	STACK DRAFT	ATOMIZING AIR	MANIFOLD DRAFT	TEMPERATURES FUEL DELIVERY	FUEL RETURN	HEAT OUT EXCHGR	HEAT IN EXCHGR	STACK	SMOKE NO.	CEM's OPACITY	CO	O2	CO2	NO	SO2	Remarks
8:29	2'5"	.5	74	3.5	.1	46	1.3	250	155	119	81	478	6	-.182	20	3.27	15.13	172	1610	
8:45	2'4"	.5	74	4.0	.1	46	1.3	250	155	164	86	481	6	-.189	20	3.56	15.14	145	1636	
9:10	2'7"	.5	74	4.0	.1	46	1.2	245	140	157	86	481	6	-.196	19	3.87	15.13	138	1481	
9:46	2'3"	.5	74	4.0	.1	46	1.2	255	155	170	87	484	7	-.204	19	3.28	15.15		1941	NOx Box
10:12	2'4"	.5	74	4.0	.2	46	1.3	255	160	170	88	491	6	-.216	19	3.49	15.12		1948	went down
10:31	2'2"	.5	74	4.0	.2	46	1.3	265	160	171	86	493	6	-.217	19	3.17	15.13		1871	By-PASS
10:53	2'2"	.5	74	4.0	.2	46	1.3	265	160	171	86	493	6	-.212	19	3.23	15.12		1958	went up
11:10	2'5"	.5	74	4.0	.2	46	1.3	255	160	170	83	496	6	-.221	18	3.89	15.06		1183	

OIL METER START: 66760.43

OIL METER END: 66804.53

OIL METER TIME: 3:01:00

NORTH AMERICAN BOILER HAP OIL TEST DATA SHEET

DATE: 3/16/95

RUN NO. _____ START TIME 11:57 END TIME _____ FUEL #6 emuls. 6-1 By _____

	FUEL		PRESSURE					TEMPERATURES					SMOKE	CEM's					
TIME	TIME	VOL (GAL)	FUEL DELIVERY	STEAM	STACK DRAFT	ATOMIZING AIR	MANIFOLD DRAFT	FUEL DELIVERY	FUEL RETURN	HEAT EXCHGR IN	HEAT EXCHGR OUT	STACK	NO.	OPACITY	CO	O2	CO2	NO	SO2	Remarks
11:59	2'10"	.5	74	4.0	.2	46	1.3	220	140	83	172	498	6	-.209	18	3.27	15.08		1870	
12:13	2'2"	.5	74	4.0	.2	46	1.3	260	140	83	171	494	6	-.215	19	3.62	15.09		1854	
12:40	2'0"	.5	74	4.0	.2	46	1.3	265	150	82	171	500	6	-.259	21	2.54	15.17		2061	
13:04	2'6"	.5	74	4.0	.2	46	1.3	245	145	82	172	500	5	-.210	18	3.64	15.10		2001	
13:20	2'4"	.5	74	4.0	.2	46	1.3	275	140	81	171	503	6	12.9	18	3.21	15.11		2111	
13:35	2'3"	.5	74	4.0	.2	46	1.3	270	135	82	172	496	6	.259	17	4.28	15.02	270	2011	NOx Back on line
13:55	2'5"	.5	74	4.0	.2	46	1.3	260	150	85	172	498	6	-1.43	18	3.73	15.08	275	2042	
14:20	2'9"	.5	74	4.0	.2	46	1.3	240	140	86	173	495	6	-2.057	16	4.65	14.96	274	1903	
14:42	2'7"	.5	74	4.0	.2	46	1.3	240	130	86	173	494	6	-2.218	16	4.92	14.96	277	1815	

OIL METER START: 66811.33

OIL METER END: 66855.9

OIL METER TIME: 3:01:11

HAP-OIL METAL RESULTS

Date	Sample ID	Test Condition	Time Start	Time Stop	Particulate wt (g)	Vol. Sampled (dscf)	Percent Isokinetic	Sb (µg)	As (µg)	Be (µg)	Cd (µg)	Cr (µg)	Pb (µg)	Ni (µg)	Mn (µg)	Se (µg)	V (µg)
3/07/95	M29-1A	#6 Oil	1415	1645	0.56768	105.93	87.9	252	6.80	0.270	7.73	37.5	302	9320	35.8	22.3	46800
3/07/95	M29-1B	#6 Oil	1415	1645	0.67114	103.06	95.5	1250	4.85	< .200	6.34	38.6	138	5420	22.9	18.9	26300
3/08/95	M29-2A	#6 Oil	1328	1558	0.75899	102.72	103.7	49.2	11.30	0.294	7.79	38.8	304	9600	39.1	32.8	47000
3/08/95	M29-2B	#6 Oil	1329	1559	0.66094	94.61	89.5	225	7.25	0.335	7.03	32.8	281	9240	33.7	23.9	44900
3/09/95	M29-3B	#6 Oil	1319	1549	0.70722	110.66	92.8	161	9.60	0.374	9.25	42.9	293	11300	44.8	32.7	54900
3/14/95	M29-4A	#6 Oil Emulsified	940	1210	0.46402	101.04	100	84.2	8.15	0.342	7.49	39.4	285	11.2	44.7	28.2	5410
3/14/95	M29-4B	#6 Oil Emulsified	940	1210	0.34192	97.629	93.2	148	5.70	0.273	6.43	37.9	226	8400	38.3	26	40600
3/16/95	M29-5A	#6 Oil Emulsified	940	1211	0.48113	98.74	99.2	604	8.80	0.372	9.10	42.5	269	11100	49.4	34.7	53400
3/16/95	M29-5B	#6 Oil Emulsified	940	1210	0.45262	90.01	90.6	29	8.70	0.353	7.42	38.8	255	10700	44.3	29.3	52500
3/17/95	M29-FB-1	Field Blank	NA	NA	0.00411	NA	NA	43.7	2.75	< .200	< 1.00	3.85	3.21	4.66	1.29	1.24	6.57

VOLATILE ORGANICS SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 3/8/95

Condition	No. 6 Oil	Operator	DJ
Location	Exhaust Duct	Exhaust Duct Flow	346.5 DSCFM

Run Number	VOST-1a		VOST-1b	
Volume Collected	20.030	liters	18.350	liters
Sample Tube IDs	467 / 74		300 / 22	

Analyte	ng	µg/m³	µg/MBtu	ng	µg/m³	µg/MBtu
Dichlorodifluoromethane	<10	<0.50	<185	17.75	0.967	357.5
Chloromethane	4.65	0.232	85.8	<10	<0.54	<200
Vinyl Chloride	<10	<0.50	<185	<10	<0.54	<200
Bromomethane	<10	<0.50	<185	<10	<0.54	<200
Chloroethane	<10	<0.50	<185	<10	<0.54	<200
Trichlorofluoromethane	<10	<0.50	<185	9.11	0.496	183.5
1,1-Dichloroethene	<10	<0.50	<185	<10	<0.54	<200
Iodomethane	<10	<0.50	<185	<10	<0.54	<200
Carbon Disulfide	<10	<0.50	<185	42.73	2.329	860.5
Acetone	<10	<0.50	<185	<10	<0.54	<200
Methylene Chloride	<10	<0.50	<185	3062.95	166.918	61684.0
1,2-Dichloroethene (total)	<10	<0.50	<185	<10	<0.54	<200
1,1-Dichloroethane	<10	<0.50	<185	<10	<0.54	<200
Chloroform	<10	<0.50	<185	35.53	1.936	715.5
1,2-Dichloroethane	<10	<0.50	<185	<10	<0.54	<200
1,4-Dioxane	<10	<0.50	<185	<10	<0.54	<200
2-Butanone	<10	<0.50	<185	<10	<0.54	<200
1,1,1-Trichloroethane	<10	<0.50	<185	3.24	0.177	65.2
Carbon Tetrachloride	<10	<0.50	<185	<10	<0.54	<200
Benzene	25.05	1.251	462.2	24.18	1.318	487.0
Trichloroethene	<10	<0.50	<185	<10	<0.54	<200
1,2-Dichloropropane	<10	<0.50	<185	<10	<0.54	<200
Dibromomethane	<10	<0.50	<185	<10	<0.54	<200
Bromodichloromethane	<10	<0.50	<185	6.15	0.335	123.9
cis-1,3-Dichloropropene	<10	<0.50	<185	<10	<0.54	<200
2-Hexanone	<10	<0.50	<185	<10	<0.54	<200
trans-1,3-Dichloropropene	<10	<0.50	<185	<10	<0.54	<200
1,1,2-Trichloroethane	<10	<0.50	<185	<10	<0.54	<200
Dibromochloromethane	<10	<0.50	<185	<10	<0.54	<200
1,2-Dibromoethane	<10	<0.50	<185	<10	<0.54	<200
Bromoform	<10	<0.50	<185	<10	<0.54	<200
4-Methyl-2-Pentanone	<10	<0.50	<185	<10	<0.54	<200
Toluene	79.10	3.949	1459.4	12.50	0.681	251.7
Tetrachloroethene	<10	<0.50	<185	<10	<0.54	<200
Chlorobenzene	<10	<0.50	<185	<10	<0.54	<200
Ethylbenzene	5.49	0.274	101.3	<10	<0.54	<200
1,1,1,2-Tetrachloroethane	<10	<0.50	<185	<10	<0.54	<200
Xylene (M,P)	20.71	1.034	382.1	<10	<0.54	<200
O-Xylene	6.12	0.306	112.9	<10	<0.54	<200
Styrene	8.70	0.434	160.5	<10	<0.54	<200
1,1,2,2-Tetrachloroethane	<10	<0.50	<185	<10	<0.54	<200
1,2,3-Trichloropropane	<10	<0.50	<185	<10	<0.54	<200
Trans-1,4-dichloro-2-butene	<10	<0.50	<185	<10	<0.54	<200
Pentachloroethane	<10	<0.50	<185	<10	<0.54	<200
1,2-Dibromo-3-chloropropane	<10	<0.50	<185	<10	<0.54	<200

VOLATILE ORGANICS SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 3/9/95

Condition	#6 Oil	Operator	DJ
Location	Exhaust Duct	Exhaust Duct Flow	382.2 DSCFM

Run Number	VOST-2a		VOST-2b		
Volume Collected	19.950	liters	20.000	liters	
Sample Tube IDs	337 / 198		301 / 136		

Analyte	ng	µg/m³	µg/MBtu	ng	µg/m³	µg/MBtu
Dichlorodifluoromethane	14.41	0.722	257.7	30.09	1.505	536.8
Chloromethane	<10	<0.50	<178	15.33	0.767	273.5
Vinyl Chloride	<10	<0.50	<178	<10	<0.50	<178
Bromomethane	9.18	0.460	164.2	3.26	0.163	58.2
Chloroethane	<10	<0.50	<178	<10	<0.50	<178
Trichlorofluoromethane	2.55	0.128	45.6	7.42	0.371	132.4
1,1-Dichloroethene	<10	<0.50	<178	<10	<0.50	<178
Iodomethane	<10	<0.50	<178	<10	<0.50	<178
Carbon Disulfide	36.84	1.847	658.9	45.63	2.282	814.1
Acetone	66.51	3.334	1189.6	<10	<0.50	<178
Methylene Chloride	2072.73	103.896	37072.1	2038.69	101.935	36372.2
1,2-Dichloroethene (total)	<10	<0.50	<178	<10	<0.50	<178
1,1-Dichloroethane	<10	<0.50	<178	<10	<0.50	<178
Chloroform	16.96	0.850	303.3	<10	<0.50	<178
1,2-Dichloroethane	<10	<0.50	<178	<10	<0.50	<178
1,4-Dioxane	<10	<0.50	<178	<10	<0.50	<178
2-Butanone	22.00	1.103	393.5	<10	<0.50	<178
1,1,1-Trichloroethane	<10	<0.50	<178	<10	<0.50	<178
Carbon Tetrachloride	<10	<0.50	<178	<10	<0.50	<178
Benzene	24.79	1.243	443.4	20.76	1.038	370.4
Trichloroethene	<10	<0.50	<178	<10	<0.50	<178
1,2-Dichloropropane	<10	<0.50	<178	<10	<0.50	<178
Dibromomethane	<10	<0.50	<178	<10	<0.50	<178
Bromodichloromethane	3.41	0.171	61.0	<10	<0.50	<178
cis-1,3-Dichloropropene	<10	<0.50	<178	<10	<0.50	<178
2-Hexanone	<10	<0.50	<178	<10	<0.50	<178
trans-1,3-Dichloropropene	<10	<0.50	<178	<10	<0.50	<178
1,1,2-Trichloroethane	<10	<0.50	<178	<10	<0.50	<178
Dibromochloromethane	<10	<0.50	<178	<10	<0.50	<178
1,2-Dibromoethane	<10	<0.50	<178	<10	<0.50	<178
Bromoform	<10	<0.50	<178	<10	<0.50	<178
4-Methyl-2-Pentanone	<10	<0.50	<178	<10	<0.50	<178
Toluene	27.55	1.381	492.8	35.43	1.772	632.1
Tetrachloroethene	<10	<0.50	<178	<10	<0.50	<178
Chlorobenzene	<10	<0.50	<178	<10	<0.50	<178
Ethylbenzene	3.30	0.165	59.0	<10	<0.50	<178
1,1,1,2-Tetrachloroethane	<10	<0.50	<178	<10	<0.50	<178
Xylene (M,P)	2.73	0.137	48.8	<10	<0.50	<178
O-Xylene	1.06	0.053	19.0	<10	<0.50	<178
Styrene	<10	<0.50	<178	<10	<0.50	<178
1,1,2,2-Tetrachloroethane	<10	<0.50	<178	<10	<0.50	<178
1,2,3-Trichloropropane	<10	<0.50	<178	<10	<0.50	<178
Trans-1,4-dichloro-2-butene	<10	<0.50	<178	<10	<0.50	<178
Pentachloroethane	<10	<0.50	<178	<10	<0.50	<178
1,2-Dibromo-3-chloropropane	<10	<0.50	<178	<10	<0.50	<178

VOLATILE ORGANICS SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 3/15/95

Condition #6 Emulsified Operator DJ
Location Exhaust Duct Exhaust Duct Flow 329.1 DSCFM

Run Number	VOST-3a		VOST-3b	
Volume Collected	19.640	liters	22.920	liters
Sample Tube IDs	496 / 10		359 / 348	

Analyte	ng	µg/m³	µg/MBtu	ng	µg/m³	µg/MBtu
Dichlorodifluoromethane	22.03	1.122	326.2	6.71	0.293	85.1
Chloromethane	553.24	28.169	8191.8	<10	<0.44	<128
Vinyl Chloride	<10	<0.51	<148	<10	<0.44	<128
Bromomethane	22.49	1.145	333.0	<10	<0.44	<128
Chloroethane	<10	<0.51	<148	<10	<0.44	<128
Trichlorofluoromethane	3.31	0.169	49.0	5.16	0.225	65.5
1,1-Dichloroethene	<10	<0.51	<148	<10	<0.44	<128
Iodomethane	<10	<0.51	<148	<10	<0.44	<128
Carbon Disulfide	21.21	1.080	314.1	21.23	0.926	269.4
Acetone	182.51	9.293	2702.4	55.35	2.415	702.3
Methylene Chloride	5438.65	276.917	80529.8	2858.20	124.703	36264.8
1,2-Dichloroethene (total)	<10	<0.51	<148	<10	<0.44	<128
1,1-Dichloroethane	<10	<0.51	<148	<10	<0.44	<128
Chloroform	<10	<0.51	<148	29.44	1.284	373.5
1,2-Dichloroethane	<10	<0.51	<148	<10	<0.44	<128
1,4-Dioxane	<10	<0.51	<148	<10	<0.44	<128
2-Butanone	42.18	2.148	624.6	<10	<0.44	<128
1,1,1-Trichloroethane	<10	<0.51	<148	<10	<0.44	<128
Carbon Tetrachloride	<10	<0.51	<148	<10	<0.44	<128
Benzene	21.25	1.082	314.6	23.88	1.042	303.0
Trichloroethene	<10	<0.51	<148	<10	<0.44	<128
1,2-Dichloropropane	<10	<0.51	<148	<10	<0.44	<128
Dibromomethane	<10	<0.51	<148	<10	<0.44	<128
Bromodichloromethane	<10	<0.51	<148	5.13	0.224	65.1
cis-1,3-Dichloropropene	<10	<0.51	<148	<10	<0.44	<128
2-Hexanone	<10	<0.51	<148	<10	<0.44	<128
trans-1,3-Dichloropropene	<10	<0.51	<148	<10	<0.44	<128
1,1,2-Trichloroethane	<10	<0.51	<148	<10	<0.44	<128
Dibromochloromethane	<10	<0.51	<148	<10	<0.44	<128
1,2-Dibromoethane	<10	<0.51	<148	<10	<0.44	<128
Bromoform	<10	<0.51	<148	<10	<0.44	<128
4-Methyl-2-Pentanone	<10	<0.51	<148	<10	<0.44	<128
Toluene	5.60	0.285	82.9	105.88	4.620	1343.4
Tetrachloroethene	<10	<0.51	<148	<10	<0.44	<128
Chlorobenzene	<10	<0.51	<148	<10	<0.44	<128
Ethylbenzene	12.77	0.650	189.1	<10	<0.44	<128
1,1,1,2-Tetrachloroethane	<10	<0.51	<148	<10	<0.44	<128
Xylene (M,P)	10.57	0.538	156.5	<10	<0.44	<128
0-Xylene	3.75	0.191	55.5	<10	<0.44	<128
Styrene	5.64	0.287	83.5	24.02	1.048	304.8
1,1,2,2-Tetrachloroethane	<10	<0.51	<148	<10	<0.44	<128
1,2,3-Trichloropropane	<10	<0.51	<148	<10	<0.44	<128
Trans-1,4-dichloro-2-butene	<10	<0.51	<148	<10	<0.44	<128
Pentachloroethane	<10	<0.51	<148	<10	<0.44	<128
1,2-Dibromo-3-chloropropane	<10	<0.51	<148	<10	<0.44	<128

VOLATILE ORGANICS SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 3/15/95

Condition: #6 Emulsified Operator: DJ
Location: Exhaust Duct Exhaust Duct Flow: 325.8 DSCFM

Run Number	VOST-3c		VOST-3d	
Volume Collected	22.660	liters	22.200	liters
Sample Tube IDs	341 / 180		383 / 4	

Analyte	ng	µg/m³	µg/MBtu	ng	µg/m³	µg/MBtu
Dichlorodifluoromethane	14.75	0.651	181.9	38.40	1.730	483.4
Chloromethane	<10	<0.44	<123	4.62	0.208	58.2
Vinyl Chloride	<10	<0.44	<123	<10	<0.45	<126
Bromomethane	15.40	0.680	189.9	<10	<0.45	<126
Chloroethane	<10	<0.44	<123	<10	<0.45	<126
Trichlorofluoromethane	<10	<0.44	<123	4.00	0.180	50.4
1,1-Dichloroethene	<10	<0.44	<123	<10	<0.45	<126
Iodomethane	<10	<0.44	<123	<10	<0.45	<126
Carbon Disulfide	49.85	2.200	614.8	<10	<0.45	<126
Acetone	290.00	12.798	3576.8	102.86	4.633	1294.9
Methylene Chloride	4221.81	186.311	52070.4	3387.16	152.575	42641.7
1,2-Dichloroethene (total)	<10	<0.44	<123	<10	<0.45	<126
1,1-Dichloroethane	<10	<0.44	<123	<10	<0.45	<126
Chloroform	<10	<0.44	<123	31.71	1.428	399.2
1,2-Dichloroethane	<10	<0.44	<123	<10	<0.45	<126
1,4-Dioxane	<10	<0.44	<123	<10	<0.45	<126
2-Butanone	55.03	2.429	678.7	<10	<0.45	<126
1,1,1-Trichloroethane	<10	<0.44	<123	<10	<0.45	<126
Carbon Tetrachloride	<10	<0.44	<123	<10	<0.45	<126
Benzene	25.43	1.122	313.6	<10	<0.45	<126
Trichloroethene	<10	<0.44	<123	<10	<0.45	<126
1,2-Dichloropropane	<10	<0.44	<123	<10	<0.45	<126
Dibromomethane	<10	<0.44	<123	<10	<0.45	<126
Bromodichloromethane	<10	<0.44	<123	5.38	0.242	67.7
cis-1,3-Dichloropropene	<10	<0.44	<123	<10	<0.45	<126
2-Hexanone	<10	<0.44	<123	<10	<0.45	<126
trans-1,3-Dichloropropene	<10	<0.44	<123	<10	<0.45	<126
1,1,2-Trichloroethane	<10	<0.44	<123	<10	<0.45	<126
Dibromochloromethane	<10	<0.44	<123	<10	<0.45	<126
1,2-Dibromoethane	<10	<0.44	<123	<10	<0.45	<126
Bromoform	<10	<0.44	<123	<10	<0.45	<126
4-Methyl-2-Pentanone	<10	<0.44	<123	<10	<0.45	<126
Toluene	117.26	5.175	1446.2	177.61	8.000	2236.0
Tetrachloroethene	<10	<0.44	<123	<10	<0.45	<126
Chlorobenzene	<10	<0.44	<123	<10	<0.45	<126
Ethylbenzene	5.10	0.225	62.9	<10	<0.45	<126
1,1,1,2-Tetrachloroethane	<10	<0.44	<123	<10	<0.45	<126
Xylene (M,P)	4.22	0.186	52.0	<10	<0.45	<126
O-Xylene	4.58	0.202	56.5	<10	<0.45	<126
Styrene	9.15	0.404	112.9	<10	<0.45	<126
1,1,2,2-Tetrachloroethane	<10	<0.44	<123	<10	<0.45	<126
1,2,3-Trichloropropane	<10	<0.44	<123	<10	<0.45	<126
Trans-1,4-dichloro-2-butene	<10	<0.44	<123	<10	<0.45	<126
Pentachloroethane	<10	<0.44	<123	<10	<0.45	<126
1,2-Dibromo-3-chloropropane	<10	<0.44	<123	<10	<0.45	<126

VOLATILE ORGANICS SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: None

Condition Field Blanks Operator DJ

Run Number	VOST-fb1			VOST-fb2		
Volume Collected	<1	liters		<1	liters	
Sample Tube IDs	250 / 58			184 / 09		
Analyte	ng	µg/m³	µg/MBtu	ng	µg/m³	µg/MBtu
Dichlorodifluoromethane	15.51			4.24		
Chloromethane	7.45			23.14		
Vinyl Chloride	ND			ND		
Bromomethane	2.77			4.16		
Chloroethane	ND			ND		
Trichlorofluoromethane	4.26			3.94		
1,1-Dichloroethene	ND			ND		
Iodomethane	ND			ND		
Carbon Disulfide	ND			ND		
Acetone	86.60			35.76		
Methylene Chloride	3524.98			2699.86		
1,2-Dichloroethene (total)	ND			ND		
1,1-Dichloroethane	ND			ND		
Chloroform	25.96			22.32		
1,2-Dichloroethane	ND			ND		
1,4-Dioxane	ND			ND		
2-Butanone	ND			ND		
1,1,1-Trichloroethane	ND			ND		
Carbon Tetrachloride	ND			ND		
Benzene	15.70			ND		
Trichloroethene	ND			ND		
1,2-Dichloropropane	ND			ND		
Dibromomethane	ND			ND		
Bromodichloromethane	5.11			4.08		
cis-1,3-Dichloropropene	ND			ND		
2-Hexanone	ND			ND		
trans-1,3-Dichloropropene	ND			ND		
1,1,2-Trichloroethane	ND			ND		
Dibromochloromethane	ND			ND		
1,2-Dibromoethane	ND			ND		
Bromoform	ND			ND		
4-Methyl-2-Pentanone	ND			ND		
Toluene	61.58			15.29		
Tetrachloroethene	ND			ND		
Chlorobenzene	ND			ND		
Ethylbenzene	ND			2.74		
1,1,1,2-Tetrachloroethane	ND			ND		
Xylene (M,P)	ND			2.26		
0-Xylene	ND			2.31		
Styrene	ND			ND		
1,1,2,2-Tetrachloroethane	ND			ND		
1,2,3-Trichloropropane	ND			ND		
Trans-1,4-dichloro-2-butene	ND			ND		
Pentachloroethane	ND			ND		
1,2-Dibromo-3-chloropropane	ND			ND		

SEMIVOLATILE ORGANICS SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 2/9/95

Condition	No. 6 Oil	Operator	DJ, ES
Location	Stack	Stack Flow	381.0 DSCFM
Start Time	930	Stop Time	1230

Run Number	MM5-1A
Volume Collected	140.397 DSCF
Isokinetic	101.7 %

Analyte	µg	µg/m³	µg/MBtu
Chlorobenzene	<1.2	<0.31	<437
Styrene	<2.6	<0.65	<918
Cumene	<1.0	<0.26	<363
1,1-Biphenyl	<1.2	<0.30	<430
N-Nitrosodimethylamine	------	------	------
N-methyl-N-nitroso-Ethanamine	------	------	------
N-ethyl-N-nitroso-Ethanamine	------	------	------
Bis(2-chloroethyl)ether	<10.0	<2.52	<3556
Aniline	------	------	------
Phenol	7.19	1.809	643.2
2-Chlorophenol	<10.0	<2.52	<3556
1,3-Dichlorobenzene	<1.0	<0.24	<345
1,4-Dichlorobenzene	<1.0	<0.24	<345
1,2-Dichlorobenzene	<1.0	<0.24	<345
Benzyl Alcohol	33.79	8.499	3022.6
Bis(2-chloroisopropyl)ether	<10.0	<2.52	<3556
2-Methylphenol	<5.1	<1.29	<1828
Acetophenone	------	------	------
Hexachloroethane	<10.0	<2.52	<3556
Methyl-Benzenamine	------	------	------
3&4-methylphenol	1.25	0.314	111.8
N-nitrosodipropylamine	<10.0	<2.52	<3556
Nitrobenzene	<2.7	<0.68	<967
1-Nitrosopiperidine	------	------	------
Isophorone	<10.0	<2.52	<3556
2,4-Dimethylphenol	<10.0	<2.52	<3556
Bis(2-chloroethoxy)methane	<10.0	<2.52	<3556
2,4-Dichlorophenol	<10.0	<2.52	<3556
1,2,4-Trichlorobenzene	<1.2	<0.29	<409
Naphthalene	2.17	0.546	194.1
4-Methoxybenzenamine	<10.0	<2.52	<3556
2-Nitrophenol	<10.0	<2.52	<3556
2,6-Dichlorophenol	------	------	------
Hexachloropropene	------	------	------
4-Chloroaniline	<20.0	<5.03	<7113
Hexachlorobutadiene	<10.0	<2.52	<3556
N-butyl-N-nitroso-butanamine	------	------	------
4-chloro-3-methyl-phenol	<20.0	<5.03	<7113
2-methylnaphthalene	<10.0	<2.52	<3556
4-chloro-2-methylbenzenamine	------	------	------
1,2,4,5-tetrachlorobenzene	------	------	------
2,3,5-trichlorophenol	<4.7	<1.19	<1682
Hexachlorocyclopentadiene	<10.0	<2.52	<3556
2,4,6-trichlorophenol	<4.3	<1.09	<1536
2,4,5-Trichlorophenol	<4.7	<1.19	<1682

2,3,4-trichlorophenol	<4.7	<1.19	<1682
2-chloronaphthalene	<1.1	<0.28	<398
1-chloronaphthalene	<0.7	<0.19	<263
4-chloroquinoline	——	——	——
2-nitroaniline	<50.0	<12.58	<17781
3-nitroaniline	<50.0	<12.58	<17781
Acenaphthylene	<1.0	<0.25	<356
Dimethylphathalate	<10.0	<2.52	<3556
2,6-dinitrotoluene	<2.4	<0.60	<846
Acenaphthene	<0.8	<0.20	<281
4-nitroaniline	<50.0	<12.58	<17781
2,4-dinitrophenol	<50.0	<12.58	<17781
Dibenzofuran	<0.9	<0.22	<306
Pentachlorobenzene	——	——	——
2,4-dinitrotoluene	<2.4	<0.60	<846
5-nitroquinoline	——	——	——
2,3,4,6-tetrachlorophenol	——	——	——
2,3,5,6-tetrachlorophenol	——	——	——
2,3,4,5-tetrachlorophenol	——	——	——
4-nitrophenol	<50.0	<12.58	<17781
Fluorene	<0.8	<0.21	<295
Diethyl phathalate	<10.0	<2.52	<3556
4-Chlorophenyl phenyl ether	<10.0	<2.52	<3556
2-methyl-5-nitrobenzenamine	——	——	——
N-nitrosodiphenylamine	<10.0	<2.52	<3556
2-methyl-4,6-dinitrophenol	<50.0	<12.58	<17781
Azobenzene	——	——	——
Diphenylamine	——	——	——
4-Bromophenyl phenyl ether	<10.0	<2.52	<3556
Phenacetin	——	——	——
Hexachlorobenzene	<0.6	<0.16	<228
Pentachlorophenol	<4.2	<1.05	<1490
Pentachloronitrobenzene	——	——	——
Phenanthrene	<0.6	<0.14	<196
Anthracene	<0.6	<0.15	<210
Azoxybenzene	——	——	——
Pentachloroaniline	——	——	——
Dibutyl phthalate	85.32	21.461	7632.0
2-nitro-N-phenylbenzenamine	——	——	——
4-nitro-1-oxide-quinoline	——	——	——
Methapyrilene	——	——	——
Fluoranthene	<0.3	<0.08	<114
Pyrene	<0.3	<0.08	<117
N-methyl-4-(phenylazo)-benzene	——	——	——
P-dimethylaminoazobenzene	——	——	——
Benzyl butyl phthalate	<10.0	<2.52	<3556
N-2-fluorenylacetamide	——	——	——
Chrysene	0.57	0.143	51.0
Benzo(a)anthracene	0.83	0.209	74.2
Bis(2-ethylhexyl)phthalate	40.88	10.283	3656.8
Di-N-octyl phthalate	1072.00	269.643	95892.3
Benzo(b)fluoranthene	<0.5	<0.13	<185
7,12-Dimethylbenz(a)anthracene	——	——	——
Benzo(k)fluoranthene	<0.7	<0.18	<249
Benzo(a)pyrene	<0.3	<0.07	<100
3-methylcholanthrene	0.49	0.123	43.8
Dibenz(a,j)acridine	——	——	——
Indeno(1,2,3-cd)pyrene	<0.6	<0.16	<220
Dibenz(a,h)anthracene	2.37	0.596	212.0
Benzo(g,h,i)perylene	2.20	0.553	196.8

SEMIVOLATILE ORGANICS SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 3/10/95

Condition	No. 6 Oil	Operator	DJ, ES
Location	Stack	Stack Flow	382.8 DSCFM
Start Time	947	Stop Time	1217

Run Number	MM5-2A
Volume Collected	105.168 DSCF
Isokinetic	92.4 %

Analyte	µg	µg/m³	µg/MBtu
Chlorobenzene	<1.2	<0.41	<427
Styrene	<2.6	<0.87	<895
Cumene	<1.0	<0.34	<354
1,1-Biphenyl	<1.2	<0.41	<420
N-Nitrosodimethylamine	-----	-----	-----
N-methyl-N-nitroso-Ethanamine	-----	-----	-----
N-ethyl-N-nitroso-Ethanamine	-----	-----	-----
Bis(2-chloroethyl)ether	<10.0	<3.36	<3470
Aniline	-----	-----	-----
Phenol	<10.0	<3.36	<3470
2-Chlorophenol	<10.0	<3.36	<3470
1,3-Dichlorobenzene	<1.0	<0.33	<337
1,4-Dichlorobenzene	<1.0	<0.33	<337
1,2-Dichlorobenzene	<1.0	<0.33	<337
Benzyl Alcohol	2.89	0.970	336.8
Bis(2-chloroisopropyl)ether	<10.0	<3.36	<3470
2-Methylphenol	<5.1	<1.73	<1784
Acetophenone	-----	-----	-----
Hexachloroethane	<10.0	<3.36	<3470
Methyl-Benzenamine	-----	-----	-----
3&4-methylphenol	<10.6	<3.57	<3686
N-nitrosodipropylamine	<10.0	<3.36	<3470
Nitrobenzene	<2.7	<0.91	<944
1-Nitrosopiperidine	-----	-----	-----
Isophorone	<10.0	<3.36	<3470
2,4-Dimethylphenol	<10.0	<3.36	<3470
Bis(2-chloroethoxy)methane	<10.0	<3.36	<3470
2,4-Dichlorophenol	<10.0	<3.36	<3470
1,2,4-Trichlorobenzene	<1.2	<0.39	<399
Naphthalene	1.46	0.490	170.1
4-Methoxybenzenamine	<10.0	<3.36	<3470
2-Nitrophenol	<10.0	<3.36	<3470
2,6-Dichlorophenol	-----	-----	-----
Hexachloropropene	-----	-----	-----
4-Chloroaniline	<20.0	<6.72	<6941
Hexachlorobutadiene	<10.0	<3.36	<3470
N-butyl-N-nitroso-butanamine	-----	-----	-----
4-chloro-3-methyl-phenol	<20.0	<6.72	<6941
2-methylnaphthalene	<10.0	<3.36	<3470
4-chloro-2-methylbenzenamine	-----	-----	-----
1,2,4,5-tetrachlorobenzene	-----	-----	-----
2,3,5-trichlorophenol	<4.7	<1.59	<1642
Hexachlorocyclopentadiene	<10.0	<3.36	<3470
2,4,6-trichlorophenol	<4.3	<1.45	<1499
2,4,5-Trichlorophenol	<4.7	<1.59	<1642

2,3,4-trichlorophenol	<4.7	<1.59	<1642
2-chloronaphthalene	<1.1	<0.38	<389
1-chloronaphthalene	<0.7	<0.25	<257
4-chloroquinoline	——	——	——
2-nitroaniline	<50.0	<16.79	<17352
3-nitroaniline	<50.0	<16.79	<17352
Acenaphthylene	<1.0	<0.34	<347
Dimethylphathalate	<10.0	<3.36	<3470
2,6-dinitrotoluene	<2.4	<0.80	<826
Acenaphthene	<0.8	<0.27	<274
4-nitroaniline	<50.0	<16.79	<17352
2,4-dinitrophenol	<50.0	<16.79	<17352
Dibenzofuran	<0.9	<0.29	<298
Pentachlorobenzene	——	——	——
2,4-dinitrotoluene	<2.4	<0.80	<826
5-nitroquinoline	——	——	——
2,3,4,6-tetrachlorophenol	——	——	——
2,3,5,6-tetrachlorophenol	——	——	——
2,3,4,5-tetrachlorophenol	——	——	——
4-nitrophenol	<50.0	<16.79	<17352
Fluorene	<0.8	<0.28	<288
Diethyl phathalate	<10.0	<3.36	<3470
4-Chlorophenyl phenyl ether	<10.0	<3.36	<3470
2-methyl-5-nitrobenzenamine	——	——	——
N-nitrosodiphenylamine	<10.0	<3.36	<3470
2-methyl-4,6-dinitrophenol	<50.0	<16.79	<17352
Azobenzene	——	——	——
Diphenylamine	——	——	——
4-Bromophenyl phenyl ether	<10.0	<3.36	<3470
Phenacetin	——	——	——
Hexachlorobenzene	<0.6	<0.21	<222
Pentachlorophenol	<4.2	<1.41	<1454
Pentachloronitrobenzene	——	——	——
Phenanthrene	<0.6	<0.18	<191
Anthracene	<0.6	<0.20	<205
Azoxybenzene	——	——	——
Pentachloroaniline	——	——	——
Dibutyl phthalate	29.23	9.815	3406.3
2-nitro-N-phenylbenzenamine	——	——	——
4-nitro-1-oxide-quinoline	——	——	——
Methapyrilene	——	——	——
Fluoranthene	<0.3	<0.11	<111
Pyrene	<0.3	<0.11	<115
N-methyl-4-(phenylazo)-benzene	——	——	——
P-dimethylaminoazobenzene	——	——	——
Benzyl butyl phthalate	<10.0	<3.36	<3470
N-2-fluorenylacetamide	——	——	——
Chrysene	0.52	0.175	60.6
Benzo(a)anthracene	0.48	0.161	55.9
Bis(2-ethylhexyl)phthalate	4461.00	1497.965	519854.2
Di-N-octyl phthalate	<10.0	<3.36	<3470
Benzo(b)fluoranthene	<0.5	<0.17	<180
7,12-Dimethylbenz(a)anthracene	——	——	——
Benzo(k)fluoranthene	<0.7	<0.24	<243
Benzo(a)pyrene	<0.3	<0.09	<97
3-methylcholanthrene	——	——	——
Dibenz(a,j)acridine	——	——	——
Indeno(1,2,3-cd)pyrene	<0.6	<0.21	<215
Dibenz(a,h)anthracene	0.50	0.168	58.3
Benzo(g,h,i)perylene	0.51	0.171	59.4

SEMIVOLATILE ORGANICS SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 3/10/95

Condition	No. 6 Oil	Operator	DJ, ES
Location	Stack	Stack Flow	372.0 DSCFM
Start Time	1300	Stop Time	1410

Run Number	MM5-3A
Volume Collected	51.295 DSCF
Isokinetic	97.1 %

Analyte	µg	µg/m³	µg/MBtu
Chlorobenzene	<1.2	<0.85	<428
Styrene	<2.6	<1.78	<898
Cumene	<1.0	<0.70	<355
1,1-Biphenyl	<1.2	<0.83	<421
N-Nitrosodimethylamine	----	----	----
N-methyl-N-nitroso-Ethanamine	----	----	----
N-ethyl-N-nitroso-Ethanamine	----	----	----
Bis(2-chloroethyl)ether	<10.0	<6.88	<3482
Aniline	----	----	----
Phenol	<10.0	<6.88	<3482
2-Chlorophenol	<10.0	<6.88	<3482
1,3-Dichlorobenzene	<1.0	<0.67	<338
1,4-Dichlorobenzene	<1.0	<0.67	<338
1,2-Dichlorobenzene	<1.0	<0.67	<338
Benzyl Alcohol	<20.0	<13.77	<6965
Bis(2-chloroisopropyl)ether	<10.0	<6.88	<3482
2-Methylphenol	<5.1	<3.54	<1790
Acetophenone	----	----	----
Hexachloroethane	<10.0	<6.88	<3482
Methyl-Benzenamine	----	----	----
3&4-methylphenol	<10.6	<7.31	<3698
N-nitrosodipropylamine	<10.0	<6.88	<3482
Nitrobenzene	<2.7	<1.87	<947
1-Nitrosopiperidine	----	----	----
Isophorone	<10.0	<6.88	<3482
2,4-Dimethylphenol	<10.0	<6.88	<3482
Bis(2-chloroethoxy)methane	<10.0	<6.88	<3482
2,4-Dichlorophenol	<10.0	<6.88	<3482
1,2,4-Trichlorobenzene	<1.2	<0.79	<400
Naphthalene	3.33	2.293	798.4
4-Methoxybenzenamine	<10.0	<6.88	<3482
2-Nitrophenol	<10.0	<6.88	<3482
2,6-Dichlorophenol	----	----	----
Hexachloropropene	----	----	----
4-Chloroaniline	<20.0	<13.77	<6965
Hexachlorobutadiene	<10.0	<6.88	<3482
N-butyl-N-nitroso-butanamine	----	----	----
4-chloro-3-methyl-phenol	<20.0	<13.77	<6965
2-methylnaphthalene	<10.0	<6.88	<3482
4-chloro-2-methylbenzenamine	----	----	----
1,2,4,5-tetrachlorobenzene	----	----	----
2,3,5-trichlorophenol	<4.7	<3.26	<1647
Hexachlorocyclopentadiene	<10.0	<6.88	<3482
2,4,6-trichlorophenol	<4.3	<2.97	<1504
2,4,5-Trichlorophenol	<4.7	<3.26	<1647

2,3,4-trichlorophenol	<4.7	<3.26	<1647
2-chloronaphthalene	<1.1	<0.77	<390
1-chloronaphthalene	<0.7	<0.51	<258
4-chloroquinoline	———	———	———
2-nitroaniline	<50.0	<34.42	<17412
3-nitroaniline	<50.0	<34.42	<17412
Acenaphthylene	<1.0	<0.69	<348
Dimethylphathalate	<10.0	<6.88	<3482
2,6-dinitrotoluene	<2.4	<1.64	<829
Acenaphthene	<0.8	<0.54	<275
4-nitroaniline	<50.0	<34.42	<17412
2,4-dinitrophenol	<50.0	<34.42	<17412
Dibenzofuran	<0.9	<0.59	<299
Pentachlorobenzene	———	———	———
2,4-dinitrotoluene	<2.4	<1.64	<829
5-nitroquinoline	———	———	———
2,3,4,6-tetrachlorophenol	———	———	———
2,3,5,6-tetrachlorophenol	———	———	———
2,3,4,5-tetrachlorophenol	———	———	———
4-nitrophenol	<50.0	<34.42	<17412
Fluorene	<0.8	<0.57	<289
Diethyl phathalate	3.71	2.554	889.5
4-Chlorophenyl phenyl ether	<10.0	<6.88	<3482
2-methyl-5-nitrobenzenamine	———	———	———
N-nitrosodiphenylamine	<10.0	<6.88	<3482
2-methyl-4,6-dinitrophenol	<50.0	<34.42	<17412
Azobenzene	———	———	———
Diphenylamine	———	———	———
4-Bromophenyl phenyl ether	<10.0	<6.88	<3482
Phenacetin	———	———	———
Hexachlorobenzene	<0.6	<0.44	<223
Pentachlorophenol	<4.2	<2.88	<1459
Pentachloronitrobenzene	———	———	———
Phenanthrene	<0.6	<0.38	<192
Anthracene	<0.6	<0.41	<205
Azoxybenzene	———	———	———
Pentachloroaniline	———	———	———
Dibutyl phthalate	61.67	42.458	14785.3
2-nitro-N-phenylbenzenamine	———	———	———
4-nitro-1-oxide-quinoline	———	———	———
Methapyrilene	———	———	———
Fluoranthene	<0.3	<0.22	<111
Pyrene	<0.3	<0.23	<115
N-methyl-4-(phenylazo)-benzene	———	———	———
P-dimethylaminoazobenzene	———	———	———
Benzyl butyl phthalate	2.55	1.756	611.4
N-2-fluorenylacetamide	———	———	———
Chrysene	<0.2	<0.16	<80
Benzo(a)anthracene	<0.2	<0.17	<84
Bis(2-ethylhexyl)phthalate	<10.0	<6.88	<3482
Di-N-octyl phthalate	130.40	89.776	31263.3
Benzo(b)fluoranthene	<0.5	<0.36	<181
7,12-Dimethylbenz(a)anthracene	———	———	———
Benzo(k)fluoranthene	<0.7	<0.48	<244
Benzo(a)pyrene	<0.3	<0.19	<98
3-methylcholanthrene	———	———	———
Dibenz(a,j)acridine	———	———	———
Indeno(1,2,3-cd)pyrene	<0.6	<0.43	<216
Dibenz(a,h)anthracene	<0.6	<0.44	<223
Benzo(g,h,i)perylene	<0.5	<0.36	<181

SEMIVOLATILE ORGANICS SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 2/15/95

Condition	No. 6 Oil Emulsified	Operator	DJ, ES
Location	Stack	Stack Flow	326.5 DSCFM
Start Time	1235	Stop Time	1535

Run Number	MM5-4A	MM5-4B
Volume Collected	117.560 DSCF	101.901 DSCF
Isokinetic	100.6 %	86.5 %

Analyte	µg	µg/m³	µg/MBtu	µg	µg/m³	µg/MBtu
Chlorobenzene	<1.2	<0.37	<345	<1.2	<0.43	<345
Styrene	<2.6	<0.78	<723	<2.6	<0.89	<723
Cumene	<1.0	<0.31	<286	<1.0	<0.35	<286
1,1-Biphenyl	<1.2	<0.36	<339	<1.2	<0.42	<339
N-Nitrosodimethylamine	——	——	——	——	——	——
N-methyl-N-nitroso-Ethanamine	——	——	——	——	——	——
N-ethyl-N-nitroso-Ethanamine	——	——	——	——	——	——
Bis(2-chloroethyl)ether	<10.0	<3.00	<2801	<10.0	<3.47	<2801
Aniline	——	——	——	——	——	——
Phenol	<10.0	<3.00	<2801	<10.0	<3.47	<2801
2-Chlorophenol	<10.0	<3.00	<2801	<10.0	<3.47	<2801
1,3-Dichlorobenzene	<1.0	<0.29	<272	<1.0	<0.34	<272
1,4-Dichlorobenzene	<1.0	<0.29	<272	<1.0	<0.34	<272
1,2-Dichlorobenzene	<1.0	<0.29	<272	<1.0	<0.34	<272
Benzyl Alcohol	<20.0	<6.01	<5603	<20.0	<6.93	<5603
Bis(2-chloroisopropyl)ether	<10.0	<3.00	<2801	<10.0	<3.47	<2801
2-Methylphenol	<5.1	<1.54	<1440	<5.1	<1.78	<1440
Acetophenone	——	——	——	——	——	——
Hexachloroethane	<10.0	<3.00	<2801	<10.0	<3.47	<2801
Methyl-Benzenamine	——	——	——	——	——	——
3&4-methylphenol	<10.6	<3.19	<2975	<10.6	<3.68	<2975
N-nitrosodipropylamine	<10.0	<3.00	<2801	<10.0	<3.47	<2801
Nitrobenzene	<2.7	<0.82	<762	<2.7	<0.94	<762
1-Nitrosopiperidine	——	——	——	——	——	——
Isophorone	<10.0	<3.00	<2801	<10.0	<3.47	<2801
2,4-Dimethylphenol	<10.0	<3.00	<2801	<10.0	<3.47	<2801
Bis(2-chloroethoxy)methane	<10.0	<3.00	<2801	<10.0	<3.47	<2801
2,4-Dichlorophenol	<10.0	<3.00	<2801	<10.0	<3.47	<2801
1,2,4-Trichlorobenzene	<1.2	<0.35	<322	<1.2	<0.40	<322
Naphthalene	2.40	0.721	202.0	1.70	0.589	165.0
4-Methoxybenzenamine	<10.0	<3.00	<2801	<10.0	<3.47	<2801
2-Nitrophenol	<10.0	<3.00	<2801	<10.0	<3.47	<2801
2,6-Dichlorophenol	——	——	——	——	——	——
Hexachloropropene	——	——	——	——	——	——
4-Chloroaniline	<20.0	<6.01	<5603	<20.0	<6.93	<5603
Hexachlorobutadiene	<10.0	<3.00	<2801	<10.0	<3.47	<2801
N-butyl-N-nitroso-butanamine	——	——	——	——	——	——
4-chloro-3-methyl-phenol	<20.0	<6.01	<5603	<20.0	<6.93	<5603
2-methylnaphthalene	<10.0	<3.00	<2801	<10.0	<3.47	<2801
4-chloro-2-methylbenzenamine	——	——	——	——	——	——
1,2,4,5-tetrachlorobenzene	——	——	——	——	——	——
2,3,5-trichlorophenol	<4.7	<1.42	<1325	<4.7	<1.64	<1325
Hexachlorocyclopentadiene	<10.0	<3.00	<2801	<10.0	<3.47	<2801
2,4,6-trichlorophenol	<4.3	<1.30	<1210	<4.3	<1.50	<1210
2,4,5-Trichlorophenol	<4.7	<1.42	<1325	<4.7	<1.64	<1325

2,3,4-trichlorophenol	<4.7	<1.42	<1325	<4.7	<1.64	<1325
2-chloronaphthalene	<1.1	<0.34	<314	<1.1	<0.39	<314
1-chloronaphthalene	<0.7	<0.22	<207	<0.7	<0.26	<207
4-chloroquinoline	——	——	——	——	——	——
2-nitroaniline	<50.0	<15.02	<14006	<50.0	<17.33	<14006
3-nitroaniline	<50.0	<15.02	<14006	<50.0	<17.33	<14006
Acenaphthylene	<1.0	<0.30	<280	<1.0	<0.35	<280
Dimethylphathalate	<10.0	<3.00	<2801	<10.0	<3.47	<2801
2,6-dinitrotoluene	<2.4	<0.71	<667	<2.4	<0.82	<667
Acenaphthene	<0.8	<0.24	<221	<0.8	<0.27	<221
4-nitroaniline	<50.0	<15.02	<14006	<50.0	<17.33	<14006
2,4-dinitrophenol	<50.0	<15.02	<14006	<50.0	<17.33	<14006
Dibenzofuran	0.36	0.108	30.3	0.18	0.062	17.5
Pentachlorobenzene	——	——	——	——	——	——
2,4-dinitrotoluene	<2.4	<0.71	<667	<2.4	<0.82	<667
5-nitroquinoline	——	——	——	——	——	——
2,3,4,6-tetrachlorophenol	——	——	——	——	——	——
2,3,5,6-tetrachlorophenol	——	——	——	——	——	——
2,3,4,5-tetrachlorophenol	——	——	——	——	——	——
4-nitrophenol	<50.0	<15.02	<14006	<50.0	<17.33	<14006
Fluorene	<0.8	<0.25	<233	<0.8	<0.29	<233
Diethyl phathalate	4.75	1.427	399.7	3.95	1.369	383.5
4-Chlorophenyl phenyl ether	<10.0	<3.00	<2801	<10.0	<3.47	<2801
2-methyl-5-nitrobenzenamine	——	——	——	——	——	——
N-nitrosodiphenylamine	<10.0	<3.00	<2801	<10.0	<3.47	<2801
2-methyl-4,6-dinitrophenol	<50.0	<15.02	<14006	<50.0	<17.33	<14006
Azobenzene	——	——	——	——	——	——
Diphenylamine	——	——	——	——	——	——
4-Bromophenyl phenyl ether	<10.0	<3.00	<2801	<10.0	<3.47	<2801
Phenacetin	——	——	——	——	——	——
Hexachlorobenzene	<0.6	<0.19	<179	<0.6	<0.22	<179
Pentachlorophenol	<4.2	<1.26	<1174	<4.2	<1.45	<1174
Pentachloronitrobenzene	——	——	——	——	——	——
Phenanthrene	<0.6	<0.17	<154	<0.6	<0.19	<154
Anthracene	<0.6	<0.18	<165	<0.6	<0.20	<165
Azoxybenzene	——	——	——	——	——	——
Pentachloroaniline	——	——	——	——	——	——
Dibutyl phthalate	93.61	28.120	7877.2	30.82	10.681	2992.0
2-nitro-N-phenylbenzenamine	——	——	——	——	——	——
4-nitro-1-oxide-quinoline	——	——	——	——	——	——
Methapyrilene	——	——	——	——	——	——
Fluoranthene	<0.3	<0.10	<90	<0.3	<0.11	<90
Pyrene	<0.3	<0.10	<92	<0.3	<0.11	<92
N-methyl-4-(phenylazo)-benzene	——	——	——	——	——	——
P-dimethylaminoazobenzene	——	——	——	——	——	——
Benzyl butyl phthalate	2.36	0.709	198.6	<10.0	<3.47	<2801
N-2-fluorenylacetamide	——	——	——	——	——	——
Chrysene	<0.2	<0.07	<64	<0.2	<0.08	<64
Benzo(a)anthracene	<0.2	<0.07	<67	<0.2	<0.08	<67
Bis(2-ethylhexyl)phthalate	<10.0	<3.00	<2801	41.45	14.365	4024.0
Di-N-octyl phthalate	2644.00	794.243	222489.2	457.10	158.412	44375.5
Benzo(b)fluoranthene	<0.5	<0.16	<146	<0.5	<0.18	<146
7,12-Dimethylbenz(a)anthracene	——	——	——	——	——	——
Benzo(k)fluoranthene	<0.7	<0.21	<196	<0.7	<0.24	<196
Benzo(a)pyrene	<0.3	<0.08	<78	<0.3	<0.10	<78
3-methylcholanthrene	——	——	——	——	——	——
Dibenz(a,j)acridine	——	——	——	——	——	——
Indeno(1,2,3-cd)pyrene	<0.6	<0.19	<174	<0.6	<0.21	<174
Dibenz(a,h)anthracene	<0.6	<0.19	<179	<0.6	<0.22	<179
Benzo(g,h,i)perylene	<0.5	<0.16	<146	<0.5	<0.18	<146

SEMIVOLATILE ORGANICS SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 3/16/95

Condition	No. 6 Emulsified	Operator	DJ, ES
Location	Stack	Stack Flow	356.5 DSCFM
Start Time	827	Stop Time	1127

Run Number	MM5-5A
Volume Collected	114.504 DSCF
Isokinetic	89.6 %

Analyte	µg	µg/m³	µg/MBtu
Chlorobenzene	<1.2	<0.38	<377
Styrene	<2.6	<0.80	<790
Cumene	<1.0	<0.31	<312
1,1-Biphenyl	<1.2	<0.37	<370
N-Nitrosodimethylamine	——	——	——
N-methyl-N-nitroso-Ethanamine	——	——	——
N-ethyl-N-nitroso-Ethanamine	——	——	——
Bis(2-chloroethyl)ether	<10.0	<3.08	<3061
Aniline	——	——	——
Phenol	36.08	11.128	3406.6
2-Chlorophenol	<10.0	<3.08	<3061
1,3-Dichlorobenzene	<1.0	<0.30	<297
1,4-Dichlorobenzene	<1.0	<0.30	<297
1,2-Dichlorobenzene	<1.0	<0.30	<297
Benzyl Alcohol	<20.0	<6.17	<6123
Bis(2-chloroisopropyl)ether	<10.0	<3.08	<3061
2-Methylphenol	<5.1	<1.59	<1574
Acetophenone	——	——	——
Hexachloroethane	<10.0	<3.08	<3061
Methyl-Benzenamine	——	——	——
3&4-methylphenol	<10.6	<3.28	<3251
N-nitrosodipropylamine	<10.0	<3.08	<3061
Nitrobenzene	<2.7	<0.84	<833
1-Nitrosopiperidine	——	——	——
Isophorone	<10.0	<3.08	<3061
2,4-Dimethylphenol	<10.0	<3.08	<3061
Bis(2-chloroethoxy)methane	<10.0	<3.08	<3061
2,4-Dichlorophenol	<10.0	<3.08	<3061
1,2,4-Trichlorobenzene	<1.2	<0.35	<352
Naphthalene	5.01	1.545	473.0
4-Methoxybenzenamine	<10.0	<3.08	<3061
2-Nitrophenol	<10.0	<3.08	<3061
2,6-Dichlorophenol	——	——	——
Hexachloropropene	——	——	——
4-Chloroaniline	<20.0	<6.17	<6123
Hexachlorobutadiene	<10.0	<3.08	<3061
N-butyl-N-nitroso-butanamine	——	——	——
4-chloro-3-methyl-phenol	<20.0	<6.17	<6123
2-methylnaphthalene	<10.0	<3.08	<3061
4-chloro-2-methylbenzenamine	——	——	——
1,2,4,5-tetrachlorobenzene	——	——	——
2,3,5-trichlorophenol	<4.7	<1.46	<1448
Hexachlorocyclopentadiene	<10.0	<3.08	<3061
2,4,6-trichlorophenol	<4.3	<1.33	<1323
2,4,5-Trichlorophenol	<4.7	<1.46	<1448

2,3,4-trichlorophenol	<4.7	<1.46	<1448
2-chloronaphthalene	<1.1	<0.35	<343
1-chloronaphthalene	<0.7	<0.23	<227
4-chloroquinoline	———	———	———
2-nitroaniline	<50.0	<15.42	<15307
3-nitroaniline	<50.0	<15.42	<15307
Acenaphthylene	<1.0	<0.31	<306
Dimethylphathalate	<10.0	<3.08	<3061
2,6-dinitrotoluene	<2.4	<0.73	<729
Acenaphthene	<0.8	<0.24	<242
4-nitroaniline	<50.0	<15.42	<15307
2,4-dinitrophenol	<50.0	<15.42	<15307
Dibenzofuran	0.83	0.256	78.4
Pentachlorobenzene	———	———	———
2,4-dinitrotoluene	<2.4	<0.73	<729
5-nitroquinoline	———	———	———
2,3,4,6-tetrachlorophenol	———	———	———
2,3,5,6-tetrachlorophenol	———	———	———
2,3,4,5-tetrachlorophenol	———	———	———
4-nitrophenol	<50.0	<15.42	<15307
Fluorene	<0.8	<0.26	<254
Diethyl phathalate	2.71	0.836	255.9
4-Chlorophenyl phenyl ether	<10.0	<3.08	<3061
2-methyl-5-nitrobenzenamine	———	———	———
N-nitrosodiphenylamine	<10.0	<3.08	<3061
2-methyl-4,6-dinitrophenol	<50.0	<15.42	<15307
Azobenzene	———	———	———
Diphenylamine	———	———	———
4-Bromophenyl phenyl ether	<10.0	<3.08	<3061
Phenacetin	———	———	———
Hexachlorobenzene	<0.6	<0.20	<196
Pentachlorophenol	<4.2	<1.29	<1283
Pentachloronitrobenzene	———	———	———
Phenanthrene	<0.6	<0.17	<168
Anthracene	<0.6	<0.18	<181
Azoxybenzene	———	———	———
Pentachloroaniline	———	———	———
Dibutyl phthalate	9.28	2.862	876.2
2-nitro-N-phenylbenzenamine	———	———	———
4-nitro-1-oxide-quinoline	———	———	———
Methapyrilene	———	———	———
Fluoranthene	<0.3	<0.10	<98
Pyrene	<0.3	<0.10	<101
N-methyl-4-(phenylazo)-benzene	———	———	———
P-dimethylaminoazobenzene	———	———	———
Benzyl butyl phthalate	<10.0	<3.08	<3061
N-2-fluorenylacetamide	———	———	———
Chrysene	<0.2	<0.07	<70
Benzo(a)anthracene	<0.2	<0.07	<73
Bis(2-ethylhexyl)phthalate	88.10	27.171	8318.3
Di-N-octyl phthalate	2599.00	801.565	245395.0
Benzo(b)fluoranthene	<0.5	<0.16	<159
7,12-Dimethylbenz(a)anthracene	———	———	———
Benzo(k)fluoranthene	<0.7	<0.22	<214
Benzo(a)pyrene	<0.3	<0.09	<86
3-methylcholanthrene	———	———	———
Dibenz(a,j)acridine	———	———	———
Indeno(1,2,3-cd)pyrene	<0.6	<0.19	<190
Dibenz(a,h)anthracene	<0.6	<0.20	<196
Benzo(g,h,i)perylene	<0.5	<0.16	<159

SEMIVOLATILE ORGANICS SAMPLING RESULTS SUMMARY

Source Description:	North American Boiler	Test Date:	3/16/95
Condition	No. 6 Emulsified	Operator	DJ, ES
Location	Stack	Stack Flow	365.1 DSCFM
Start Time	1158	Stop Time	1458
Run Number	MM5-6A		
Volume Collected	117.239 DSCF		
Isokinetic	88.3 %		

Analyte	µg	µg/m³	µg/MBtu
Chlorobenzene	<1.2	<0.37	<382
Styrene	<2.6	<0.78	<801
Cumene	<1.0	<0.31	<317
1,1-Biphenyl	<1.2	<0.36	<376
N-Nitrosodimethylamine	----	----	----
N-methyl-N-nitroso-Ethanamine	----	----	----
N-ethyl-N-nitroso-Ethanamine	----	----	----
Bis(2-chloroethyl)ether	<10.0	<3.01	<3106
Aniline	----	----	----
Phenol	16.81	5.063	1572.5
2-Chlorophenol	<10.0	<3.01	<3106
1,3-Dichlorobenzene	<1.0	<0.29	<301
1,4-Dichlorobenzene	<1.0	<0.29	<301
1,2-Dichlorobenzene	<1.0	<0.29	<301
Benzyl Alcohol	<20.0	<6.02	<6211
Bis(2-chloroisopropyl)ether	<10.0	<3.01	<3106
2-Methylphenol	<5.1	<1.55	<1596
Acetophenone	----	----	----
Hexachloroethane	<10.0	<3.01	<3106
Methyl-Benzenamine	----	----	----
3&4-methylphenol	<10.6	<3.20	<3298
N-nitrosodipropylamine	<10.0	<3.01	<3106
Nitrobenzene	<2.7	<0.82	<845
1-Nitrosopiperidine	----	----	----
Isophorone	<10.0	<3.01	<3106
2,4-Dimethylphenol	<10.0	<3.01	<3106
Bis(2-chloroethoxy)methane	<10.0	<3.01	<3106
2,4-Dichlorophenol	<10.0	<3.01	<3106
1,2,4-Trichlorobenzene	<1.2	<0.35	<357
Naphthalene	2.65	0.798	247.9
4-Methoxybenzenamine	<10.0	<3.01	<3106
2-Nitrophenol	<10.0	<3.01	<3106
2,6-Dichlorophenol	----	----	----
Hexachloropropene	----	----	----
4-Chloroaniline	<20.0	<6.02	<6211
Hexachlorobutadiene	<10.0	<3.01	<3106
N-butyl-N-nitroso-butanamine	----	----	----
4-chloro-3-methyl-phenol	<20.0	<6.02	<6211
2-methylnaphthalene	<10.0	<3.01	<3106
4-chloro-2-methylbenzenamine	----	----	----
1,2,4,5-tetrachlorobenzene	----	----	----
2,3,5-trichlorophenol	<4.7	<1.42	<1469
Hexachlorocyclopentadiene	<10.0	<3.01	<3106
2,4,6-trichlorophenol	<4.3	<1.30	<1342
2,4,5-Trichlorophenol	<4.7	<1.42	<1469

2,3,4-trichlorophenol	<4.7	<1.42	<1469
2-chloronaphthalene	<1.1	<0.34	<348
1-chloronaphthalene	<0.7	<0.22	<230
4-chloroquinoline	——	——	——
2-nitroaniline	<50.0	<15.06	<15528
3-nitroaniline	<50.0	<15.06	<15528
Acenaphthylene	<1.0	<0.30	<311
Dimethylphathalate	<10.0	<3.01	<3106
2,6-dinitrotoluene	<2.4	<0.72	<739
Acenaphthene	<0.8	<0.24	<245
4-nitroaniline	<50.0	<15.06	<15528
2,4-dinitrophenol	<50.0	<15.06	<15528
Dibenzofuran	0.24	0.072	22.5
Pentachlorobenzene	——	——	——
2,4-dinitrotoluene	<2.4	<0.72	<739
5-nitroquinoline	——	——	——
2,3,4,6-tetrachlorophenol	——	——	——
2,3,5,6-tetrachlorophenol	——	——	——
2,3,4,5-tetrachlorophenol	——	——	——
4-nitrophenol	<50.0	<15.06	<15528
Fluorene	<0.8	<0.25	<258
Diethyl phathalate	9.31	2.804	870.9
4-Chlorophenyl phenyl ether	<10.0	<3.01	<3106
2-methyl-5-nitrobenzenamine	——	——	——
N-nitrosodiphenylamine	<10.0	<3.01	<3106
2-methyl-4,6-dinitrophenol	<50.0	<15.06	<15528
Azobenzene	——	——	——
Diphenylamine	——	——	——
4-Bromophenyl phenyl ether	<10.0	<3.01	<3106
Phenacetin	——	——	——
Hexachlorobenzene	<0.6	<0.19	<199
Pentachlorophenol	<4.2	<1.26	<1301
Pentachloronitrobenzene	——	——	——
Phenanthrene	<0.6	<0.17	<171
Anthracene	<0.6	<0.18	<183
Azoxybenzene	——	——	——
Pentachloroaniline	——	——	——
Dibutyl phthalate	35.53	10.702	3323.7
2-nitro-N-phenylbenzenamine	——	——	——
4-nitro-1-oxide-quinoline	——	——	——
Methapyrilene	——	——	——
Fluoranthene	<0.3	<0.10	<99
Pyrene	<0.3	<0.10	<102
N-methyl-4-(phenylazo)-benzene	——	——	——
P-dimethylaminoazobenzene	——	——	——
Benzyl butyl phthalate	<10.0	<3.01	<3106
N-2-fluorenylacetamide	——	——	——
Chrysene	<0.2	<0.07	<71
Benzo(a)anthracene	<0.2	<0.07	<75
Bis(2-ethylhexyl)phthalate	<10.0	<3.01	<3106
Di-N-octyl phthalate	<10.0	<3.01	<3106
Benzo(b)fluoranthene	<0.5	<0.16	<161
7,12-Dimethylbenz(a)anthracene	——	——	——
Benzo(k)fluoranthene	<0.7	<0.21	<217
Benzo(a)pyrene	<0.3	<0.08	<87
3-methylcholanthrene	——	——	——
Dibenz(a,j)acridine	——	——	——
Indeno(1,2,3-cd)pyrene	<0.6	<0.19	<193
Dibenz(a,h)anthracene	<0.6	<0.19	<199
Benzo(g,h,i)perylene	<0.5	<0.16	<161

DIOXIN SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 3-6-95

Condition	No. 6 Oil	Operator	DJ, ES
Location	Stack	Stack Flow	392.5 DSCFM
Start Time	1510	Stop Time	1810

Run Number	M23-1A	M23-1B
Volume Collected	146.191 DSCF	138.563 DSCF
Isokinetic	102.4 %	90.7 %

Analyte	ng	ng/m³	µg/MBtu	ng	ng/m³	µg/MBtu
1.) Monochlorodibenzodioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
2.) Dichlorodibenzodioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
3.) Trichlorodibenzodioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
4.) Tetrachlorodibenzodioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
5.) Pentachlorodibenzodioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
6.) Hexachlorodibenzodioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
7.) Heptachlorodibenzoioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
8.) Octachlorodibenzodioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
1.) Monochlorodibenzodioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
2.) Dichlorodibenzodioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
3.) Trichlorodibenzodioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
4.) Tetrachlorodibenzodioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
5.) Pentachlorodibenzodioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
6.) Hexachlorodibenzodioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
7.) Heptachlorodibenzoioxin	ND	<2.416	<0.813	ND	<2.549	<0.858
8.) Octachlorodibenzodioxin	ND	<2.416	<0.813	ND	<2.549	<0.858

DIOXIN SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 3/8/95

Condition	No. 6	Operator	DJ, ES
Location	Stack	Stack Flow	343.0 DSCFM
Start Time	938	Stop Time	1238

Run Number	M23-2A	M23-2B
Volume Collected	125.695 DSCF	123.012 DSCF
Isokinetic	97.5 %	96.2 %

Analyte	ng	ng/m³	µg/MBtu	ng	ng/m³	µg/MBtu
1.) Monochlorodibenzodioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
2.) Dichlorodibenzodioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
3.) Trichlorodibenzodioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
4.) Tetrachlorodibenzodioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
5.) Pentachlorodibenzodioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
6.) Hexachlorodibenzodioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
7.) Heptachlorodibenzoioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
8.) Octachlorodibenzodioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
1.) Monochlorodibenzodioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
2.) Dichlorodibenzodioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
3.) Trichlorodibenzodioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
4.) Tetrachlorodibenzodioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
5.) Pentachlorodibenzodioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
6.) Hexachlorodibenzodioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
7.) Heptachlorodibenzoioxin	ND	<2.810	<0.945	ND	<2.871	<0.966
8.) Octachlorodibenzodioxin	ND	<2.810	<0.945	ND	<2.871	<0.966

DIOXIN SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 3/9/95

Condition	No. 6 Oil	Operator	DJ, ES
Location	Stack	Stack Flow	372.3 DSCFM
Start Time	1318	Stop Time	1618

Run Number	M23-2A
Volume Collected	134.510 DSCF
Isokinetic	90.2 %

Analyte	ng	ng/m³	µg/MBtu
1.) Monochlorodibenzodioxin	ND	<2.625	<0.883
2.) Dichlorodibenzodioxin	ND	<2.625	<0.883
3.) Trichlorodibenzodioxin	ND	<2.625	<0.883
4.) Tetrachlorodibenzodioxin	ND	<2.625	<0.883
5.) Pentachlorodibenzodioxin	ND	<2.625	<0.883
6.) Hexachlorodibenzodioxin	ND	<2.625	<0.883
7.) Heptachlorodibenzoioxin	ND	<2.625	<0.883
8.) Octachlorodibenzodioxin	ND	<2.625	<0.883
1.) Monochlorodibenzodioxin	ND	<2.625	<0.883
2.) Dichlorodibenzodioxin	ND	<2.625	<0.883
3.) Trichlorodibenzodioxin	ND	<2.625	<0.883
4.) Tetrachlorodibenzodioxin	ND	<2.625	<0.883
5.) Pentachlorodibenzodioxin	ND	<2.625	<0.883
6.) Hexachlorodibenzodioxin	ND	<2.625	<0.883
7.) Heptachlorodibenzoioxin	ND	<2.625	<0.883
8.) Octachlorodibenzodioxin	ND	<2.625	<0.883

DIOXIN SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 3/10/95

Condition	No. 6 Oil	Operator	DJ, ES
Location	Stack	Stack Flow	383.2 DSCFM
Start Time	945	Stop Time	1215

Run Number	M23-4A
Volume Collected	116.317 DSCF
Isokinetic	88.6 %

Analyte	ng	ng/m³	µg/MBtu
1.) Monochlorodibenzodioxin	ND	<3.036	<1.021
2.) Dichlorodibenzodioxin	ND	<3.036	<1.021
3.) Trichlorodibenzodioxin	ND	<3.036	<1.021
4.) Tetrachlorodibenzodioxin	ND	<3.036	<1.021
5.) Pentachlorodibenzodioxin	ND	<3.036	<1.021
6.) Hexachlorodibenzodioxin	ND	<3.036	<1.021
7.) Heptachlorodibenzoioxin	ND	<3.036	<1.021
8.) Octachlorodibenzodioxin	ND	<3.036	<1.021
1.) Monochlorodibenzodioxin	ND	<3.036	<1.021
2.) Dichlorodibenzodioxin	ND	<3.036	<1.021
3.) Trichlorodibenzodioxin	ND	<3.036	<1.021
4.) Tetrachlorodibenzodioxin	ND	<3.036	<1.021
5.) Pentachlorodibenzodioxin	ND	<3.036	<1.021
6.) Hexachlorodibenzodioxin	ND	<3.036	<1.021
7.) Heptachlorodibenzoioxin	ND	<3.036	<1.021
8.) Octachlorodibenzodioxin	ND	<3.036	<1.021

DIOXIN SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 3/10/95

Condition	No. 6 Oil	Operator	DJ, ES
Location	Stack	Stack Flow	370.9 DSCFM
Start Time	1307	Stop Time	1417

Run Number	M23-5A
Volume Collected	49.606 DSCF
Isokinetic	78.6 %

Analyte	ng	ng/m³	µg/MBtu
1.) Monochlorodibenzodioxin	ND	<7.119	<2.395
2.) Dichlorodibenzodioxin	ND	<7.119	<2.395
3.) Trichlorodibenzodioxin	ND	<7.119	<2.395
4.) Tetrachlorodibenzodioxin	ND	<7.119	<2.395
5.) Pentachlorodibenzodioxin	ND	<7.119	<2.395
6.) Hexachlorodibenzodioxin	ND	<7.119	<2.395
7.) Heptachlorodibenzoioxin	ND	<7.119	<2.395
8.) Octachlorodibenzodioxin	ND	<7.119	<2.395
1.) Monochlorodibenzodioxin	ND	<7.119	<2.395
2.) Dichlorodibenzodioxin	ND	<7.119	<2.395
3.) Trichlorodibenzodioxin	ND	<7.119	<2.395
4.) Tetrachlorodibenzodioxin	ND	<7.119	<2.395
5.) Pentachlorodibenzodioxin	ND	<7.119	<2.395
6.) Hexachlorodibenzodioxin	ND	<7.119	<2.395
7.) Heptachlorodibenzoioxin	ND	<7.119	<2.395
8.) Octachlorodibenzodioxin	ND	<7.119	<2.395

DIOXIN SAMPLING RESULTS SUMMARY

Source Description: North American Boiler Test Date: 3/14/95

Condition	No. 6 Emulsified	Operator	DJ, ES
Location	Stack	Stack Flow	345.7 DSCFM
Start Time	1330	Stop Time	1600

Run Number	M23-5A	M23-6B
Volume Collected	96.318 DSCF	95.245 DSCF
Isokinetic	91.0 %	89.7 %

Analyte	ng	ng/m³	µg/MBtu	ng	ng/m³	µg/MBtu
1.) Monochlorodibenzodioxin	ND	<3.666	<1.233	NA	NA	NA
2.) Dichlorodibenzodioxin	ND	<3.666	<1.233	NA	NA	NA
3.) Trichlorodibenzodioxin	ND	<3.666	<1.233	NA	NA	NA
4.) Tetrachlorodibenzodioxin	ND	<3.666	<1.233	NA	NA	NA
5.) Pentachlorodibenzodioxin	ND	<3.666	<1.233	NA	NA	NA
6.) Hexachlorodibenzodioxin	ND	<3.666	<1.233	NA	NA	NA
7.) Heptachlorodibenzoioxin	ND	<3.666	<1.233	NA	NA	NA
8.) Octachlorodibenzodioxin	ND	<3.666	<1.233	NA	NA	NA
1.) Monochlorodibenzodioxin	ND	<3.666	<1.233	NA	NA	NA
2.) Dichlorodibenzodioxin	ND	<3.666	<1.233	NA	NA	NA
3.) Trichlorodibenzodioxin	ND	<3.666	<1.233	NA	NA	NA
4.) Tetrachlorodibenzodioxin	ND	<3.666	<1.233	NA	NA	NA
5.) Pentachlorodibenzodioxin	ND	<3.666	<1.233	NA	NA	NA
6.) Hexachlorodibenzodioxin	ND	<3.666	<1.233	NA	NA	NA
7.) Heptachlorodibenzoioxin	ND	<3.666	<1.233	NA	NA	NA
8.) Octachlorodibenzodioxin	ND	<3.666	<1.233	NA	NA	NA

DIOXIN SAMPLING RESULTS SUMMARY

Source Description:	North American Boiler		Test Date: 3/16/95
Condition	No. 6 Emulsified	Operator	DJ, ES
Location	Stack	Stack Flow	354.4 DSCFM
Start Time	828	Stop Time	1128
Run Number	MM5-5A		
Volume Collected	113.820 DSCF		
Isokinetic	88.0 %		

Analyte	ng	ng/m³	µg/MBtu
1.) Monochlorodibenzodioxin	ND	<3.103	<1.044
2.) Dichlorodibenzodioxin	ND	<3.103	<1.044
3.) Trichlorodibenzodioxin	ND	<3.103	<1.044
4.) Tetrachlorodibenzodioxin	ND	<3.103	<1.044
5.) Pentachlorodibenzodioxin	ND	<3.103	<1.044
6.) Hexachlorodibenzodioxin	ND	<3.103	<1.044
7.) Heptachlorodibenzoioxin	ND	<3.103	<1.044
8.) Octachlorodibenzodioxin	ND	<3.103	<1.044
1.) Monochlorodibenzodioxin	ND	<3.103	<1.044
2.) Dichlorodibenzodioxin	ND	<3.103	<1.044
3.) Trichlorodibenzodioxin	ND	<3.103	<1.044
4.) Tetrachlorodibenzodioxin	ND	<3.103	<1.044
5.) Pentachlorodibenzodioxin	ND	<3.103	<1.044
6.) Hexachlorodibenzodioxin	ND	<3.103	<1.044
7.) Heptachlorodibenzoioxin	ND	<3.103	<1.044
8.) Octachlorodibenzodioxin	ND	<3.103	<1.044

DIOXIN SAMPLING RESULTS SUMMARY

Source Description:	North American Boiler		Test Date: 3/16/95
Condition	No. 6 Emulsified	Operator	DJ, ES
Location	Stack	Stack Flow	367.8 DSCFM
Start Time	1157	Stop Time	1457
Run Number	M23-8A		
Volume Collected	134.062 DSCF		
Isokinetic	100.0 %		

Analyte	ng	ng/m³	µg/MBtu
1.) Monochlorodibenzodioxin	ND	<2.634	<0.886
2.) Dichlorodibenzodioxin	ND	<2.634	<0.886
3.) Trichlorodibenzodioxin	ND	<2.634	<0.886
4.) Tetrachlorodibenzodioxin	ND	<2.634	<0.886
5.) Pentachlorodibenzodioxin	ND	<2.634	<0.886
6.) Hexachlorodibenzodioxin	ND	<2.634	<0.886
7.) Heptachlorodibenzoioxin	ND	<2.634	<0.886
8.) Octachlorodibenzodioxin	ND	<2.634	<0.886
1.) Monochlorodibenzodioxin	ND	<2.634	<0.886
2.) Dichlorodibenzodioxin	ND	<2.634	<0.886
3.) Trichlorodibenzodioxin	ND	<2.634	<0.886
4.) Tetrachlorodibenzodioxin	ND	<2.634	<0.886
5.) Pentachlorodibenzodioxin	ND	<2.634	<0.886
6.) Hexachlorodibenzodioxin	ND	<2.634	<0.886
7.) Heptachlorodibenzoioxin	ND	<2.634	<0.886
8.) Octachlorodibenzodioxin	ND	<2.634	<0.886