

**SOURCE TEST REPORT
PCB TREATABILITY DEMONSTRATION TEST
ON THE PYROLYTIC THERMAL CONVERSION
WITH A THERMAL OXIDIZER**

**PREPARED FOR:
BALBOA PACIFIC CORPORATION**

No. 30990-001-131

February, 1986

DAMES & MOORE

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--LIQUID FEED--

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PREFACE

Firm Tested: Balboa Pacific Corporation
Address 11240 Bloomfield Ave
City: Santa Fe Springs, CA 90670
Contact: Dr. Shapoor Hamid
Source: BAL-PAC Exhaust

Date of Test: November 21, 1995
Test Requested by: Balboa Pacific Corporation
Contact: Dr. Shapoor Hamid
Test Observed by: Balboa Pacific Staff
Test Performed by: Dames & Moore
Team Members: Tony Host, Christopher J. Barth, Brian Satow, Jason Wirth
Test Objectives: Demonstrate the PCB destruction efficiency of the BAL-PAC Pyrolytic Thermal Conversion Unit with a Thermal Oxidizer
Test Methods: EPA Method 23 "Determination of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans from Municipal Waste Combustors"
CARB Method 100 "Instrumental Methods for Gaseous Emissions"
EPA Method 26 "Determination of Hydrogen Chloride Emissions From Stationary Sources"
TGNMO - Determination of Total Gaseous Non-Methane Organics

EXECUTIVE SUMMARY

Balboa Pacific Corporation has developed the BAL-PAC Pyrolytic Conversion System for treatment of solid or liquid hazardous and non-hazardous waste. The basic principle of this system is the destruction and stabilization of the waste stream using high temperatures up to 2000 °F in an oxygen free environment during which the waste is converted into a stabilized ash and a combustible gas. The gas is further treated at up to 2250 °F and routed to a heat recovery boiler. Gas exits the boiler at approximately 350-500 °F and is fed through a wet scrubber system and then through an activated carbon bed where it exhausts to atmosphere at approximately 150 °F.

Dames & Moore was contracted by Balboa Pacific to conduct a PCB treatability demonstration study of the BAL-PAC Pyrolytic Conversion System. The primary goal of the treatability test was to determine the destruction efficiency of the BAL-PAC system using a PCB contaminated transformer oil waste feed. The test was conducted by Dames & Moore personnel on November 21, 1995. During the test, the PCB laced oil feed was fed into the system at a constant rate while both the liquid feed and exhaust gas exiting the carbon bed was sampled for PCB's. The results of this testing showed that there were no detectable quantities of PCB's in the exhaust gas of the BAL-PAC System. A PCB destruction efficiency was calculated to be 99.999984 % based on the detection limit of the exhaust gas PCB sampling technique.

In addition to the PCB testing, the following tests were conducted on the BAL-PAC exhaust:

- Dioxins and Furans
- Hydrogen chloride
- Hydrocarbons
- Oxygen
- Carbon dioxide
- Carbon monoxide
- Oxides of Nitrogen

Testing was coordinated with Dr. Shapoor Hamid of Balboa Pacific Corporation (310-929-1633). Results of the testing are shown in the following Tables.

Table ES-1 BAL-PAC Exhaust Gas Data

Parameter	Units	BAL-PAC Exhaust
Temperature	°F	147
Velocity	ft/sec	11.5
Static Pressure	" H2O	-0.01
Stack Dimension	in.	16 x 21
Moisture	%	22.3
Flow Rate	ACFM	1,616
	DSCFM	1,085

Table ES-2 PCB Emissions

Compound	Concentrations			Emissions ug/hr
	ng/sample	DL	ng/dscf	
Monochlorobiphenyl	ND	5.0	1.892	1.163
Dichlorobiphenyl	ND	5.0	1.892	1.163
Trichlorobiphenyl	ND	5.0	1.892	1.163
Tetrachlorobiphenyl	ND	5.0	1.892	1.163
Pentachlorobiphenyl	ND	5.0	1.892	1.163
Hexachlorobiphenyl	ND	5.0	1.892	1.163
Heptachlorobiphenyl	ND	5.0	1.892	1.163
Octachlorobiphenyl	ND	5.0	1.892	1.163
Nonachlorobiphenyl	ND	5.0	1.892	1.163
Decachlorobiphenyl	ND	5.0	1.892	1.163

ND = Not Detected

DL = Detection Limit

Note: ug/hr based on 1/2 the detection limit

Table ES-3 PCB Destruction Removal Efficiency

Feed		
Flow Rate	gal/hr	2.56
PCB Concentration	g/gal	2.898
PCB Mass Flow Rate	g/hr	7.419
Exhaust		
Flow Rate	DSCFM	1,085
PCB Concentration	ng/DSCF	1.892
PCB Mass Flow Rate	ug/hr	1.163
Destruction Removal Efficiency	%	99.999984

Table ES-4 Dioxin/Furan Emissions

Compound	Concentrations			Emissions ng/hr
	pg/sample	DL	pg/dscf	
2,3,7,8-TCDD	ND	9.2	0.000	0.000
Total TCDD	ND	9.2	0.000	0.000
1,2,3,7,8-PeCDD	ND	4.6	0.000	0.000
Total PeCDD	ND	4.6	0.000	0.000
1,2,3,4,7,8-HxCDD	ND	4.4	0.000	0.000
1,2,3,6,7,8-HxCDD	ND	4.7	0.000	0.000
1,2,3,7,8,9-HxCDD	ND	4.2	0.000	0.000
Total HxCDD	ND	4.7	0.000	0.000
1,2,3,4,6,7,8-HpCDD	ND	6.0	0.000	0.000
Total HpCDD	ND	6.0	0.000	0.000
OCDD	25		6.307	11.632
2,3,7,8-TCDF	ND	6.8	0.000	0.000
Total TCDF	160		40.367	74.445
1,2,3,7,8-PeCDF	ND	15	0.000	0.000
2,3,4,7,8-PeCDF	ND	12	0.000	0.000
Total PeCDF	63		15.895	29.313
1,2,3,4,7,8-HxCDF	ND	6.4	0.000	0.000
1,2,3,6,7,8-HxCDF	ND	7.5	0.000	0.000
2,3,4,6,7,8-HxCDF	ND	4.4	0.000	0.000
1,2,3,7,8,9-HxCDF	ND	3.1	0.000	0.000
Total HxCDF	19		4.794	8.840
1,2,3,4,6,7,8-HpCDF	ND	8.1	0.000	0.000
1,2,3,4,7,8,9-HpCDF	ND	5.0	0.000	0.000
Total HpCDF	ND	8.1	0.000	0.000
OCDF	18		4.541	83.375

ND = Not Detected

DL = Detection Limit

Table ES-5 Other Emission Data

CONSTITUENT	CONCENTRATION	EMISSION RATE
Oxygen, O ₂	11.4 %	-----
Carbon Dioxide, CO ₂	4.4%	-----
Carbon Monoxide, CO	0.5 ppmv	0.002 lb/hr
Oxides of Nitrogen, NO _x	48.8 ppmv	0.39 lb/hr
Hydrogen Chloride, HCl	0.24 ppmv	0.002 lb/hr
Total Non-Methane Hydrocarbons	< 1 ppmv	< 0.002 lb/hr

1.0 INTRODUCTION

Balboa Pacific Corporation (Balboa Pacific) has developed a BAL-PAC Pyrolytic Conversion System for treatment of hazardous and non-hazardous waste. This patented technology is based on destruction and stabilization of waste, using intense indirect thermal energy in a controlled oxygen free environment.

Balboa Pacific has contracted Dames & Moore to conduct a treatability study for polychlorinated biphenyls (PCB's). The objectives of the treatability study are to meet the Department of Health Services, Title 22, Section 66261.4 (e) *Treatability Study Samples* and (f) *Samples Undergoing Treatability Studies at Laboratories and Testing Facilities* requirements and obtain data demonstrating the effectiveness and efficiency of the BAL-PAC system. This data will be presented to prospective clients to assure them of the feasibility of this technology. Any purchased units would have to meet the permitting and testing requirements of the area in which it would be installed.

On November 21, 1995, Dames & Moore personnel conducted source emissions testing at the exhaust of the BAL-PAC system. The following test methods were used:

- EPA Method 23 "Determination of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzo Furans from Municipal Waste Combustors"
- SCAQMD Method 100.1 "Instrumental Methods for Gaseous Emissions"
- EPA Method 26 "Determination of Hydrogen Chloride Emissions from Stationary Sources"
- TGNMO "Total Non-Methane Hydrocarbons"

The testing was conducted at Balboa Pacific, 11240 Bloomfield Avenue, Santa Fe Springs, California 90670. The BAL-PAC system has been granted a Research Permit (A/N 304641) under Rule 441 of the Rules and Regulations and the South Coast Air Quality Management District (SCAQMD).

This document presents a detailed description of the system, a description of the operating parameters within which the system was operated during the course of the test, a description of the monitoring, sampling techniques and analytical procedures which were used, and the results of the testing.

2.0 PROJECT ORGANIZATION

An organization chart for the treatability study of the Balboa Pacific Pyrolytic Conversion System is presented in Figure 2-1. The Site Manager for Balboa Pacific was Mr. Shapoor Hamid. The Site Manager was responsible for the mechanical operation of the Pyrolytic Conversion System. The Treatability Study Coordinator was Mr. Tony Host of Dames & Moore. The Treatability Study Coordinator had the authority and responsibility of coordinating the activities of the Pyrolytic Conversion System operational personnel and the Test Team Sampling Crew.

Under the direction of the Site Manager, the Coordinator assisted the operating personnel during start-up and optimization of the Pyrolytic Conversion System. The Coordinator monitored the operating conditions and ensured that the system was operated within the parameters established by the regulatory agencies. The Coordinator also insured that the spiked samples were correctly prepared and fed to the system.

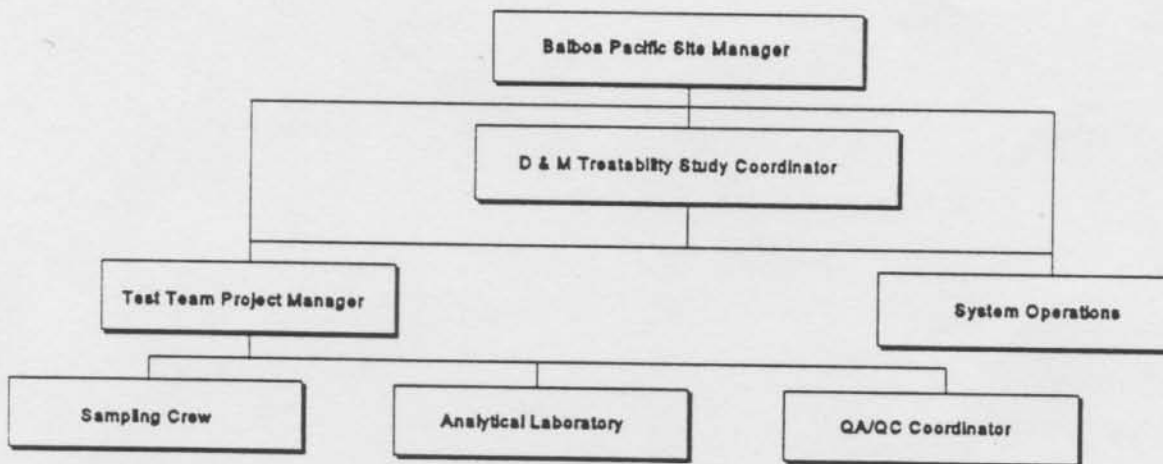


Figure 2-1 Treatability Study Organization

The Sampling Team Project Manager was Mr. Chris Barth of Dames & Moore. He was responsible for the proper collection of all samples specified in the sampling and monitoring plan. He kept the Coordinator informed of overall progress and problems or potential problems on a timely basis and was responsible for the proper shipment of samples to the analytical laboratory as outlined in the project Quality Assurance Plan.

3.0 EQUIPMENT AND PROCESS ENGINEERING INFORMATION

The BAL-PAC Pyrolytic Conversion System is based on patented technology. The basic principle of this technology is the destruction and stabilization of the waste stream using very high temperatures (1900-2000 °F) in an oxygen free environment. By this process the waste stream entering the unit is converted into combustible gases and a stabilized solid waste stream. The gases produced are subjected to high temperature (2250 °F) in a thermal oxidizer where the toxic gases are destroyed. There are four main subsystems to the BAL-PAC system described below. A diagram of the unit is shown in Figure 3-1.

- The Feed or Input System: The waste material is introduced into the system through a series of valves and gates that are synchronized to prevent unwanted oxygen or air from entering into the processing chamber.
- Pyrolytic Conversion Chamber (retort): A thermally insulated outer housing surrounding a retort or pyrolytic chamber containing a rotary screw that conveys the waste through the retort as pyrolysis occurs. The space between the outer housing and the internal retort chamber contains a heat chamber, through which natural gas at a maximum rate of 500 cubic feet per minute is routed for combustion, providing the heat source for pyrolysis.
- Thermal Oxidizer: The gases liberated by pyrolysis are drawn off by a "closed coupled thermal oxidizer" where they are ignited, converting them primarily to carbon dioxide and water. The temperature in the thermal oxidizer can reach 2500 degrees F. The retention time for the gases in the chamber is at least 2 seconds. The thermal oxidizer is also fired on natural gas.
- Output System: This system is for the solid by-product produced after the pyrolytic retort. It is characterized by air locks implemented by synchronized valves that expel inert residual pyrolysis matter for post-pyrolytic processing.

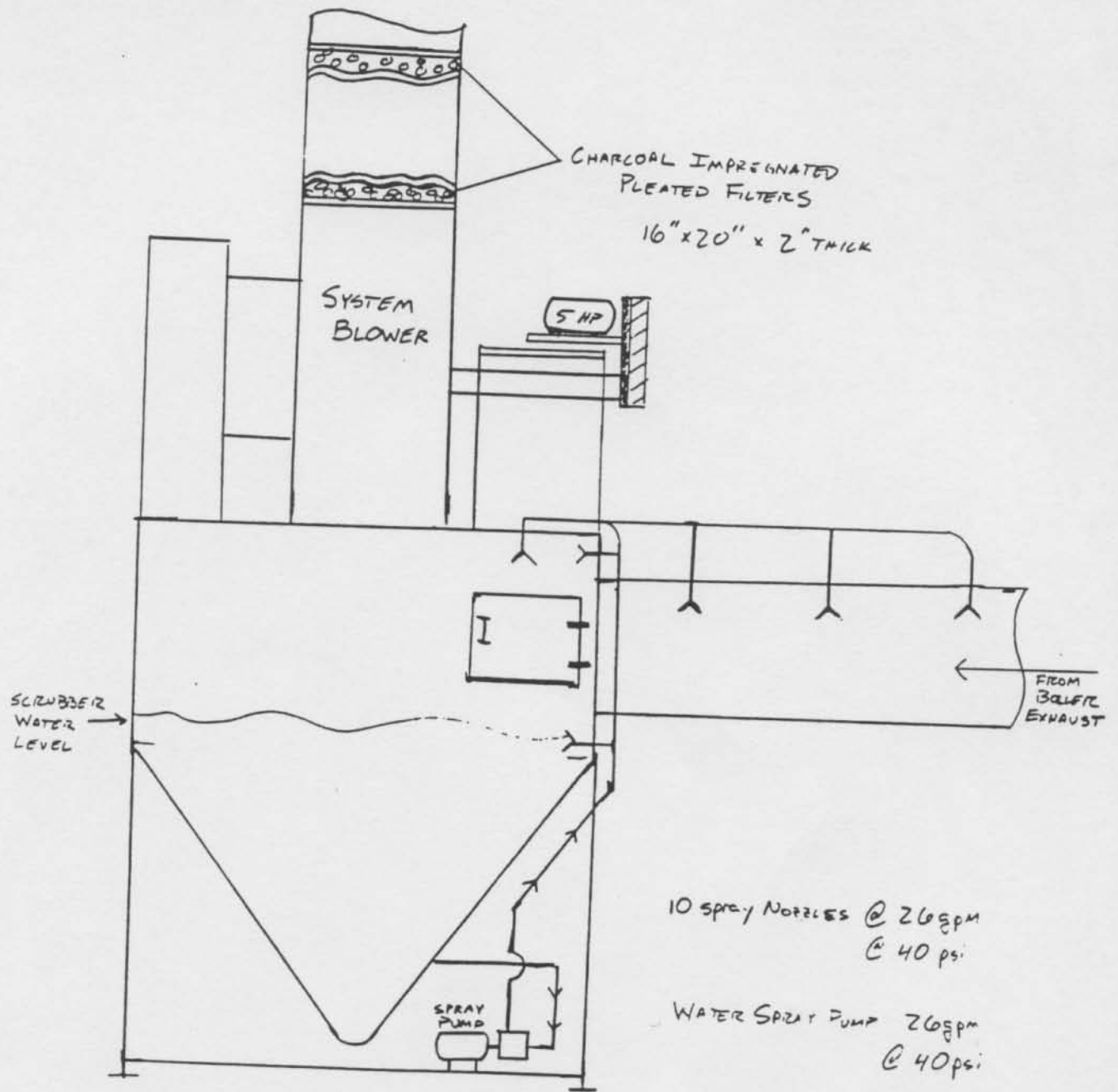


Figure 3-2 Diagram of BAL-PAC Scrubber and Carbon Bed

4.0 PROCESS OPERATION

The sampling and monitoring plan for the treatability study has been designed so that effective destruction of the PCB spiked mineral oil can be verified. The test procedures were designed to consist of a single pyrolytic conversion run at the specified operating conditions to assess system performance.

Stack emission monitoring was conducted for the following parameters while the BAL-PAC System was used for the destruction of the PCB spiked transformer oil:

- PCB's
- Dioxins and Furans
- Carbon Monoxide
- Oxides of Nitrogen
- Oxygen
- Carbon Dioxide
- Total Gaseous Non-Methane Hydrocarbons
- Hydrogen Chloride

In addition, the PCB concentration in the transformer oil was determined in order to calculate the systems' PCB destruction efficiency. Any ash produced during the testing period was to be collected and analyzed, however, due to the nature of the feed, no ash byproduct was produced during the testing period.

One day prior to the testing date, Balboa Pacific staff tuned the BAL-PAC system and adjusted the operating conditions to the proper test plan settings. During this period pure transformer oil (not PCB spiked), was used as the feed and the system was allowed to run overnight in order to maintain proper operating conditions during the testing date.

Twenty five (25) gallons of transformer oil were mixed with 200 grams of PCB's (Arochlor 1254) in a 55 gallon drum. Prior to the test run, the PCB spiked transformer oil was pumped into the BAL-PAC twenty-five gallon feed hopper. Upon transferring the oil to the hopper, the system was allowed to stabilize for approximately 90 minutes in order to ensure steady state conditions prior to conducting any testing.

The system operations team, under the direction of the Balboa Pacific Site Manager, was responsible for monitoring and recording system process parameters, including feed rate, pyrolytic

retort temperatures, thermal oxidizer temperatures and recovery boiler exit temperatures. A copy of the system parameters recorded during the testing period are included in Appendix A.

Table 4-1 "BAL-PAC Operating Parameters" tabulates the system parameters during the course of the testing.

Feed Rate gal/hr	Retort Temperature		Oxidizer Temp. °F	Boiler Exh. Temp. °F	Stack Temp. °F
	Inlet °F	Outlet °F			
2.56	1314	1450	2250	580	149

Table 4-1 BAL-PAC Operating Parameters

The Pyrolytic Conversion System was operated at an average temperature of 1382 °F in an oxygen free environment. The gases produced were then introduced to the thermal oxidizer operating at an average temperature of 2250 °F. Following the oxidizer, the gas entered the boiler and was subsequently cooled to 580 °F. Excess steam produced from the boiler was vented to atmosphere. Following the boiler was a wet scrubber and a carbon bed which further cooled the gas stream down to an average exhaust stack temperature of 149 °F.

5.0 SAMPLING AND MONITORING

The sampling and monitoring plan for the treatability study was designed so that effective destruction of the impoundment material could be verified. As only preliminary data was desired in order to demonstrate the technology to potential clients, only one test run was performed. The following stack gas constituent concentrations were determined:

- PCB's
- Dioxins and Furans
- Carbon Monoxide
- Oxygen
- Carbon Dioxide
- Total Gaseous Non-Methane Hydrocarbons
- Hydrogen Chloride

In addition, the PCB concentration in the transformer oil feed was determined in order to calculate the PCB destruction efficiency. Due to the nature of the feed, no ash byproduct was produced during the testing period.

The system was monitored during the testing to record specific process parameters, including feed rate, pyrolytic retort temperatures, thermal oxidizer temperatures and recovery boiler exit temperatures.

The testing program consisted of several tests conducted over a four hour duration. Samples were collected from two areas:

- Material feed
- Exhaust gas

5.1 TEST OVERVIEW

A PCB spiked transfer oil was incinerated as a liquid in the BAL-PAC Pyrolytic Conversion System. One week prior to the test, Dames & Moore personnel prepared and thoroughly mixed the PCB spiked oil at the Balboa Pacific facility. The oil was mixed a second time, on the testing date, immediately prior to transferring it to the BAL-PAC feed hopper where it was again mixed

to ensure a homogenous feed composition.

On Friday, November 17, Dames and Moore field crew performed a preliminary moisture determination and flow rate traverse of the stack gas. In addition, the flue gas molecular weight was determined by analyzing for oxygen and carbon dioxide using a Fyrite Gas Analyzer. These preliminary measurements were needed in order to determine the optimum sampling nozzle diameter and to perform the isokinetic calculations required for the Method 23 "PCB" testing.

On Monday, November 20, Dames and Moore personnel setup for the testing to be conducted on the following day. The necessary hardware and rail traverse system was installed on the stack sampling ports and the Dames & Moore Mobile Laboratory and analyzers were tuned and warmed up.

On Tuesday, November 21, the system monitoring, alarm and interlock units were checked out and the system was brought to optimum operating conditions. During this time period, the field test crew was responsible for equipment set up and conducting preliminary measurements and calibrations of their equipment. Upon confirmation that the system was stabilized, the Site Manager informed the Treatability Study Coordinator that sampling could begin.

Dames & Moore personnel, who have received special training for working around PCB spiked mineral oil, were responsible for sampling of the feed to the treatment system. Dames & Moore personnel were also responsible for providing the necessary equipment to measure the gaseous and semi-volatile organic emissions from the exhaust stack.

When all sampling was completed, the Sampling Team Leader informed the Treatability Study Coordinator. The Coordinator then informed the Site Manager to record the total amount of feed material processed during the sampling run. At this point, clean mineral oil was processed to clean the feed system of the PCB spiked feed.

Table 5-1 summarizes the Dames & Moore field activities during the course of the BAL-PAC System treatability testing.

Table 5-1 Dames & Moore Activity Schedule

Activity	Nov. 13	Nov. 17	Nov. 20	Nov. 21
Prepare 25 gallons of PCB spiked oil feed	X			
Preliminary Measurements - Exhaust Flow Rate, Moisture Content, Gas Density		X		
Field Setup - Warm-up Mobile Laboratory, Install Meth. 23 Traverse Hardware, Calibration Checks			X	
Testing - PCB's, Dioxins and Furans, HCl, TGNMO, Oxygen, Carbon Dioxide, Carbon Monoxide, Oxides of Nitrogen				X
Demobilization				X

5.2 FEED MATERIAL

The feed material used during the treatability study program was transformer oil (Shell Diala AX Oil) spiked with Arochlor 1254 (PCB). A fifty-five gallon drum was used to spike twenty-five gallons of transformer oil with 200 grams of Arochlor 1254.

The feed rate was measured volumetrically. Prior to the testing date, Balboa Pacific staff performed a volumetric calibration of the twenty-five gallon feed hopper in order to get an accurate feed rate. During this procedure, known volumes of oil were transferred to the hopper and the liquid level was measured giving a chart of volume versus liquid level. This chart was used to determine the PCB spiked oil feed rate during the testing period. The spiked transformer oil was fed from the hopper to the system at a rate of 18.9 pounds per hour during the testing period. The feed hopper calibration chart is included in Appendix A.

A four milliliter feed sample was collected every thirty minutes during periods of stack sampling in order to produce a composite feed sample. These samples were withdrawn from the bottom of the feed hopper and collected in a wide-mouth glass jar, sealed with a Teflon-lined screw cap. This sample was subsequently sent to ALTA Analytical, El Dorado, CA for PCB analysis.

5.3 PRODUCT (ASH)

Due to the nature of the feed matrix, no product ash was observed during the testing period.

5.4 EXHAUST GAS SAMPLING

During the four hour sample run, exhaust gas emissions were sampled for subsequent determination of PCB's, Dioxins and Furans, Hydrocarbons, HCl, O₂, CO₂, CO and NO_x.

5.4.1 Sampling Traverse Locations

The exhaust stack from the wet scrubber exhaust is 16 inches by 21 inches (18" equivalent diameter). Figure 5-1 shows the port locations on the exhaust stack. Three test ports are located in the 21 inch face, the ports being 4 inches in diameter and 1.5 inches in length. For the PCB sampling, eight sampling points for each sample port were used as shown in Figure 5-2 and Table 5-2. The HCl, hydrocarbon and Method 100.1 testing were all conducted at a single point located at the center of the stack. The ports were located 30" upstream and 92" downstream of the nearest flow disturbance, meeting EPA Method 1 requirements (2 duct diameters upstream and 1/2 duct diameter downstream of the nearest flow disturbance).

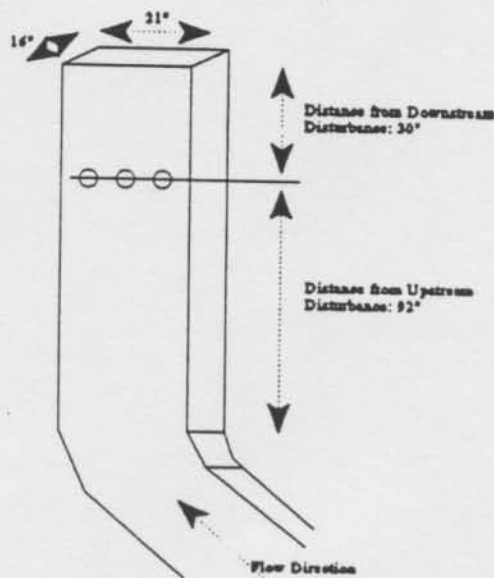


Figure 5-1 Exhaust Stack Diagram

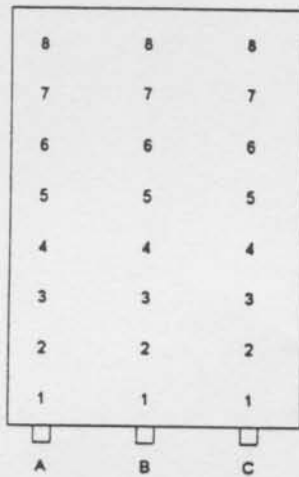


Figure 5-2 Port Locations

Traverse Point	Inside of Near Wall to Traverse Point	Traverse Point Location from Outside of Nipple
1	1	2.5
2	3	4.5
3	5	6.5
4	7	8.5
5	9	10.5
6	11	12.5
7	13	14.5
8	15	16.5

Table 5-2 Traverse Point Locations

5.4.2 Sampling for PCB's and Dioxins and Furans

EPA Method 23 was used to collect samples for polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and PCB's. Multi-point isokinetic sampling was conducted at ten minutes per traverse point for a total of four hours. Testing began at 11:30 and concluded at 16:30. The sampling train consisted of a glass-lined, heat traced probe with a stainless steel, button hook nozzle with an attached thermocouple and pitot tube assembly. A glass fiber filter heated to 248 (\pm 25) °F, a water-cooled condenser, and sorbent module containing pre-cleaned XAD-2 resin, maintained at < 68 °F are located downstream of the probe assembly. The organic module components were oriented to direct the flow of condensate formed vertically downward from the conditioning section, through the adsorbent media, and into the condensate knockout trap. The adsorbent media collects any PCB's, Dioxins or Furans. The knockout trap consisted of an oversized impinger (approximately one liter in volume) similar in appearance to an empty impinger directly underneath the sorbent module, it had a shortened center stem to collect a large volume of condensate without bubbling and overflowing into the impinger train. All surfaces of the sampling train contacted by the gas sample, including nozzle, probe, filter holder, connecting glassware and O-rings, were fabricated of borosilicate glass or Teflon.

To determine the stack-gas moisture content, four 500-ml impingers connected in series with leak-free ground-glass joints, followed the knockout trap. The first, third, and fourth

impingers were of the Greenburg-Smith design, modified by replacing the tip with a 1.3 cm (½ inch) I.D. glass tube extending about 1.3 cm (½ inch) from the bottom of the outer cylinder. The second impinger was of the Greenburg-Smith design with the standard tip. The first and second impingers contained approximately 100 mls of distilled water and the fourth contained a known weight of silica gel. Purification of the XAD-2 resin used for the collection of the sample was performed by ALTA Analytical. A schematic of the sampling train used in this method is shown in Figure 5-3. The majority of the required equipment is identical to that used in an EPA Method 5 determination. The new components required are a condenser coil and a sorbent module. Due to expected low concentrations, a minimum of 3 dry standard cubic meters (105.9 dscf) of sample volume was required. Special field sample recovery procedures were followed to recover the organic material. Analysis of PCB's, Dioxins and Furans was conducted by high resolution gas chromatography/mass spectroscopy using fused-silica capillary GC column.

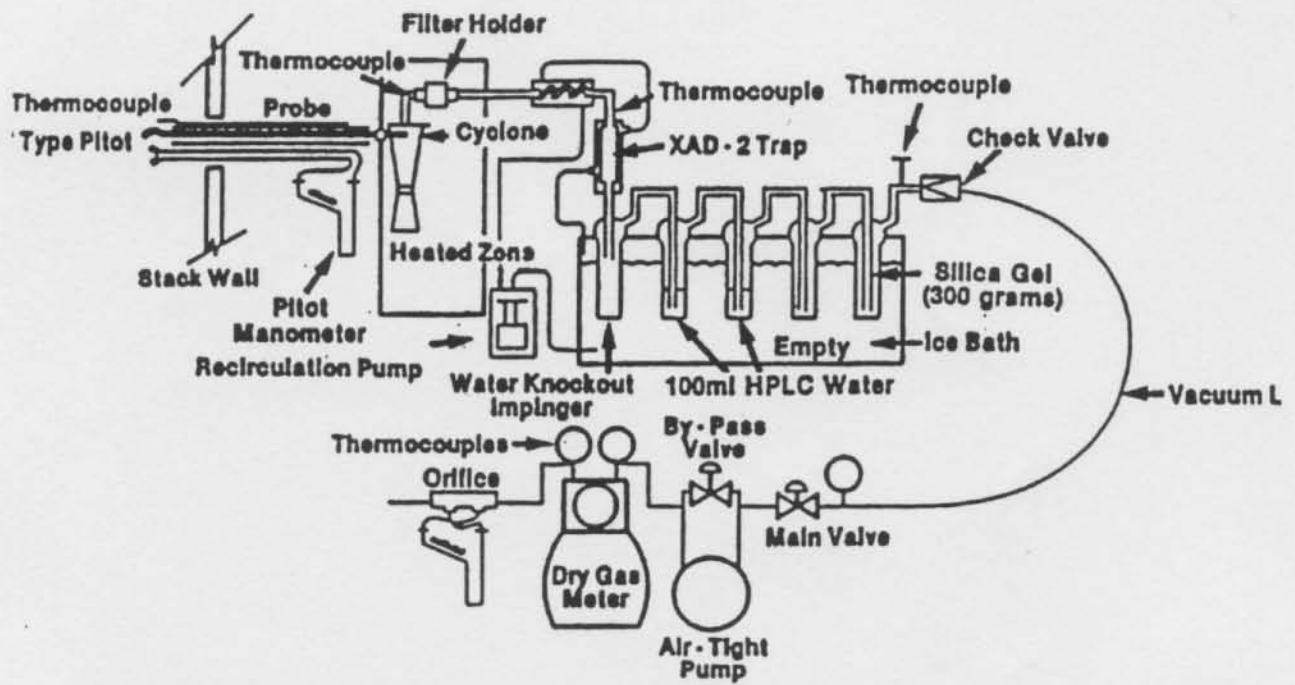


Figure 5-3. CDD/CDF Sampling Train Configuration

5.4.3 Sampling for Hydrogen Chloride

Hydrogen Chloride (HCl) sampling was conducted according to a modified EPA Method 26 testing setup. HCl testing began 11:40. At 11:48, the sampling pump lost power and the sampling train was down for a total of eight minutes. Sampling commenced at 11:55 and concluded at 12:48 for a total of one hour of sampling time..

A 1/4" Teflon line was used as the sampling probe and was placed at the center of the stack. The total sampling time was one hour at a rate of 1,985 cc/min. The probe was connected to a set of 4-midget impingers. The first two contained a known amount of 0.1 N H₂SO₄ absorbing solution, the third was left empty and the fourth contained a known amount of silica gel. A rotameter and a sampling pump followed the midget impinger train. The volumetric flow rate of the entire sampling system was calibrated with a M5 mini-BUC Calibrator.

System calibrations were conducted prior to and immediately following the test in order to quantify the volumetric flow rate during the test. System leak checks were conducted before and after testing. No leaks were found.

Upon completion of the test and calibration checks, the sample was transported to the Dames & Moore Laboratory facility. The impinger solution along with the rinses of the connecting glassware were measured and transferred to a polyethylene sample container. A blank sample, containing the absorbing solution was also prepared. Both samples were sent to West Coast Analytical Services Inc. for subsequent chloride determination. Ion Chromatography was used as the instrumental method.

5.4.4 Sampling for Total Non-Methane Hydrocarbons

Hydrocarbon sampling began at 14:00 and concluded at 16:00 for a total of two hours of sampling.

Total non-methane hydrocarbons were sampled using a 1/4" Teflon line located at the center of the stack. The line was connected to a lung-sampler, containing a ten-liter Tedlar bag, followed by a sample pump. Approximately 8-liters of sample were collected over a two hour period. Upon completion of the hydrocarbon sampling, the tedlar bag was removed from the lung-sampler and transported to the Dames & Moore laboratory.

Due to the 72-hour holding time of tedlar bag samples, the bag was shipped out that night, November 21, to ATMAA Inc. for hydrocarbon analysis on the following day. In addition to hydrocarbon analysis, the bag was also analyzed for oxygen and carbon dioxide content in order to confirm there were no system leaks.

5.4.5 Continuous Emission Monitoring

Oxygen, oxides of nitrogen (NO_x), carbon dioxide, and carbon monoxide gas concentrations in the flue gas were measured using an extractive Continuous Emissions Monitoring System (CEMS) in Dames & Moore's Mobile Laboratory. Two sequential Continuous Emission Tests were conducted on the exhaust stack. The first of the two tests was conducted for one hour, 12:12 - 13:12. The second test was conducted for two hours, 1:56 - 3:56.

The Continuous Monitoring System is comprised of four major subsystems. They are: (1) the sample acquisition and conditioning system, (2) the calibration gas system, (3) the analyzers, and (4) the data recording system.

The sample acquisition and conditioning system extracts a representative sample from the stack, removes moisture and particulate material from the sample, and transports the sample to the analyzers. The sample acquisition system consists of a 7 micron stainless steel filter and a 3/8 inch 316 stainless steel probe. The probe is insulated and heated between 250-275°F to avoid condensation. From the probe, the sample gas is transported through a heat-traced Teflon sample line maintained at 240-260°F from the probe to the Universal Analyzer Thermoelectric Gas Sample Cooler Model 3080 via a Teflon-lined diaphragm pump. The outlet temperature of the thermoelectric sample cooler is fully automatic and maintains the dewpoint of sample gas below 37°F.

Sample gas flow is controlled by a series of flow-meter, valves, and regulators upstream of the instrument manifold. Excess sample is vented through a back-pressure regulator, maintaining a constant pressure of 6-7 psig and flow of 2 scfh to each analyzer rotameter. Instrument response is permanently recorded using an online data acquisition system. All fittings and sample line which may contact the sample gas are constructed of stainless steel and Teflon.

Following system performance checks, preliminary calibration error checks were

performed on each analyzer by introducing zero and high span gases and recording the response. A system bias check was then performed to determine the effect of the sample lines, pump, and sample cooler on the measurements. This was done by comparing the calibrations through a 3-way valve at the probe outlet, to calibrations done using calibration gases (zero and upscale concentrations) introduced directly to the instruments. EPA Protocol 1 calibration gases in current certification will be used for all calibration purposes. Calibration gas certifications are included in Appendix D. Post test calibration and bias checks were performed upon completion of the test.

Specifications for the continuous monitors used in Dames & Moore's Mobile Lab are presented in Table 5.3.

Table 5-3 Description of Continuous Monitoring Instrumentation

Gas	Carbon Monoxide (CO)	Oxygen O ₂	Carbon Dioxide CO ₂
Instrument Manufacturer and Model Number	TECO Model 48	Servomex Model 1400	California Analytical Model 3300
Detection Principle	Gas filter Correlation Analyzer	Magneto-Dynamic Paramagnetic Analyzer	Nondispersive Infrared Absorption (NDIR)
Drift: Zero Span	± 0.2 ppm ± 1 percent full scale	<1 percent full scale/24 hr <1 percent full scale/24 hr	± 1 percent full scale/ 24 hr ± 1 percent full scale/24 hr
Output	0-1V	0-1V	0-1V
Ranges	0-1, 2, 5, 10, 20, 50, 100, 200, 500, 1000 ppm	0-25 percent 0-100 percent	0-10 percent 0-20 percent
Response Time	30 sec	30 sec	30 sec

Microprocessor Hybrid Recorder: Yokogawa Model 2300

6.0 ANALYTICAL PROCEDURES

6.1 FEED MATERIALS

In order to determine the destruction efficiency of the PCB spiked transformer oil, the feed composition as well as the feed rate was accurately measured.

Since the feed material contained a known amount of Arochlor 1254, the EPA procedure for analysis of PCBs in transformer oils and waste oils (USEPA 1981, Bellar and Lichtenberg 1981) was used as the analytical method. This procedure provides recommendations for several cleanup techniques. For the instrumental analysis, GC with halogen specific, electron capture, or mass spectrometer detectors are all allowed. Alta Analytical of El Dorado Hills, California, performed the analysis.

6.2 STACK GAS SAMPLES

6.2.1 PCB's and Dioxins and Furans

Stack gas samples for PCB's and dioxins and furans collected by modified the Method 5 trains were extracted, cleaned up and analyzed by high resolution gas chromatography. The filter and the sorbent cartridge (XAD-2) were cleaned and checked by the laboratory prior to usage in the field. The sorbent cartridge was spiked with an appropriate internal standard prior to sampling. All glass components of the train upstream of and including the adsorbent module, were cleaned as described in Section 3A of the "Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples." Special care was devoted to the removal of residual silicone grease sealants on ground glass connections of used glassware.

Sample recovery began as soon as the probe was removed from the stack at the end of the sampling period. The nozzle end of the sampling probe was sealed with acetone washed aluminum foil. External particulate matter was wiped off near the tip of the probe. The probe was removed from the train and closed off at both ends with aluminum foil.

The probe and impinger assembly was transferred to the Dames & Moore laboratory facility. No smoking, which could contaminate the sample, was allowed in the cleanup area. The filter

was carefully removed from the filter holder and placed in its identified container using Teflon forceps.

The sorbent module was removed from the train, tightly capped on both ends, labeled, and stored on ice for transport to the laboratory.

Material deposited in the nozzle, probe transfer lines, and the front half of the filter holder was recovered by brushing while rinsing three times with acetone and then, by rinsing the probe three times with toluene. All the rinses were collected in container No. 2.

The back half of the filter holder was rinsed three times with acetone. The connecting line between the filter and the condenser was also rinsed three times with acetone. The condenser was treated in the same manner as the connecting line. All the rinses were collected in Container No. 2 and the level of the liquid marked on the container.

The liquid gain in the first four impingers was measured to within 1 ml by using a top loading balance and weighing it to within 0.5 g. The weight of liquid present was recorded. The color of the indicating silica gel was noted to determine if it has been completely spent. The silica gel weight was also determined and recorded to calculate stack gas moisture.

The samples were sent by Federal Express to Alta Analytical, El Dorado, California, under chain of custody procedures for extraction and analysis. EPA Method 23 procedures were followed. Laboratory analysis data is included in Appendix E.

6.2.2 Hydrogen Chloride

Hydrogen Chloride sampling was conducted at a single point located at the center of the duct for a total of one hour. Sample was bubbled through a series of midget impingers containing 0.1 N H_2SO_4 solution.

Upon completion of the hydrogen chloride testing and field calibration procedures, the sample was transported to the Dames & Moore laboratory facility. The impinger solution along with the rinses of the connecting glassware were measured and transferred to a polyethylene sample container. A blank sample, for quality control, containing the absorbing solution was also prepared. Both samples were sent to West Coast Analytical Services Inc., Santa Fe Springs, for

subsequent chloride determination. Ion Chromatography was used as the instrumental method. Laboratory analysis data can be found in Appendix E.

6.2.3 Total Non-Methane Hydrocarbons

Total Non-Methane Hydrocarbon (TGNMO) sampling was conducted at a single point located at the center of the duct for a total of two hours. Approximately 8-liters of sample were collected in a Tedlar sample bag.

Due to the 72-hour holding time of Tedlar bag samples, the bag was shipped out that night, November 21, to ATMAA Inc. for hydrocarbon analysis on the following day. In addition to hydrocarbon analysis, the bag was also analyzed for oxygen and carbon dioxide content in order to confirm there were no system leaks. TGNMO, methane and carbon dioxide were analyzed by flame ionization detection/total combustion analyses. Oxygen was analyzed by thermal conductivity detection/gas chromatography. Laboratory analysis data can be found in Appendix E.

7.0 TEST RESULTS

7.1 FEED DATA

Matrix	Shell Daila Oil AX
PCB	Arochlor 1254
PCB Concentration, g/gal	2.898
Oil Feed Rate, gal/hr	2.56
PCB Feed Rate, g/hr	7.419

7.2 PCB/DIOXIN/FURAN EXHAUST SAMPLING DATA

Parameter	Units	BAL-PAC Exhaust
Start Time	Time	11:30
End Time	Time	4:25
Total Sampling Time	min	240
Sample Volume	DSCF	139.92
Isokinetics	%	92
Stack Temperature	°F	146.5
Stack Gas Velocity	ft/s	11.5
Static Pressure	"H ₂ O	-0.01
Stack Dimensions	in.	21 x 16
Moisture	%	22.3
Flow Rate	ACFM	1,616
	DSCFM	1,085

7.2.1 PCB Emission Results

Compound	Concentrations			Emissions ug/hr
	ng/sample	DL	ng/dscf	
Monochlorobiphenyl	ND	5.0	1.892	1.163
Dichlorobiphenyl	ND	5.0	1.892	1.163
Trichlorobiphenyl	ND	5.0	1.892	1.163
Tetrachlorobiphenyl	ND	5.0	1.892	1.163
Pentachlorobiphenyl	ND	5.0	1.892	1.163
Hexachlorobiphenyl	ND	5.0	1.892	1.163
Heptachlorobiphenyl	ND	5.0	1.892	1.163
Octachlorobiphenyl	ND	5.0	1.892	1.163
Nonachlorobiphenyl	ND	5.0	1.892	1.163
Decachlorobiphenyl	ND	5.0	1.892	1.163

ND = Not Detected

DL = Detection Limit

Note: ug/hr based on 1/2 the detection limit

7.2.2 Dioxin/Furan Emission Results

Compound	Concentrations			Emissions ng/hr
	pg/sample	DL	pg/dscf	
2,3,7,8-TCDD	ND	9.2	0.000	0.000
Total TCDD	ND	9.2	0.000	0.000
1,2,3,7,8-PeCDD	ND	4.6	0.000	0.000
Total PeCDD	ND	4.6	0.000	0.000
1,2,3,4,7,8-HxCDD	ND	4.4	0.000	0.000
1,2,3,6,7,8-HxCDD	ND	4.7	0.000	0.000
1,2,3,7,8,9-HxCDD	ND	4.2	0.000	0.000
Total HxCDD	ND	4.7	0.000	0.000
1,2,3,4,6,7,8-HpCDD	ND	6.0	0.000	0.000
Total HpCDD	ND	6.0	0.000	0.000
OCDD	25		6.307	11.632
2,3,7,8-TCDF	ND	6.8	0.000	0.000
Total TCDF	160		40.367	74.445
1,2,3,7,8-PeCDF	ND	15	0.000	0.000
2,3,4,7,8-PeCDF	ND	12	0.000	0.000
Total PeCDF	63		15.895	29.313
1,2,3,4,7,8-HxCDF	ND	6.4	0.000	0.000
1,2,3,6,7,8-HxCDF	ND	7.5	0.000	0.000
2,3,4,6,7,8-HxCDF	ND	4.4	0.000	0.000
1,2,3,7,8,9-HxCDF	ND	3.1	0.000	0.000
Total HxCDF	19		4.794	8.840
1,2,3,4,6,7,8-HpCDF	ND	8.1	0.000	0.000
1,2,3,4,7,8,9-HpCDF	ND	5.0	0.000	0.000
Total HpCDF	ND	8.1	0.000	0.000
OCDF	18		4.541	83.375

ND = Not Detected

DL = Detection Limit

7.3 Hydrogen Chloride

Parameter	Units	BAL-PAC EXHAUST
Start Time	Time	11:40
End Time	Time	12:48
Sampling Time	min	61.0
Sample Volume	DSCF	20.087
HCl Stack Concentration	ppmv	0.24
HCl Emissions, lb/hr	lb/hr	0.002

7.4 Continuous Emissions and Hydrocarbon Data

CONSTITUENT	CONCENTRATION	EMISSION RATE
Oxygen, O2	11.4 %	NA
Carbon Dioxide, CO2	4.4%	NA
Carbon Monoxide, CO	0.5 ppm	NA
Oxides of Nitrogen, NOx	48.8 ppm	0.39 lb/hr
Total Non-Methane Hydrocarbons	< 1 ppm	< 0.002

8.0 QUALITY ASSURANCE PLAN

It is required by 40 CFR Part 266 that every monitoring and measurement project must have written and approved Quality Assurance (QA) Project Plan. The Quality Assurance Project Plan (QAPP) is a written document, which presents, in specific terms, the policies, organization (where applicable), objectives, functional activities, and specific Quality Assurance and Quality Control (QA/QC) activities designed to achieve the data quality goals of the project. The mandatory QAPP acts as a total integrated program for assuring the reliability of monitoring and measurement data. The mandatory QAPP acts as a system for integrating the quality planning, quality assessment, and quality improvement efforts to meet user requirements. The mandatory QAPP will consist of the sampling and analytical methods for pre-test and post-test equipment calculations, calibration of GC, and other instruments before and after sample analysis. It will specify methods and requirements for background runs and for the verification of reagents and collection media. Surrogate and blind spikes will be explained in the QAPP as well as chain of custody procedures.

It is policy that precision and accuracy of data shall be assessed routinely and reported on all environmental monitoring and measurement data. Therefore specific procedures to assess precision and accuracy on a routine basis are described in the QAPP.

EPA-600/4-83-004 "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans" list sixteen (16) essential elements which must be considered and included in each QAPP. If a particular element is not relevant to the project under consideration, a brief explanation of why the element is not relevant must be included.

The following are the 16 essential elements which must be considered for inclusion in every QAPP:

1. Title page with provision for approval signatures.
2. Table of contents.
3. Project description.
4. Project organization and responsibility.
5. QA/QC objectives for measurement data in terms of precision, accuracy, completeness, representativeness and comparability
6. Sampling and monitoring procedures.
7. Sample custody, traceability, and holding times.

8. Calibration procedures and frequency.
9. Analytical procedures.
10. Data reduction, validation and reporting.
11. Internal quality control checks and frequency.
12. Performance and system audits and frequency.
13. Preventive/routine maintenance procedures and schedules.
14. Assessment procedures for accuracy, precision and completeness.
15. Corrective action.
16. Quality Assurance reporting.