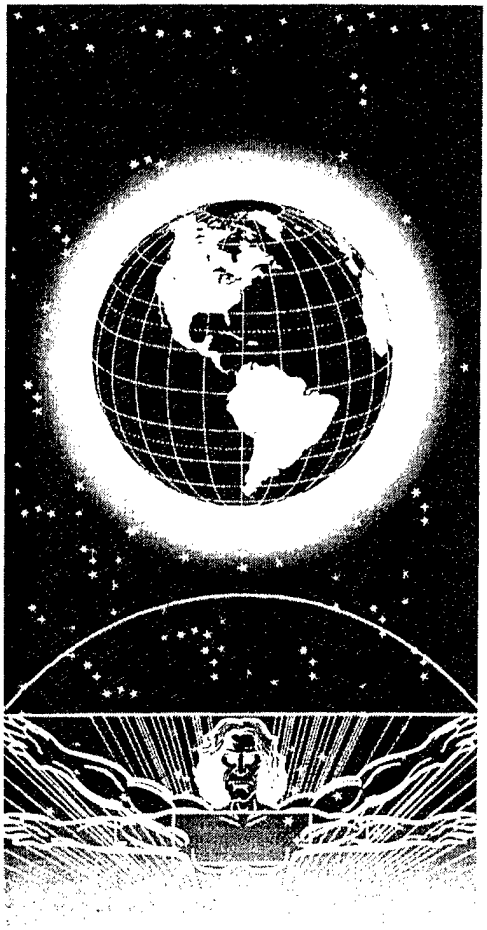
IERA-RS-BR-SR-2002-0006



UNITED STATES AIR FORCE
IERA

Aircraft Engine and Auxiliary Power Unit Emissions Testing: Final Report Addendum F119-PW-100 Engine Emissions Testing Report

Thomas Gerstle

Environmental Quality Management, Inc.
1310 Kemper Meadow Drive, Suite 100
Cincinnati, OH 45240

Peter Virag

Roy F. Weston, Inc.
1400 Weston Way
West Chester, PA 19380

Mark D. Wade

Karta Technology, Inc.
5555 N.W. Parkway
San Antonio, TX 78245

Phillip P. Brown, Major, USAF, BSC

June 2002

Air Force Institute for Environment, Safety and Occupational Health Risk Analysis
Risk Analysis Directorate
Environmental Analysis Division
2513 Kennedy Circle
Brooks Air Force Base TX 78235-5116

NOTICES

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely Government-related procurement, the United States Government incurs no responsibility or any obligation whatsoever. The fact that the Government may have formulated or in any way supplied the said drawings, specification, or other data, is not to be regarded by implication, or otherwise in any manner construed, as licensing the holder or any other person or corporation; or as conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

The mention of trade names or commercial products in this publication is for illustration purposes and does not constitute endorsement or recommendation for use by the United States Air Force.

The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

The report has been reviewed and is approved for publication.

Government agencies and their contractors registered with Defense Technical Information Center (DTIC) should direct requests for copies to: Defense Technical Information Center, 8725 John J. Kingman Rd., Suite 0944, Ft Belvoir, VA 22060-6218.

Non-Government agencies may purchase copies of this report from: National Technical Information Services (NTIS), 5285 Port Royal Road, Springfield, VA 22161-2103.

FOR PHILLIP P. BROWN, Major, USAF, BSC
Technical Project Manager

LYNN L. BORLAND, Lt Col, USAF, BSC
Chief, Environmental Analysis Division

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	June 2002	FINAL

4. TITLE AND SUBTITLE

Aircraft Engine and Auxiliary Power Unit Emissions Testing: Final Report Addendum
F119-PW-100 Engine Emissions Testing Report

5. FUNDING NUMBERS

F41624-95-D-9019

6. AUTHOR(S)

*Thomas Gerstle; ** Peter Virag; Maj Phillip Brown; ***Mark Wade

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

*Environmental Quality Management, Inc.; 1310 Kemper Meadow Drive, Suite 100
Cincinnati, OH 45240
**Roy F. Weston Inc.; 1400 Weston Way, West Chester, PA 19380
***Karta Technology Inc.; 5555 N.W. Parkway; San Antonio, TX 78245

8. PERFORMING ORGANIZATION

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Air Force Institute for Environment, Safety, and Occupational Health Risk Analysis
Risk Analysis Directorate
Environmental Analysis Division
2513 Kennedy Circle
Brooks Air Force Base TX 78235-5116

10. SPONSORING/MONITORING

IERA-RS-BR-SR-2002-0006

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This report is the product of a 5 year emissions testing program designed to document, characterize, and evaluate emissions from seventeen aircraft engines, two helicopter engines, and two auxiliary power units (APUs) burning JP-8 fuel. The purpose of this engine testing program was to develop emission factors for the tested engines under representative engine load conditions. All testing was performed by the Environmental Quality Management , Inc. (EQ) and Roy F. Weston, Inc. (Weston) team. Testing was conducted for criteria pollutants and select hazardous air pollutants (HAPs), e.g., aldehyde/ketones and semivolatile and volatile organic compounds.

14. SUBJECT TERMS

Aircraft engine, F-119 engine, emissions testing

15. NUMBER OF PAGES

258

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

FIGURES

TABLES

TABLES (continued)

EXECUTIVE SUMMARY

I.0 INTRODUCTION

The U.S. Air Force is developing a new fighter bomber designated as the F-22, Raptor. The aircraft will be equipped with two F119-PW-100 augmented turbofan engines. To evaluate the potential impacts of this aircraft on ambient air quality, AFIERA/RSEQ with the assistance of the F-22 Systems Program Office characterized emissions from the F119-PW-100 engine. The emission tests were conducted at the Lockheed Martin Marietta, Georgia, facility in a government-owned hush house. During the emission test, Pratt & Whitney operated the engine.

The results from this test and other emission test programs will be used to evaluate potential environmental impacts that may be created by the bed down of the aircraft at various Air Force Bases.

I.1 Objectives

The purpose of this engine emissions testing program was to develop emission factors for the F119-PW-100 engine under representative engine load conditions. All testing was performed by the Environmental Quality Management Inc. (EQ) and Roy F. Weston, Inc. (Weston) team. Testing was conducted for criteria pollutants and select hazardous air pollutants (HAPs), e.g., aldehyde/ketones and volatile organic compounds.

II. 0 SAMPLING METHODOLOGY

Sampling was performed for criteria pollutants and those HAPs that are products of incomplete combustion (PICs). Environmental Protection Agency (EPA) emissions test methods (Title 40, Code of Federal Regulations, Part 60, Appendix A) were followed during this test program. The test methods were modified where necessary due to the unique circumstances encountered during the program: i.e., high flow rates, unique exhaust configuration, and a large volume of dilution (ambient) air in the exhaust gas stream. A custom EPA Method 5 was used due to the physical configuration of the

test cell. The nature of the location did not permit a full cross-section traverse; instead, single point sampling was performed via a slipstream. A verification was made through the use of tracer gas that the sample point was representative of the entire exhaust stream. The following is a list of the constituents of the exhaust stream that were measured along with the corresponding EPA test methods used:

- Filterable and condensable particulate (EPA Methods 5 and 202).
- Aldehydes and ketones (EPA 0011[1] and TO-05).
- Volatile organic compounds (VOCs) (EPA Method 0030).
- Oxygen and carbon dioxide (EPA Method 3A).
- Carbon monoxide (EPA Method 10).
- Nitrogen oxides (EPA Method 7E).
- Non-methane hydrocarbons (NMHCs) (EPA Method 25A).

Sampling was not performed for sulfur dioxide and metals in the engine exhaust streams. Historic testing of metals provided random results with a number of interferences. Sulfur dioxide emissions were reported based on the procedure documented by AFIERA. This procedure estimates that sulfur dioxide emissions can be estimated by assuming all sulfur in the fuel undergoes complete oxidation to SO_2. The emission factor for SO_2 is provided in this report. JP-8 fuel samples were also collected for metals analysis. Dioxins/furans and other HAPs not listed in this report would not have been emitted in significant quantities to be readily detected by conventional sampling methods. Therefore, these compounds were not part of the emissions testing program.

Ambient air samples were collected and analyzed to correct for background conditions and thus reduce any potential bias. Ambient air samples were analyzed for many of the same compounds found in the exhaust stream. Ambient air samples were collected concurrent with emissions testing to account for emissions from large nearby sources (e.g., exhaust from other test cells) having the potential to bias the test results.

Ambient samples were collected for the following compounds:

---

[1] From EPA SW-846.

- Particulate - TSP (40 CFR, Part 60, Appendix B).
- Semivolatiles (EPA Method TO-13).
- VOCs (EPA Method TO-14).
- CO_2 (EPA Method 3A)
- CO (EPA Method 10)
- NO_x (EPA Method 7E)

During the sampling program, ambient pollutant concentrations were subtracted from source concentrations to account for background levels. During the program, background concentrations of pollutants were generally in the <1 to 20 percent range when compared to source concentrations. Background concentrations were highly dependent on local background sources.

II.1 Engine Testing Considerations/Complications

The engine was tested at five actual flight settings. Nominal engine conditions for emissions sampling are provided below:

- Idle (I), 10% power
- Approach (A), 20% power
- Intermediate (N), 70% power
- Military (M), 100% power
- Afterburner (AB), 150% power

Emissions tests comprised three 1-hour sampling runs for each pollutant at each power setting with the exception of the aldehydes/ketones tests. Due to sample volume requirements needed to meet method detection limits, aldehydes/ketones were collected over a 3-hour sampling period. Only two test runs were conducted at intermediate and military. The F119-PW-100 could not be operated continuously at military or afterburner maximum power for one continuous hour in order to prevent engine and/or test cell damage. The sample run time in the higher operative modes was reduced to a "safe" operating period. The sample collection procedures were reduced to accommodate the reduced operating time. In order to reach the analytical detection limit for the target pollutants, the sample team paused the sample run at the end of the safe operating period, waited as the engine was allowed to cool, then resumed sampling for the next operating period until the 1-hour sample run was

completed. At the afterburner setting, a single 10-minute sample run was conducted for gaseous pollutants only.

III.0 RESULTS

III.1 Criteria Pollutants

Results of the gaseous emissions testing are presented in Table III-1. The tables present both emission rates and factors for NO_x, CO, total particulate, NMHC, and CO_2 for each engine at each engine test condition. The emissions presented are the average of three 1-hour sampling runs. Results of individual runs are presented in Section 6 of this report.

III.2 Hazardous Air Pollutants

Table III-2 depicts the average HAP emissions for each power setting. These tables combine and summarize volatile and aldehyde/ketones compounds. The 10 HAPs shown in Table III-2 are the most frequently detected HAPs that are combustion by-products. Within this table, HAPs have been totaled for each power setting. The remaining HAP data that was analyzed during this sampling program is presented in Section 6 of this report.

IV.0 CONCLUSIONS

The following conclusions pertain to future engine testing and data analysis. During the testing program over 120 individual compounds were sampled and analyzed, but only a small percentage of those compounds was detected repeatedly. Those compounds that were detected had concentrations significantly above the analytical detection levels. Depending on the use of this data, it may be justifiable to reduce the compounds sampled in subsequent programs to only those compounds that were detected during this program. This is based on the assumption that sufficient HAP data was gathered during this program that can be directly applied to future engines. Any future sampling must take into account what the potential use of the data may be

(health risk, HAP qualification/quantification, regulatory, etc.) and then determine what compounds need to be sampled.

Likewise if similar test methodologies, as applied during this program, are used to collect and analyze for various compounds, no significant cost savings would be achieved in reducing the number of compounds analyzed for in a specific test method (i.e., sampling for VOCs by EPA method 0030 and only analyzing for benzene, toluene, and xylene). If sampling is conducted by an alternate method requiring significantly less effort to collect the sample and analyze for fewer compounds, a significant cost savings may be achieved.

The data collected during this program can also be reviewed to determine if surrogate compounds can be used to predict other HAPs (i.e., can benzene be used to predict formaldehyde). Based on the data currently available, however, there are not sufficient data points at each engine conduction to do a meaningful analysis. If additional data was available, primarily at those engine conditions that have the highest emission rates, a statistically significant analysis could be conducted.

- Benzene, toluene, and xylene represent the most significant VOCs measured during the program.
- Formaldehyde surrogate for aldehydes group. Formaldehyde accounts for over 90% of total aldehydes/ketones. Future sampling should only be done for formaldehyde.
- Most HAP emissions occur during the idle and engine setting. Future testing should concentrate on these modes to characterize emissions.
- An alternative particle sampling methodology is necessary. Using EPA Method 5 in an attempt to meet regulatory testing requirements is not necessary. The sampling environment is at or below the Method 5 detection limit.
- The particles are predominately less than 2.5 microns in size (range from 70% - 80% of the total particles). As the fuel firing rate increases, the percentage of particles less than 2.5 microns also increases. These particles are primarily carbon soot. The larger particles, 2.5 to 10 microns, were found to be agglomerates of smaller combustion particles. These agglomerates accounted for 4.1% to 10.8% of the particle total. The largest particles, 7.5 to

10+ microns, were found to be angular particles that are believed to have been cooled and deposited on a surface and suspended during the test program. These particles are not considered a combustion product during testing. These particles ranged from 0.7 to 4.3% of the particle total.

TABLE III-1
F119-PW-100
CRITERIA POLLUTANT SUMMARY

	Idle		Approach		Intermediate		Military		Afterburner	
Exhaust Flow, dscfm	289029		663582		974449		1294958		1821290	
	lb/hr	lbs/1000 lbs fuel	lb/hr	lbs/1000 lbs fuel	lb/hr	lbs/1000 lbs fuel	lb/hr	lbs/1000 lbs fuel	lb/hr	lbs/1000 lbs fuel
NOx[a]	4.1	3.0	18.1	6.6	125.4	12.4	368.8	19.8	369.8	7.4
CO	66.3	48.2	21.7	7.9	21.6	2.1	14.0	0.8	807.7	16.1
NMHC[b]	9.4	6.8	0.9	0.3	5.3	0.5	0.0	0.0	9.3	0.2
Total Particulate	3.43	2.49	5.49	2.00	14.24	1.41	20.92	1.12	(c)	(c)

a = Reported as NO_2

b = Total Non-Methane Hydrocarbons

c = Particulate sampling not conducted at afterburner

TABLE III-2
F119-PW-100
HAZARDOUS AIR POLLUTANT SUMMARY

	Idle		Approach		Intermediate		Military	
Exhaust Flow, dscfm	289029		663582		974449		1294958	
Pollutant	lb/hr	lbs/1000 lbs fuel	lb/hr	lbs/1000 lbs fuel	lb/hr	lbs/1000 lbs fuel	lb/hr	lbs/1000 lbs fuel
Formaldehyde	1.3740	0.9978	0.0975	0.0356	0.2473	0.0245	0.1413	0.0076
Acetaldehyde	0.1527	0.1109	0.0185	0.0068	0.0264	0.0026	0.0155	0.0008
Acrolein	0.0496	0.0360						
Isobutyraldehyde / MEK [a]	0.0916	0.0665						
Benzene	0.1453	0.1055	0.0091	0.0033	0.0069	0.0007	0.0091	0.0005
Toluene	0.0877	0.0637	0.0007	0.0003				
Ethylbenzene	0.0226	0.0164	0.0012	0.0004	0.0050	0.0005	0.0034	0.0002
m,p - Xylene	0.0539	0.0391	0.0015	0.0006			0.0057	0.0003
o-Xylene	0.0384	0.0279	0.0009	0.0003	0.0049	0.0005	0.0031	0.0002
Styrene	0.0430	0.0312	0.0012	0.0004				
Total HAPs	**2.0587**	**1.4950**	**0.1307**	**0.0477**	**0.2906**	**0.0287**	**0.1781**	**0.0096**

a - Analytical "peaks" overlap preventing determination of a single compound. Result could be either compound or combination of b

Blanks represent a non-detect value.

SECTION 1

INTRODUCTION

This Emission Summary Scientific and Technical Report has been prepared by Environmental Quality Management, Inc. (EQ) under Delivery Order 0008 of the Occupational and Environmental Health Assessments Contract (Contract Number F41624-95-D-9019) supporting the Air Force Occupational and Environmental Health programs around the world. This contract is administered by the Air Force Institute for Environment, Safety, and Occupational Health Risk Analysis/Risk Analysis Environmental Quality (AFIERA/RSEQ), Brooks Air Force Base (AFB), Texas.

The project requirements are described in the delivery order and its attached Statement of Work and Contract Data Requirements Lists (CDRL's).

The project includes:

- Preparation of the SAP (submitted August 2000, A004).
- Preparation of the Site Survey Report (submitted 6 April 2000, A011).
- Preparation of monthly progress, status, and management reports (A001).
- Preparation of conference agenda and minutes (A008).
- Preparation of a summary Scientific and Technical Report (this document, A003).

A description of the project background and objectives is provided in this section.

1.1 PREVIOUS STUDIES

The USAF began to develop a database of known engine emissions data in the 1970s. The purpose of developing the database was to produce a catalog of smoke plume opacity and gaseous emissions from engine test facilities. Environmental managers could use data from the catalog to meet regulatory reporting requirements. Subsequently, the USAF and the U.S. Navy (USN) have attempted to amass and review existing engine emissions data, validate the data, and identify data gaps. The USAF's Engineering and Services Laboratory and Engineering Services Center, and the

USN's Environmental Support Office have been the lead organizations for this effort. Available aircraft emissions technical references were compiled and reviewed by the U.S. Environmental Protection Agency (U.S. EPA) in 1993. The current effort is being undertaken by the USAF's AFIERA/RSEQ located at Brooks AFB, TX.

1.2 BACKGROUND

In 1973, the Defense Energy Task Force recommended that assertive action be taken to standardize U.S. Department of Defense (DOD) fuels. The Joint Logistics Coordinating Group, established to perform the standardization studies, recommended that the U.S. Air Force (USAF) replace naphtha-based JP-4 (MIL-T-5624) with the kerosene-based JP-8 (MIL-T-83133) as the standard turbine fuel. JP-8 is similar to commercial-grade jet engine fuel Jet A-1, with two additives previously required in JP-4. The hydrocarbon fuel is composed of various medium molecular weight organic compounds including paraffins, olefins, and aromatics. JP-8 specifications require a maximum olefin and aromatic content of 5% and 25% by volume, respectively. The maximum allowable sulfur content to meet the specifications of JP-8 is 0.3% by weight. The guaranteed minimum net heating content of the fuel is 18,400 Btu/lb. Table 1-1 lists the general specifications of JP-8 jet fuel. JP-8 fuel also contains several additives. Ethylene glycol monomethyl ether (EGME) is added as a fuel system icing inhibitor. Corrosion inhibitors and antistatic additives are also required to meet JP-8 specifications. Antioxidant and metal deactivator additives are optional for JP-8.

The principal reasons for replacing JP-4 with JP-8 were the following:

- Standardize military fuels with commercial aviation kerosene (Jet A-1).
- Be consistent with the ongoing standardization efforts in the North Atlantic Treaty Organization (NATO).
- Improve safety (JP-8 is less volatile than JP-4).
- Eliminate expenditures required for fuel evaporative equipment.

TABLE 1-1. U.S. MILITARY SPECIFICATIONS OF TURBINE FUELS, JP-8 USAF MIL-T-83133A-AMD.1; 4 APRIL 1980; KEROSENE OR JP-8

Composition	(Acidity, Total; mg KOH/g) Aromatics Sulfur, Mercaptan; wt % Sulfur Total; wt % Color, Saybolt	0.015 25.0 0.05 0.3 0.3
Volatility	Residue; vol % for D-86 Loss vol % for D-86 Flash Point; ° C Gravity; ° API at 15° C Density; kg/m^3 at 15° C	1.5 1.5 38 37-51 775-840
Fluidity	Freezing Point; ° C (° F) Viscosity; cSt at -20° C	-50 (-58) 8.0
Combustion	Smoke Point Hydrogen Content; wt %	19.0 13.5
Stability	JFTOT delta P; mm HG JFTOT Tube Color Code	25 < 3
Contaminants	Existent Gum; mg/100 ml Particulates; mg/liter Water Separation Index, Modified	7 1 70[a]
Additives	Anti-icing; vol % Antioxidant Corrosion Inhibitor Metal Deactivator Anti-static	0.10 to 0.15 Option Required Option Required
Other	Conductivity; pS/m Service NATO Code No.	200 to 500 USAF F-34; F-35[b]

[a] With all additives except electrical conductivity additive.

[b] Same as JP-8 without additives.

Source: *Handbook of Aviation Fuel Properties*, Coordinating Research Council, Inc., Society of Automotive Engineers, Inc. General Publications, Warrendale, PA 15096, 1983.

1.3 PROJECT OBJECTIVES

Although engine emissions from combustion of JP-4 are well documented for criteria pollutants,[1] little information exists for hazardous air pollutants (HAPs)[2] from combustion of JP-8 fuel. Due to intrinsic differences between these two raw fuels, their combustion products may differ. As part of a broader engine-testing program, the USAF, through the Human Systems Center (HSC) (now AFIERA/RSEQ) at Brooks Air Force Base, TX, contracted to have the emissions characterized from 17 aircraft engines, 2 helicopter engines, and 2 auxiliary power units (APUs) operating at a variety of settings. Criteria pollutants and targeted HAP emissions were quantified during the test program. Emission test results are used to develop emission factors for the aircraft engines and APUs tested. The USAF intends to develop a mathematical relationship, using the data collected during the previously completed tests and this sampling effort, to extrapolate existing JP-4 emission factors to representative JP-8 emission factors for the remaining untested engines. Past sampling events are detailed in Volumes 1, 2 and 3 of the Aircraft Engine and Auxiliary Power Unit Emissions Testing Final Report, EQ, 1998. This Addendum to that report details the testing program completed for the F119-PW-100 engine.

The overall focus of the program is to determine engine emissions from each test facility as the emissions exit to the atmosphere as opposed to directly behind the engine. The engine emission data from the test source will be utilized for engine "Bed Down" and conformity analysis for compliance with state implementation plans and federal implementation plans for the purpose of attaining or maintaining the national ambient air quality standards.

1.4 CURRENT TESTING PROGRAM

---

1 Criteria pollutants are pollutants for which National Ambient Air Quality Standards (NAAQS) (see 40 CFR 50) have been established. They include: carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, lead, and ozone (and its precursors).

2 Hazardous air pollutants (HAPs) are toxic chemicals and compounds regulated under Title III, Section 112(b) of the Clean Air Act Amendments of 1990 (CAAA). Presently, there are 189 HAPs.

As part of the broader engine-testing program, the USAF, through the Human Systems Center (HSC) (now AFIERA/RSEQ) at Brooks Air Force Base, TX, has contracted to have the emissions characterized from the F119-PW-100 engine operating at a variety of settings utilizing JP-8 fuel. Testing of the F119-PW-100 engine conducted during the week of September 11, 2000 at the Lockheed Martin Aeronautical Systems Facility is the focus of the sampling effort described within this document.

1.4.1 F119-PW-100

Two F119-PW-100 turbofan engines power the F-22 Raptor aircraft. Pratt & Whitney manufactures these engines at its Florida Operations Center. The maximum thrust of the engine is in the 35,000 pound class; however, the engine is experimental and no other data was available prior to the sampling program.

1.4.2 Test Facility

The F119-PW-100 engine was sampled at the Lockheed Martin Aeronautical Systems (LMAS) facility located in Marietta, Georgia. The LMAS Facility is a contractor facility which develops, manufactures, and tests a variety of military and rocket engines. Testing was conducted within a facility hush house.

SECTION 2

FACILITY AND SAMPLING APPARATUS DESCRIPTION

As stated in Section 1, testing of the F119-PW-100 engine was performed at the Lockheed Martin Aeronautical Systems (LMAS) facility utilizing JP-8 jet fuel. Due to the physical layout of the LMAS hush house testing location, the engine exhaust could not be sampled safely or cost-effectively using traditional EPA-recommended emission testing methodologies. In addition, the traditional International Civil Aviation Organization (ICAO) sampling method does not address particulate or HAP analysis. A description of the hush house, sampling system apparatus, and general sampling methodology is provided in this section. A more detailed description of the sampling methodology is provided in Sections 3 and 4.

2.1 LOCKHEED MARTIN AERONAUTICAL SYSTEMS (LMAS) TEST FACILITY OVERVIEW

Military aircraft jet turbine engines are tested in indoor enclosures designed to restrain the engine or aircraft and to provide suitable environmental protection while testing occurs. These facilities are also known as hush houses. The building functions include supply air filtration, noise suppression, exhaust diversion, and technical support for various test functions. The layout of a typical hush house interior and exterior are illustrated in Figures 2-1and 2-2. During the test process, aircraft or isolated engines are mounted in the rear of the hangar-like enclosure with the exhaust nozzle pointing toward the augmentor tube and out of the building (Figure 2-3). The engine exhaust is directed out of the test facility and into the ambient air via a horizontal elliptical duct (the augmentor tube) which finally directs the air flow upward via a terminal deflector plate in

the blast box (Figure 2-4). The hush house emits combustion products mixed with filtered dilution air directly to the atmosphere at the augmentor tube terminus.

For this test program, the test team collected samples directly behind the engine exhaust nozzle at two engine settings and prior to the exit of the hush house augmentor tube, near the point of entry into the blast box at all engine settings.

2.2 ENGINE EXHAUST SAMPLING RAKE SYSTEM

As part of the test program at LMAS, gaseous emissions directly behind the engine were measured at timed intervals in a similar manner described by ICAO at the idle and approach engine settings. Engine exhaust sampling was conducted using a cruciform rake mounted approximately 2.5 feet downstream from the exhaust. The intent of the ICAO mounting location parameters were considered for rake placement. A schematic diagram of the rake assembly is illustrated in Figure 2-5. This system was utilized during a previous test program and was obtained by AFIERA for use during this portion of the engine study. The rake contains 12 ports spaced across four rake arms, each of which contains a 1/8-inch orifice. A mixed exhaust sample was drawn from the 12 ports and transferred via a single stainless steel tube through filtered and heated Teflon® lines to the combustion and diluent gas conditioning system and analyzers. The photograph in Figure 2-6 shows the rake assembly mounted behind the F119-PW-100 engine. The rake was installed behind the engine during the idle and approach phases of the testing program. The rake was removed during the remaining engine settings in order to eliminate the potential for engine or hush house damage.

2.3 AUGMENTOR TUBE SLIPSTREAM SAMPLING SYSTEM

Access to the area of emissions exhaust is restricted during operation of engines in the hush house due to safety concerns including high temperatures, high velocity and vibration, excessive noise, and the potential of exposure to the exhaust gases. It was therefore necessary to devise a sampling scheme that allows sampling to be conducted

from a remote location that required modification to existing point source EPA emission test procedures.

The slipstream sampling system shown in Figures 2-7, 2-8 and 2-9 was constructed to measure jet engine emissions from the Langley AFB hush house as part of the F100-PW-100 jet engine emission tests conducted in November 1996. Similarities between that testing program and the current sampling effort allowed the sampling system to be applied to the F119-PW-100 engine sampling program completed at the LMAS facility hush house. The system was designed to extract an augmentor tube exhaust sample and to permit use of standard source emission test methods that could not be applied immediately behind the test engine or in the augmentor tube.

A stainless steel pipe, 10 inches in diameter, was utilized to extract a side-stream sample of the diluted engine emissions at a point upstream of the augmentor tube exit. The duct was centered in the augmentor tube and extended approximately 10 feet into the augmentor tube. The duct was supported inside the augmentor tube by two sets of support stands. The duct was directed horizontally toward the rear of the blast box and then turned at an angle out of the blast box to the top of the deflector shield wall, where a transition to a 24 inch by 24 inch square duct occurred. The duct was constructed of stainless steel seamless pipe with flanged ends. Each section was bolted together at the flanged end. Each piece was 10 feet in length except for the inlet and elbows. Any welds in the duct system were factory welds. The larger square duct provided a decrease in gas velocity and a suitable sampling location for applying standard emission testing methods. The inlet to the slipstream was circular, similar to the inlet of a large Method 5 sampling nozzle. At the end of the square duct was a deflector plate to vent emissions upward away from ground activities (See Figures 2-10, 2-11 and 2-12).

The stainless steel slipstream ductwork was supported inside the augmentor tube by attaching pipe risers to existing bolts in the U-channels inside the augmentor tube. Two radial stands were used inside the augmentor tube.

Attachments were made to the 10-inch pipe with 10-inch pipe collars and bolts. All bolts were secured with a washer, lock washer, and a nut. Bulkhead fittings were used to provide sampling ports through the C-Channel in the first support brace. The same inlets were constructed of four pieces of 1/4 inch C-Channel extending from the duct radially outward (at 90^0 angles) to the wall of the augmentor tube to create the slipstream rake. Sampling lines and thermocouples were directed through an iron pipe conduit to the exit. The conduit was secured to the supporting braces via bolts and U-clamps. The duct was then fastened to the blast box and supporting scaffolding outside the blast box. This approach provided structural integrity, reduced the cross sectional exposure profile of freestanding duct, and subjected the duct only to radial flow forces on the plate, or turbulent forces along the entire exposed length. Twelve sampling points were used for gaseous sampling inside the augmentor tube. Scaffolding fixed to the hush house and ground supported the rectangular ductwork outside the hush house. Scaffolding was secured to each other and to 1/2-inch-thick plywood on the ground to provide further vibration support.

This sample collection structure provided full use of the hush house for purposes other than emission testing. Once the sampling structure was installed, the hush house was available for testing of other engines as needed. The structure did not interfere with the normal operation of the hush house.

Engine exhaust samples were collected at multiple locations along the slipstream. Gaseous emission (CO, NO_x CO_2 and VOC) samples were collected at the slipstream rake from 12 sample ports installed in the brace. Particulate and HAP emission samples were collected from sample ports in the slipstream duct outside of the hush house.

The locations of the sampling points for the slipstream sampling rake were positioned using EPA Method 1 criterion. Since the duct was oval shaped and EPA Method 1 does not accommodate this configuration, the points were determined across the major axis assuming a circular diameter. Similarly, the points across the minor axis

were calculated assuming a circular diameter. The slipstream duct was positioned in the center of the augmentor tube. Although the oval cross sectional shape of the augmentor tube is not addressed in EPA Method 1, locating the sampling point inlet at least 1/2 duct diameter prior to the exit of the tube was consistent with the basic tenets of EPA Method 1. Samples of the augmentor tube exhaust were obtained for combustion and diluent gas analysis using the slipstream rake assembly mounted in the augmentor tube.

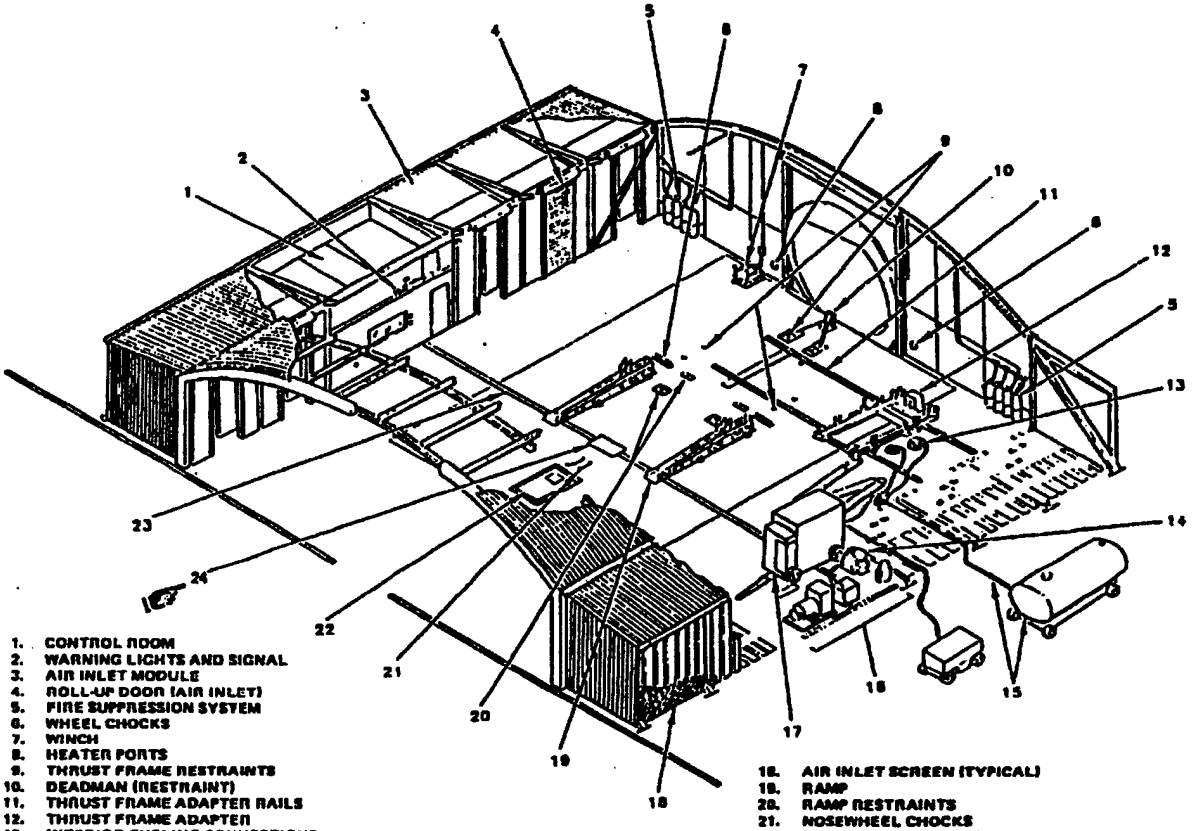


Figure 2-1. Overview of Hush House Physical Layout

EQ ENVIRONMENTAL QUALITY MANAGEMENT, INC.

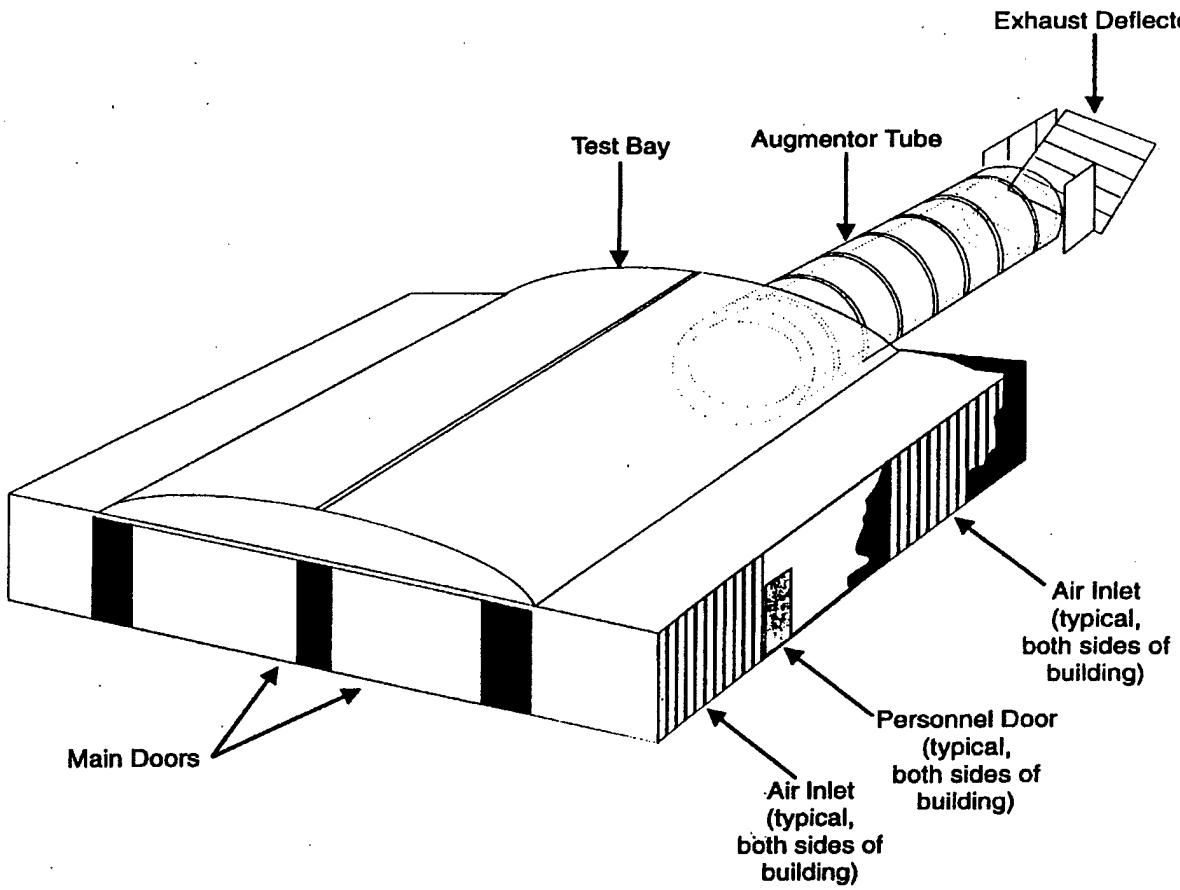


Figure 2-2. Overview of Hush House Layout

EQ ENVIRONMENTAL QUALITY MANAGEMENT, INC.

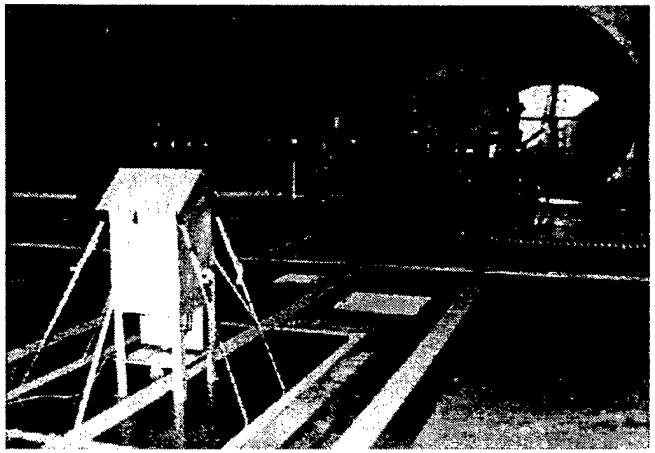


Figure 2-3. Engine Mounted for Testing in Hush House

EQ ENVIRONMENTAL QUALITY MANAGEMENT, INC.

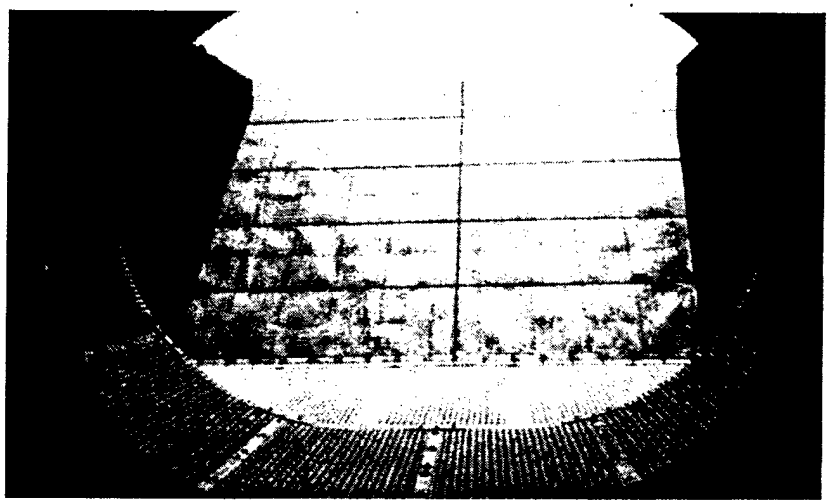


Figure 2-4. Exhaust Deflector Plate

EQ ENVIRONMENTAL QUALITY MANAGEMENT, INC.

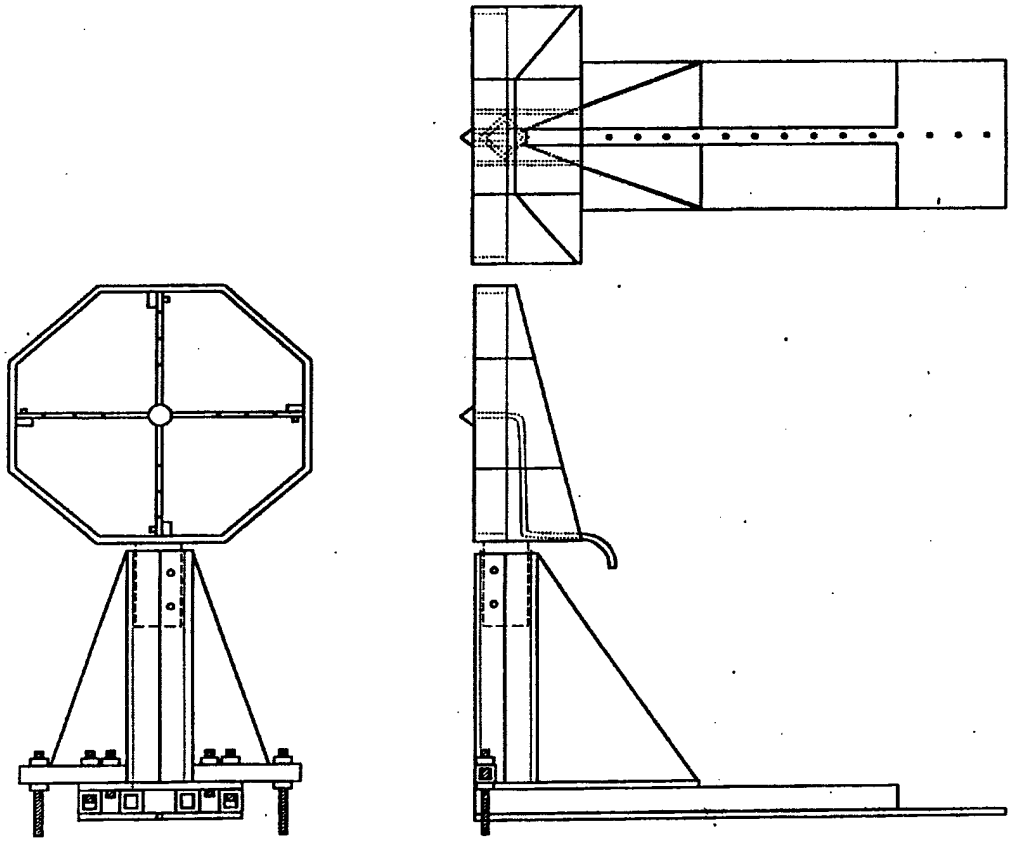


Figure 2-5. Rake Assembly

ENVIRONMENTAL QUALITY MANAGEMENT, INC.

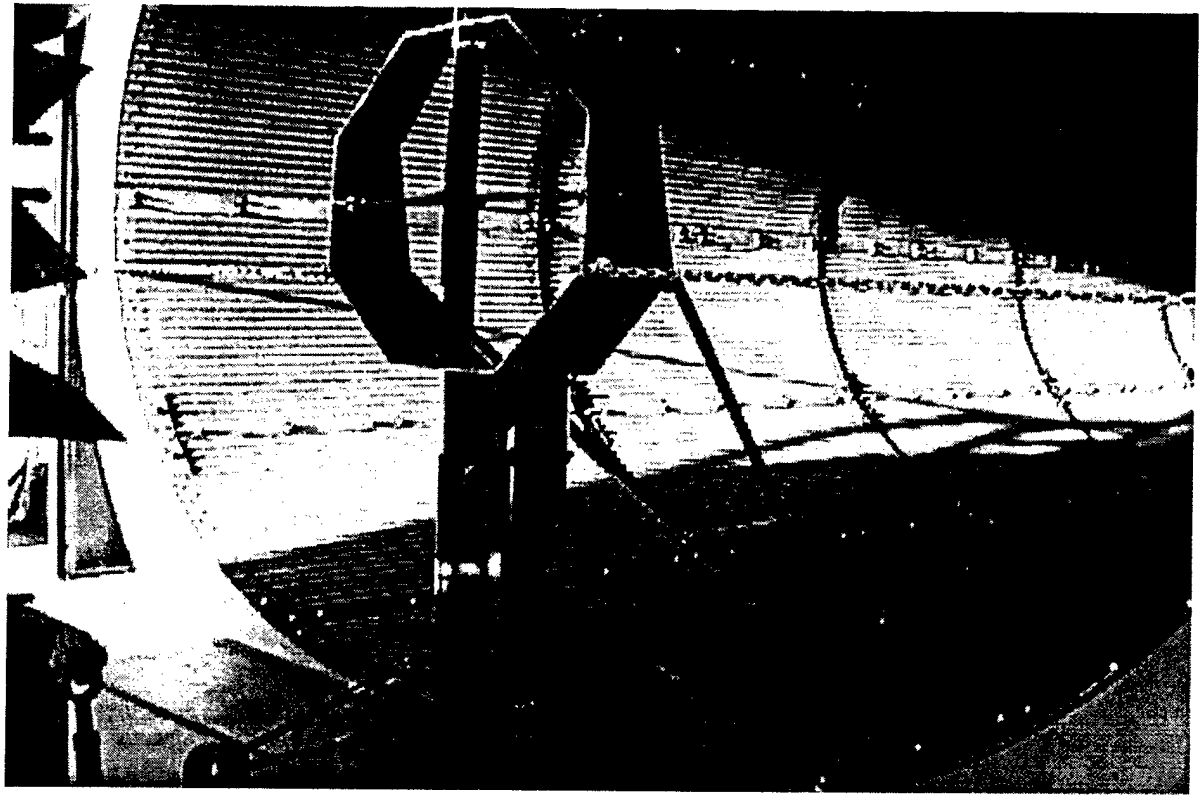


Figure 2-6. Engine Sampling Rake

EQ ENVIRONMENTAL QUALITY MANAGEMENT, INC.

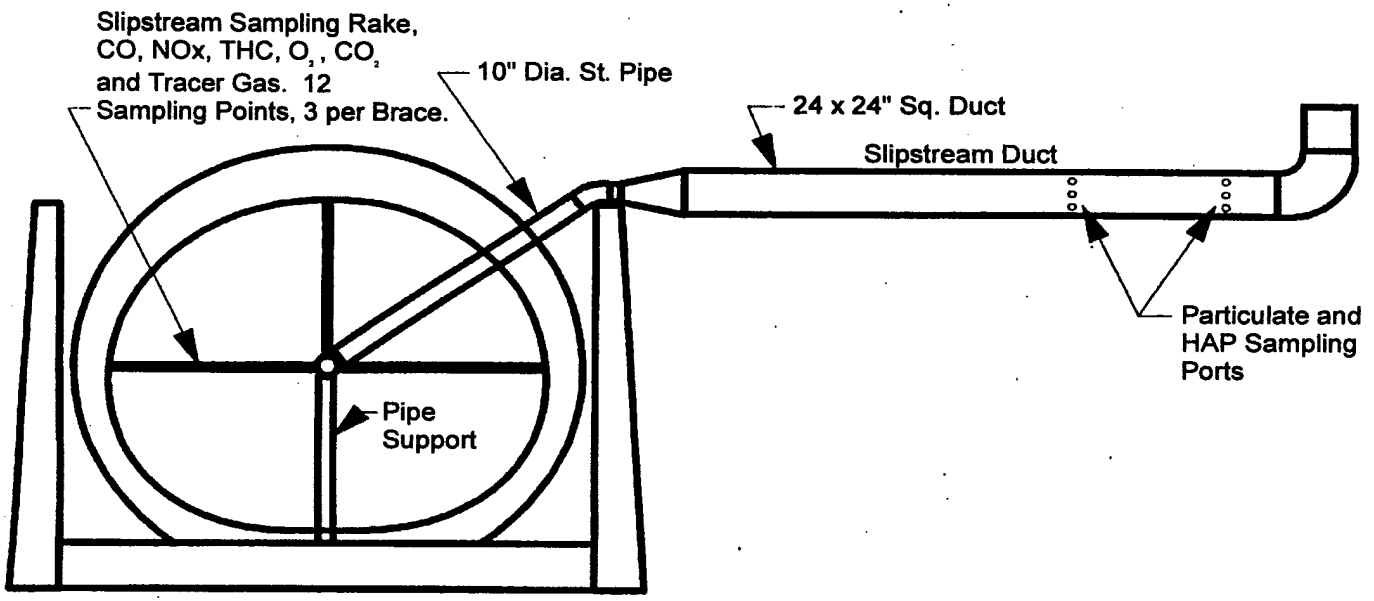


Figure 2-7. Augmentor Tube Side-Stream Sampling System (Elevation View)

EQ ENVIRONMENTAL QUALITY MANAGEMENT, INC.

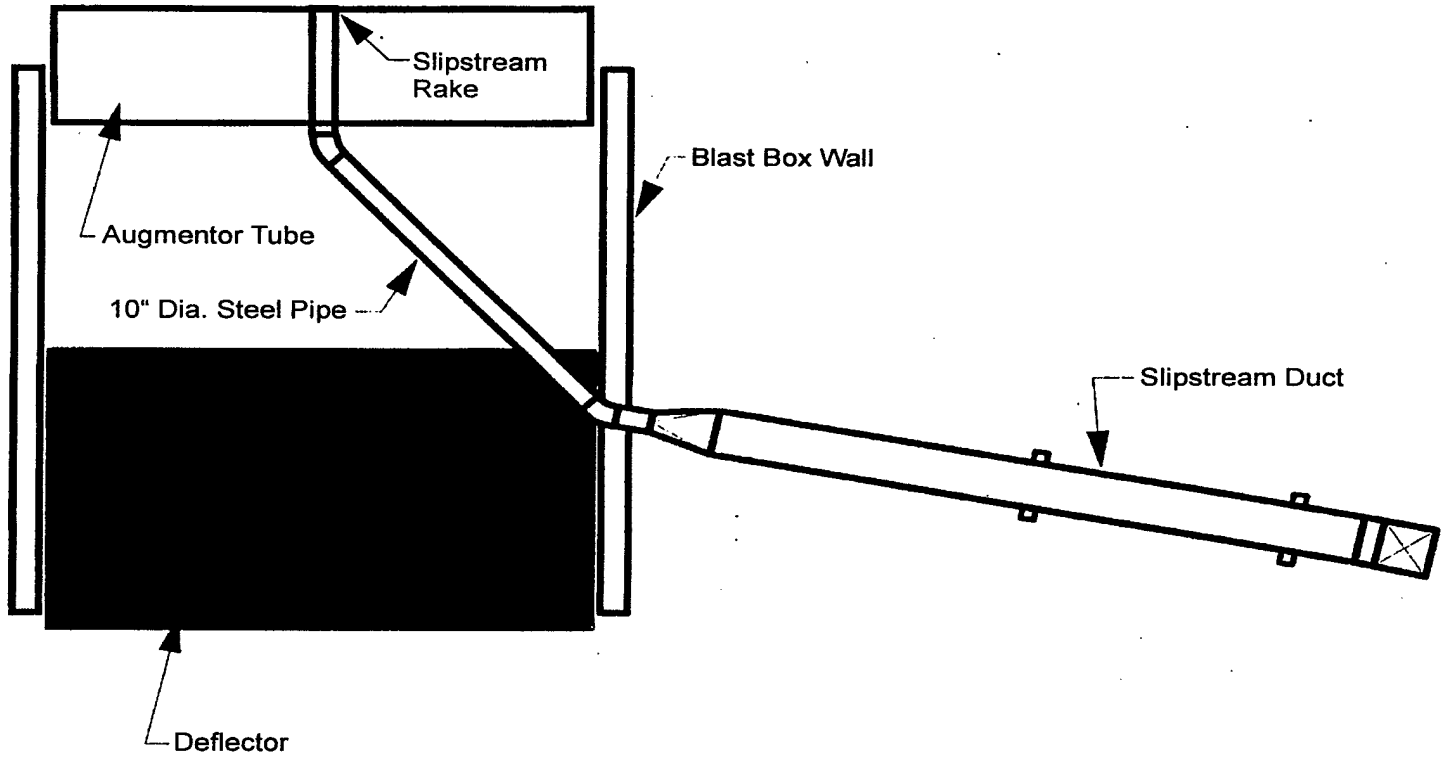


Figure 2-8. Augmentor Tube Side-Stream Sampling System (Plan View)

EQ ENVIRONMENTAL QUALITY MANAGEMENT, INC.

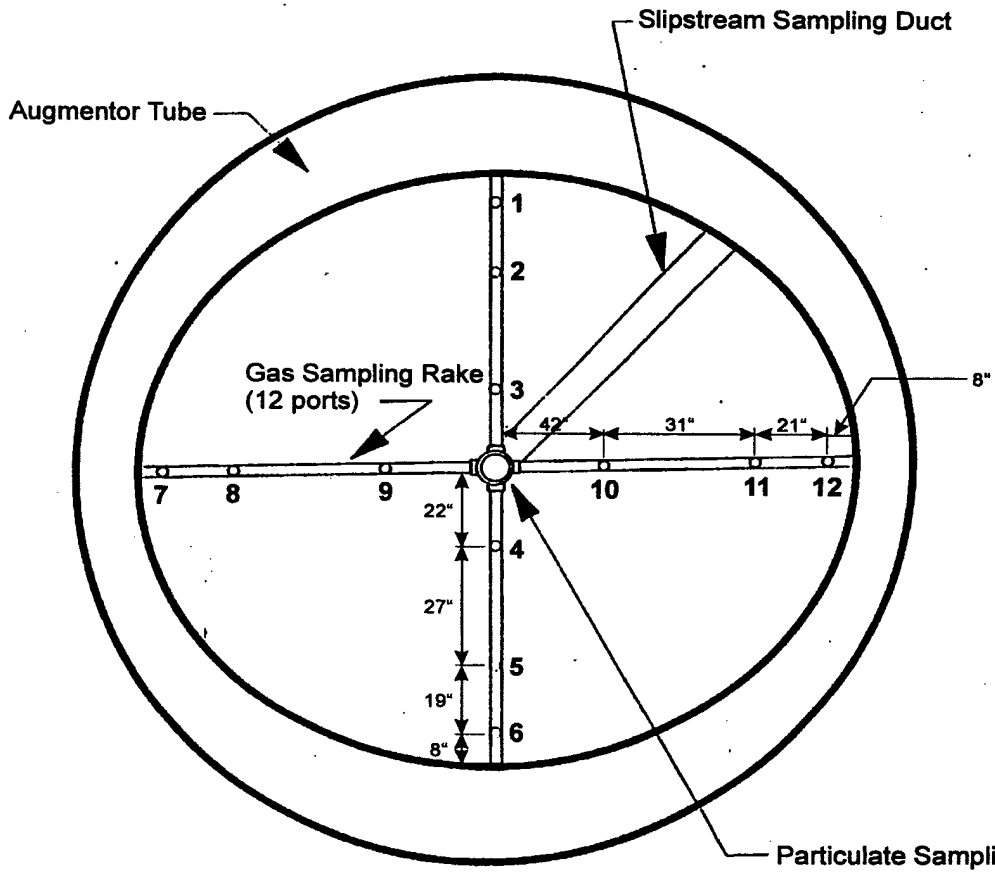


Figure 2-9. Augmentor Tube Sampling Rake (View from Test Engine)

EQ ENVIRONMENTAL QUALITY MANAGEMENT, INC.

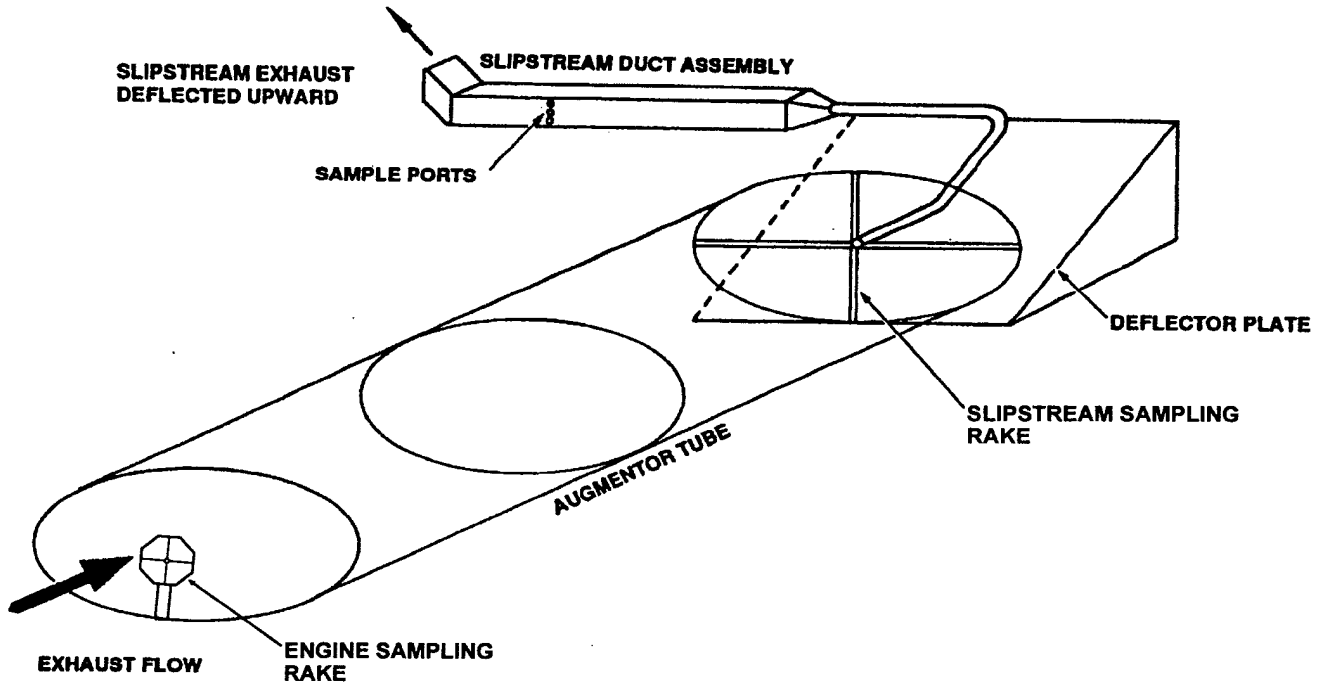


Figure 2-10. Orthogonal View of Slip-Stream Sampling Apparatus

EQ ENVIRONMENTAL QUALITY MANAGEMENT, INC.

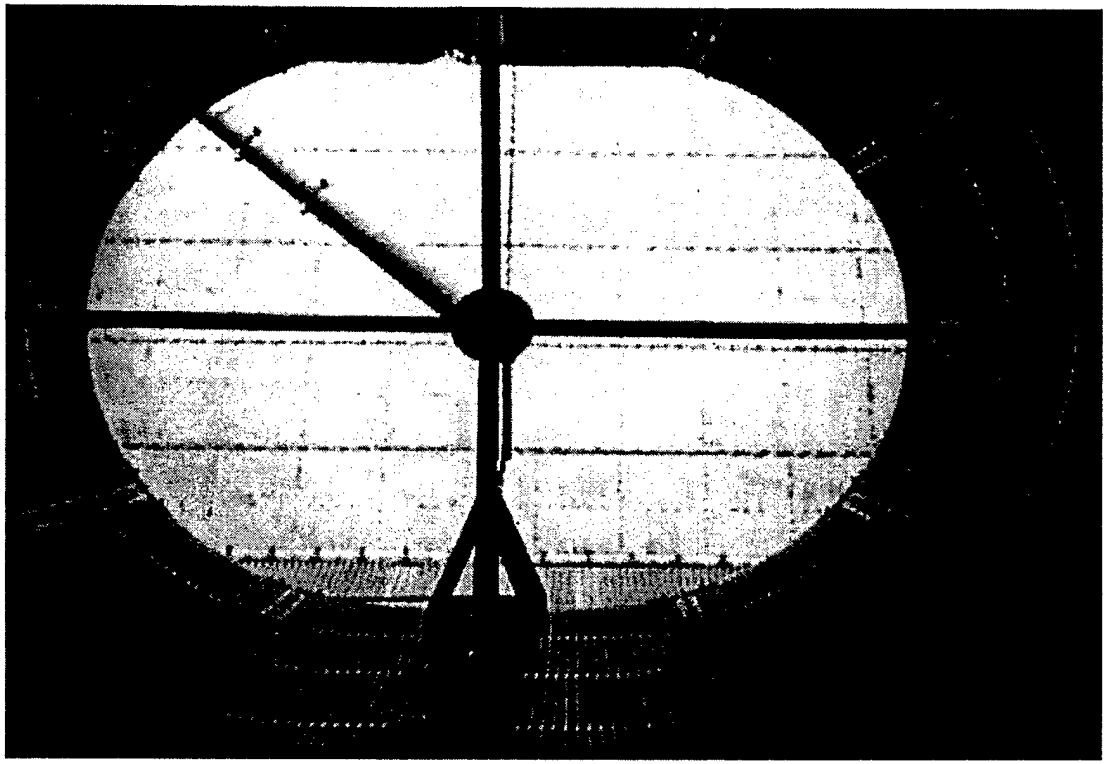


Figure 2-11. Augmentor Tube Side-Stream Extraction Tube and Gas Sampling

EQ ENVIRONMENTAL QUALITY MANAGEMENT, INC.

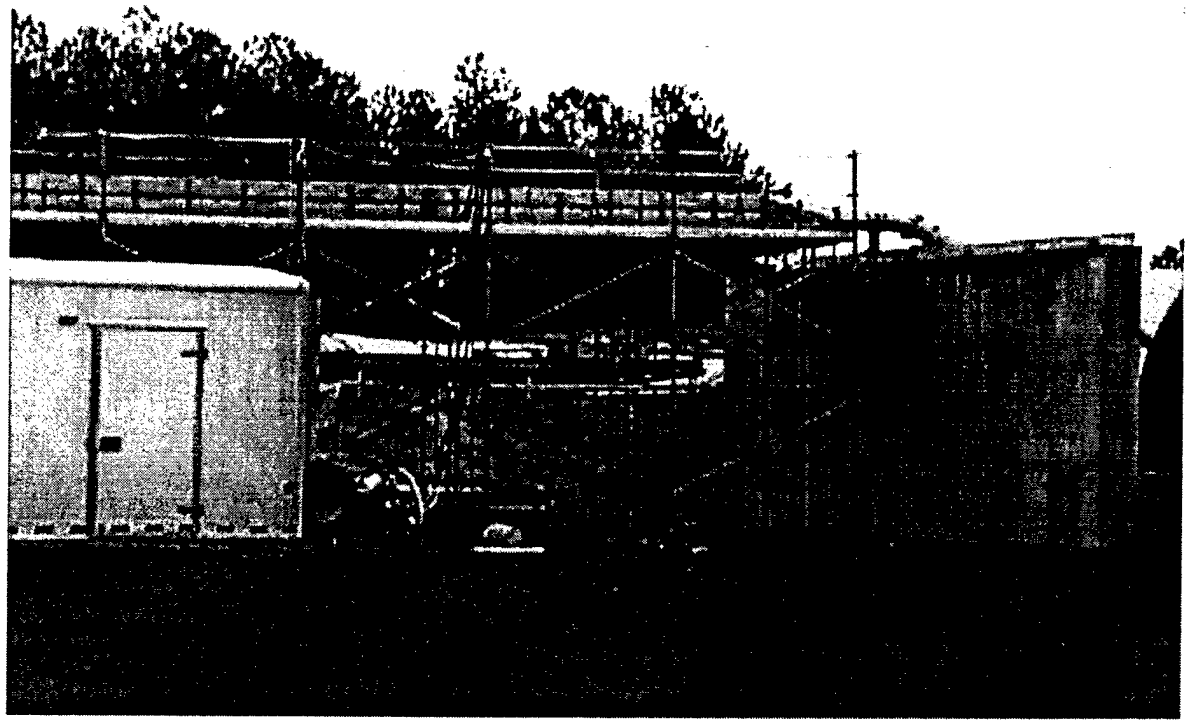


Figure 2-12. Augmentor Tube Side-Stream Sampling System Duct

EQ ENVIRONMENTAL QUALITY MANAGEMENT, INC.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 3

SAMPLING PROCEDURES AND METHODS

The testing program involved sample collection at three locations: 1) directly behind the engine (gaseous emissions, benzene and formaldehyde), 2) at the hush house augmentor tube exit (particulate and HAP), and 3) at the intake to the slipstream inside the augmentor tube (gaseous emissions). The purpose of the multiple sample locations was to note the variance (if any) in gaseous emissions (CO, NO_x, VOC) inside the hush house augmentor tube and to look at pollutant dilution and secondary pollutant formation by sampling directly behind the engine. (During the idle and approach slipstream sample runs, an approximate 30-minute sample was collected from the engine sampling rake). The focus of the program was to verify engine emissions from the hush house.

The determination of emissions from the engine test stand through the hush house augmentor tube presented a unique challenge to accurately measure emission rates of the target pollutants. A number of constraints and unknown parameters were present sampling this engine that are not associated with a more traditional emissions testing programs. These variables were difficult to account for because of the inability to measure outlet flow parameters. The flow parameters included flow rates, temperature, and dilution of ambient air in the exhaust gas stream. The program was designed to allow for those variables so that representative data could be collected in a timely and cost-effective manner.

3.1 GENERAL SAMPLING CONSIDERATIONS/COMPLICATIONS

Access to the area of emissions exhaust was restricted during operation of engines in the hush house due to safety concerns including high temperatures, high velocity

and vibration, excessive noise, and the potential of exposure to the exhaust gases. It was therefore necessary to devise a sampling scheme, which allowed sampling to be conducted from a remote location, which required some modification to existing test procedures. The slipstream sampling approach allowed particulate matter and HAP testing personnel to be located outside the exclusion zone.

The physical structure of the exhaust through the augmentor tube did not allow for use of the traditional isokinetic sampling methodologies. Complicating factors included large amounts of dilution air and limited testing windows. Based on these considerations, several assumptions were made to address the unique nature of this program. Assumptions included homogeneous mixing of the exhaust stream (verification of this assumption was made in the field); theoretical methods for determining air flow through the system; and particulate distribution behavior equivalent to gaseous. These assumptions were based on previous engine testing programs and reference documents.

3.1.1 Pollutant Distribution in the Augmentor Tube

The test program was based on the assumption that, as the exhaust gas exits the test stand through the augmentor tube, the exhaust stream from the engine and the dilution air have reached a homogeneous mixture. This assumption had been validated in testing conducted by EQ at Edwards AFB (EQ Report, *Source Sampling and Testing of Aerospace Equipment and Jet Engines at Edwards AFB, CA*) and by Radian Corporation at Langley and Cannon Air Force Bases (presentation by Captain Gregory Durand, USAF at the 89th Annual Meeting and Exhibition of the Air and Waste Management Association, *Emission Factors for JP-8 Combustion Sources*). The gas stream was found to be homogeneous in the hush house augmentor tube at approximately 60 feet behind the jet engine exhaust point. The complete mixing of exhaust gases and the dilution air are the result of the very turbulent flow from the jet engine exhaust. This is discussed further in Section 6.

Particulate size distribution in the engine exhaust was shown to be significantly less than 10 microns (μm) in size (*Characterization of Chemicals on Engine Exhaust Particles: F101 and F110 Engines*, ESL-TR-89-20, Air Force Engineering and Services Center Engineering and Services Laboratory and *Source Sampling and Testing of Aerospace Equipment and Jet Engines - Test Protocol* - Edwards AFB, CA, EQ December 1995). Typically, and in the case of this test program, the majority of particles are less than 2.5 μm. Because of the size of the particles, it was assumed that they would behave as an aerosol or gas and that pollutants would be distributed evenly throughout the test stand exhaust. The basis for this assumption was also discussed in the reference *Air Pollution, Its Origin and Control* by K. Wark and C. Warner, published by Harper & Row Publishers, 1981. Since it was assumed that all particulate (and those contaminants bound to the particulate) would behave as an aerosol, the stack or any point in the stack would have the same concentration of pollutants. This assumption was used as the basis to conduct single-point isokinetic sampling at one point in the exhaust, which was representative of all points in this engine test exhaust. This was justified during the test program and is presented in Section 6.4.

Because it was assumed, and had been documented, that the majority of the particulate was less than 10 μm, EPA Method 5 was used. The particulate filters were analyzed by a scanning electron microscope (SEM) to confirm the particle morphology and size distribution. The distribution was based on the particle count in each size range. In addition, an experimental real time sampler was utilized to collect particulate matter samples. Sampling methodologies for particulate are discussed in Section 3.2.4-1. A cascade impactor was considered to determine the particle size distribution by mass. Due to the expected low particulate concentrations, the impactor would not be effective in collecting a quantitative sample. Also, the size range of each stage of the impactor is larger
than the expected particle diameter; therefore, all particles would be collected on the final stage.

Although it was assumed that pollutant concentrations in the augmentor tube would be homogeneous, this assumption was verified by the use of tracer gas. The tracer gas, sulfur hexafluoride (SF_6), was dispersed from multiple points outside the hush house into the engine exhaust gas stream as it entered the augmentor tube and was measured near the outlet at multiple points on the slipstream support brace. Based on the turbulent flow of the exhaust and the passage of the exhaust gases through the silencer, the SF_6 was dispersed equally in the exhaust. A random number of the 12 sample points from the slipstream cross brace were sampled at various engine settings to verify that the tracer gas was dispersed equally. Further discussion of tracer gas methodology is included in Section 4.1 of this document.

3.2 EMISSION TESTING

Sampling was performed for criteria pollutants and those HAPs that are products of incomplete combustion (PICs). The following compounds were monitored from the slipstream system sampling:

- Filterable and condensable particulate (EPA Methods 5 and 202).
- Aldehydes and ketones (EPA Method 0011).
- Volatile organic compounds (VOCs) (EPA Method 0030), including 1,3 Butadiene.
- Oxygen and carbon dioxide (EPA Method 3A).
- Carbon monoxide (EPA Method 10).
- Nitrogen oxides (EPA Method 7E).
- Total hydrocarbons (THCs) (EPA Method 25A).
- Methane (EPA Method 25A).
- Total particulate matter (Continuous monitor, experimental method).

The following compounds were monitored from the engine rake:

- Oxygen and carbon dioxide (EPA Method 3A).
- Carbon monoxide (EPA Method 10).
- Nitrogen oxides (EPA Method 7E).
- Total hydrocarbons (THCs) (EPA Method 25A).
- Methane (EPA Method 25A).
- Benzene and formaldehyde

The engine exhaust system was not sampled for sulfur dioxide, metals or semi-volatiles. Sulfur dioxide emissions were reported based on the procedure documented by AESO. This procedure estimates that sulfur dioxide emissions can be estimated by assuming all sulfur in the fuel undergoes complete oxidation to SO_2. The sulfur content in JP-8 fuel was determined during testing to assure consistency with published results. The emission factor for SO_2 is provided in this report. Concentrations of the following metals were not detected in the fuel analysis: antimony, arsenic, barium, beryllium, cadmium, cobalt, chromium, lead, manganese, mercury, nickel, selenium, silver and thallium. Dioxins, furans, semi-volatiles and HAPs not discussed in the subsequent text were not a target of this program and had the potential to be emitted in quantities too small to be detected by the sampling methods described in this program.

Grab samples were collected behind the engine at the engine rake to determine the concentration of benzene and formaldehyde. This was performed at the idle and approach engine settings to compare to the data collected at the slipstream.

The unique feature in conducting emissions testing for this engine was that the exhaust stream at the hush house exhaust was significantly diluted with ambient air. This presented three problems: (1) the volume of exhaust gas was significantly increased; (2) dilution of the exhaust may have made it difficult to detect various pollutants; and (3) the ambient air concentration of various pollutants may have been detectable by emissions test methods. These problems may have biased the engine exhaust emissions estimates on the high side. The volume of gas at the augmentor tube exhaust was not measured directly, but was calculated indirectly through a tracer gas and calculated by F-factor and carbon balance. Because of significant dilution with the ambient air, some compounds needed to be sampled for and composited over three runs to provide adequate sample volume to reach analytical detection limits. The background ambient air concentrations were variable and could significantly bias results since ambient concentrations may have been higher than the detection limit of the source sampling methods.

Ambient air sampling was conducted in conjunction with emissions testing to quantify and qualify background emissions concentrations. Ambient samples were collected at the air intakes for the following compounds:

- Particulate - TSP (40 CFR, Part 60, Appendix B).
- VOCs (EPA Method TO-14).
- CO (EPA Method 10)
- NO_X (EPA Method 7E)
- CO_2 (EPA Method 3A)

It was not known which compounds would have been detected using the methods proposed because this level of testing for HAPs had not been documented on aircraft engine emissions. Based on the results for the first 17 engines, the program was modified by reducing the target number of HAPs collected (ambient and source). The target pollutant list was reduced based upon the lack of detection of semi-volatile HAPs. Ambient data for aldehydes and ketones was not consistent during past sampling efforts and therefore was removed from the target list.

3.2.1 Flow Rate Measurement

As stated previously, standard flow rate measurements could be performed at this test location. Additionally, there was a limited test window in which the inlet flow measurements could be taken. The identification of inlet flow rates was critical to determining the ambient contribution of pollutants in the inlet air. Outlet flow from the augmentor tube was determined by an indirect method (tracer gas) and theoretical methods (carbon balance and F-factors). Regardless of the SF_6 injection temperature, discussed in Section 4, the use of multiple-flow measurement/calculation methods was intended to provide a firm basis for identifying and rejecting outlier data. The flow data collected by any one method at a given condition was compared against the alternate measurement data collected at that same condition, as well as the flow data collected by all methods for the engine at different operating conditions. An established relationship was expected between engine operating level and total flow. All flow measurement methods provided valid data at one or more operating conditions. The

data evaluation identified which measurement deviated from that relationship, and whether that deviation could be attributed to a physical parameter such as temperature, oxygen concentration, etc. If the deviation was predicted (e.g., high oxygen concentration impact on F-factor calculation), that data was discarded. If there was no obvious physical explanation, best-fit estimates at other loads were used to identify and reject the outlier.

Inlet concentrations for some compounds were measured as part of the theoretical flow determination method using carbon balance and F-factors. At the inlet location, THC was measured using a hydrocarbon analyzer identical to the one that measured engine exhaust gas THC. An inlet carbon dioxide (CO_2) measurement was also required as input to the theoretical flow model. An ambient CO_2 monitor was used to measure the inlet CO_2 concentration during each test run.

Section 4 discusses in detail the methodologies that were applied to calculate air flow at the LMAS engine test facility.

3.2.2 Pretest Measurements

Preliminary test data were obtained at the slipstream during the shakedown runs. Preliminary flow rate data and gas composition data were collected. Augmentor tube and slipstream sampling geometry measurements were obtained and recorded, and sampling point distances verified. A preliminary velocity traverse was performed in the slipstream utilizing a calibrated S-type pitot tube and a Dwyer inclined manometer to determine velocity profiles. Exhaust gas temperatures were observed with a calibrated direct readout pyrometer equipped with a chromel-alumel thermocouple. Water vapor content was measured using EPA Method 4.

A check for the presence or absence of cyclonic flow was conducted in the slipstream. Preliminary test data were used for nozzle sizing and sampling rate determinations. Probe nozzles, pitot tubes, metering systems, and temperature measurement devices were calibrated on site as specified in Section 5 of EPA Method 5 test procedures.

3.2.3 Emissions Test Methods

The following paragraphs discuss methods that were utilized for emissions testing. Furthermore, Appendix B of this document presents the emissions sampling methods in greater detail, including descriptions of exhaust emissions test sampling trains, sample preparation, sample procedures, sample recovery, and analytical procedures.

Particulate Sampling - EPA Method 5 was used for particulate sampling at the slipstream exhaust. The sampling train utilized to perform particulate sampling conformed to EPA Reference Methods 5 and 202 for the collection of both filterable particulate and back-half condensable particulate. Select particulate samples were submitted for analysis of particle size distribution and shape. The particulate was analyzed using a scanning electron microscope (SEM) equipped with an IXRF iridium digital image system. Due to the low concentration of particulate matter in the exhaust, several sampling procedure comments were received from SPAWAR SYSCEN D3621. EQ incorporated the following suggestions:

- 47 mm diameter filters will be used
- The humidity in the weighing room will be less than 50%
- A balance accurate to 5 decimal places will be used.

Real Time Particulate Mass Determination - In addition to EPA Methods 5 and 202, an attempt was made to utilize an experimental TEOM® Series 7000 Source Particulate Monitor to collect real-time total particulate matter samples. However, the sampler could not withstand the vibrations on the test stand created by the engine thrust. Therefore, data collected by the sampler was limited and could be utilized only for particle size analysis. A more detailed description of the sampling apparatus and methodology is found in Appendix B.

Aldehyde and Ketone - The sampling train utilized to perform aldehyde and ketone sampling conformed to BIF Method 0011.

VOCs - The sampling train utilized to perform VOC sampling conformed to EPA Reference Method 0030. Table 3-1 lists the VOCs that were analyzed for in each sample.

TABLE 3-1. SUMMARY OF SOURCE TARGET COMPOUNDS FOR VOLATILE ORGANIC COMPOUNDS

VOST Compounds – Clean Air Act List	
Acetone	Trans-1,2-Dichloroethene
Benzene	1,2-Dichlorophropane
Bromodichloromethane	Cis-1,3-Dichloropropene
Bromomethane	Trans-1,3-Dichloropropene
Bromoform	Ethylbenzene
2-Butanone	2-Hexanone
1,3 Butadiene	Methylene chloride
Carbon disulfide	4-Methyl-2-pentanone
Carbon tetrachloride	Styrene
Chlorobenzene	1,1,2,2-Tetrachloroethane
Chlorodibromomethane	Tetrachloroethene
Chloroethane	Toluene
Chloroform	1,1,1-Trichloroethane
Chloromethane	1,1,2-Trichloroethane
1,1-Dichloroethane	Trichloroethene
1,2-Dichloroethane	Trichlorofluoromethane
1,1-Dichloroethene	Vinyl acetate
Cis-1,2-Dichloroethene	M, P-Xylene
	O-Xylene

Gaseous Pollutants – EPA methods 7E and 10 were utilized to determine the concentration and mass emission rate of NO_x and CO, respectively.

Methane and Non-methane Hydrocarbons (NMHC) – NMHCs were measured directly using a JUM Model 109A methane/non-methane hydrocarbon analyzer. The Model 109A contains two flame ionization detectors (FIDs). The sample is split before being sent to the respective FIDs. One fraction is passed through a catalytic converter to combust all non-methane hydrocarbons (to CO_2) before the sample is measured in the FID. The methane residual in the sample is the only component that is measured by that detector. The other sample fraction is sent to the second FID, which measures the total hydrocarbon concentration of the sample. Both FIDs are initially calibrated with a methane calibration standard, so both the total hydrocarbon and the methane residual are measured as methane. The difference between these two values is automatically determined and reported as non-methane hydrocarbons by the Model 109A.

The THC analyzer was challenged with a zero and span gas at the beginning and end of each sample day to calibrate and assess the instrument's calibration.

Metals - Emissions sampling was not completed for metal exhaust emissions. Fuel analysis for JP-8 was performed to determine the concentration of various metals in JP-8 fuel. The analytical procedure involved the combustion of JP-8 fuel in an evaporative dish. The combustion residue was ashed in a muffle furnace. Ash product was treated with an aqua regia to digest any residual carbon. The solution was diluted then analyzed via Inductively Coupled Plasma Spectroscopy, Cold Vapor Atomic Absorption Spectroscopy (Hg), or treated with chelating agent and analyzed via colorimetric methodology (P). Concentrations were determined for the metals listed in Table 3-2.

TABLE 3-2. SUMMARY OF SOURCE TARGET METALS FROM JP-8 FUEL ANALYSIS

Antimony	Arsenic
Barium	Beryllium
Cadmium	Cobalt
Chromium	Copper
Lead	Manganese
Mercury	Nickel
Phosphorus	Selenium
Silver	Thallium
Zinc	

3.2.4 Ambient Air Sampling

Due to the high ambient air dilution rate for the engine tests, background levels of gaseous pollutants were taken into account in determining the emissions from the hush house. For example, fuel handling operations in the area could have contributed to background hydrocarbons. Similarly, CO and/or NO_x levels could have been affected by vehicles, heavy machinery operating in the area, or aircraft emissions. The carbon balance methodology used for flow rate determination required ambient samples to be collected as part of the normal testing. A sample was collected from one side of the hush house near the air intake.

The ambient air sampling program was designed to collect air samples to be analyzed for pollutants in the following two major categories:

- Gases
- Particulates

Ambient air sampling, equipment operations, and calibration followed standard operating procedures (SOPs) for each method. Ambient air sampling was performed in conjunction with all emissions testing. Ambient air sampling commenced at the start of each emissions test run and was concluded at the completion of the final emissions test run. The ambient air samples were composited over the three 1-hour test runs for each engine power setting. Samplers were turned on and off manually. These results were used to correct for any bias introduced by pollutants found in the ambient air.

The following subsections present brief descriptions of the ambient air sampling and analytical methods used for each of the pollutants or pollutant groups. The descriptions include overviews of the sampling equipment, collection media, and analytical techniques used for each pollutant or pollutant group.

3.2.4.1 Particulates

Particulate matter (total suspended particulates) was sampled using General Metal Works high-volume (Hi-Vol) air samplers with volumetric flow controllers. The particulate sampling program was operated according to EPA guidelines as described in the *Quality Assurance Requirements for Prevention of Significant Deterioration*, 40 CFR, Part 50, Appendix B. Sample filters were analyzed by a gravimetric method using pre- and post-weights to determine total particulates. During each 1-hour sample run, 68 m^3 of sample were collected. For the composite 3-hour sample, a total of 204 m^3 of volume was sampled. With an analytical detection limit of 0.1 milligram (mg), the method detection was 0.5 $\mu g/m^3$.

3.2.4.2 Volatile Organic Compounds

Volatile organics were sampled using passivated stainless-steel Summa® canisters, which were analyzed by gas chromatography/mass spectrometry (GC/MS) per EPA Method TO-14.

A Summa® canister is a stainless-steel vessel that has had its internal surfaces specially passivated using a "Summa" process. This process combines an electropolishing step with chemical inert. A Summa surface has the appearance of a bright and shiny mirror. A sample enters the canister through a high-temperature, stainless-steel bellows valve. A Summa canister will hold a high vacuum (<1 m Torr: <28 inches Hg) for up to 30 days. After 30 days, it is necessary to evacuate the canister prior to use to ensure that it is free of contaminants.

Canisters are cleaned using a combination of exponential dilution, heat, and high vacuum. They are generally batch-certified (1 in 10) by filling them with ultra-high-purity

air, which is subsequently analyzed using either GC/MS (TO-14) or GC/ flame ionization detection (FID) (TO-12). If the target analyte concentrations are below 0.2 part per billion by volume (ppbv) (TO-14) or if the total hydrocarbon level is less than 0.2 ppbv, the batch of canisters is considered "clean" and is certified for use.

Although 14 days is the most commonly cited holding time for a canister sample, the holding time is somewhat analyte-specific. For example, nonpolar analytes such as chloroform, benzene, and vinyl chloride are stable in a canister for at least 30 days. However, polar analytes such as methanol and acetone often will condense on the canister walls (the degree of which is a function of the sample humidity). Analysis of these samples should be performed within 72 hours.

The passivated canister sampling used pre-set flow controller devices to regulate the sampling flow rate into the canister. The flow controllers allowed an integrated sample to be collected without the canister achieving an equilibrium ambient pressure. Sampling was conducted using an evacuated 6 liter Summa canister. The flow into the canister was controlled by an orifice to allow approximately 1.5 liters of sample to be collected during each 1-hour sample run for a total of 4.5 liters per three runs.

Table 3-3 lists the VOCs that were analyzed for in each sample.

3.2.4.3 Carbon Monoxide and Nitrogen Oxides

Sampling was performed using a continuous emissions monitoring system (CEM) for oxygen and carbon dioxide (EPA Method 3A), carbon monoxide (EPA Method 10), and nitrogen oxides (EPA Method 7E). Due to the expected low concentration of CO_2 in the exhaust stream at the slipsteam, an ambient CO_2 monitor was used at the exhaust. The ambient analyzer had the ability to measure the concentration in several ranges: 0-1,000 ppm, 0-1% and 0-5% CO_2.

TABLE 3-3. SUMMARY OF AMBIENT TARGET COMPOUNDS FOR VOLATILE ORGANIC COMPOUNDS

Volatile Organic Compounds – EPA Method TO-14 List	
Freon 12	m,p-Xylene
Freon 114	o-Xylene
Chloromethane	Styrene
Vinyl Chloride	1,1,2,2-Tetrachloroethane
Bromomethane	1,3,5-Trimethylbenzene
Chloroethane	1,2,4-Trimethylbenzene
Freon 11	1,3-Dichlorobenzene
1,1-Dichloroethene	1,4-Dichlorobenzene
Freon 113	Chlorotoluene
Methylene Chloride	1,2-Dichlorobenzene
1,1-Dichloroethane	1,2,4-Trichlorobenzene
cis-1,2-Dichloroethene	Hexachlorobutadiene
Chloroform	Methanol
1,1,1-Trichloroethane	Ethanol
Carbon Tetrachloride	Isopropanol
Benzene	Acrolein
1,2-Dichloroethane	Acetone
Trichloroethene	Acetonitrile
1,2-Dichloropropane	Acrylonitrile
cis-1,3-Dichloropropene	Vinyl Acetate
Toluene	Tetrahydrofuran
trans-1,3-Dichloropropene	1,4-Dioxane
1,1,2-Trichloroethane	Ethyl Acetate
Tetrachloroethene	2-Butanone
Ethylene Dibromide	Methyl Methacrylate
Chlorobenzene	4-Methyl-2-Pentanone
Ethyl Benzene	

3.3 ENGINE TEST CYCLE DATA

In order to correlate the aircraft engine emissions data with the engine operation, facility personnel compiled selected engine test cycle data during testing. The engine test monitoring system at this test stand constantly monitored a variety of engine parameters during engine testing. For the purpose of emissions sampling, a select number of these parameters were provided to the SPO for emission factor development. These parameters assisted in noting the effect of a specific pollutant for a specific engine load condition. The following data (or equivalent) was compiled and retained by facility personnel:

- Fuel flow at each load (primary and afterburner fuel flow).
- Engine rpm at each load.
- Thrust at each load.
- Engine pressure ratio (EPR).
- Humidity and temperature.

Please note that fuel flow and engine thrust were the most important data items in the above list. The remaining data were important for documentation of engine conditions during sample collection. Due to security issues, EQ was not involved in the collection or review of any engine operating data. This was controlled by LMAS and the SPO.

3.4 JP-8 FUEL SAMPLING AND ANALYSIS

The proximate/ultimate JP-8 fuel analysis and level of nitrogen was determined for the facility in order to verify fuel characteristics during testing. Table 3-4 lists a portion of the fuel analysis that was performed by the facility. During the testing period, EQ collected two fuel samples for metals analysis.

TABLE 3-4. JP-8 FUEL ANALYSIS REQUIREMENTS

Parameter	Analytical Method
Trace Sulfur	ASTM D-2622
Carbon, Hydrogen, and Oxygen	ASTM D-5291
Trace Nitrogen	ASTM 4629 (chemiluminescence)
Heating Value (Net and Gross)	ASTM D-240
Density	ASTM D-1480
API Gravity/Density	ASTM D-1298

3.5 ENGINE TESTING MATRIX

3.5.1 Engine Shakedown Runs

Prior to the commencement of emission testing, a preliminary set of gaseous emission and exhaust flow data was determined at each setting. The purpose of the shakedown runs was to determine the expected gaseous pollutant concentrations so that the appropriate calibration gases could be determined. Also, the preliminary flow measurements were used to select the proper sample nozzle diameter.

During the shakedown runs, several measurements were made at multiple idle settings and at several settings that were not planned for the complete test program. The fuel flow was adjusted at small increments, and gaseous emissions were measured at the slipstream rake to note the variance in emissions as fuel flow increased. This provided gaseous emissions data.

3.5.2 Engine Testing

Emissions testing was performed on the F119-PW-100 engine at five power settings. These power settings are the following:

- Idle, 10% power
- Approach, 20% power
- Intermediate, 70% power

- Military, 100% power
- Maximum afterburner, 150% power

Emissions testing was comprised of three 1-hour emissions tests for each pollutant at the idle and approach power settings. Two 1-hour tests were completed at the intermediate and military settings. An oil leak occurred during testing at the intermediate setting, thereby limiting available testing time. The engine had to be allowed to cool and investigated prior to any further testing. The limited testing time did not allow for a third test at intermediate. At the military setting, the engine could be operated continuously for approximately 35 minutes before being shut down for refueling. Due to time constraints for refueling, only two runs were conducted at military; a single 10-minute run for gaseous pollutants only was performed at afterburner. Sample time at afterburner was limited due to fuel constraints and the need to limit engine run time at afterburner.

In addition, a 30-minute sample was collected from the engine rake at the idle and approach settings. At each setting, a sample was collected for approximately 15 minutes at the beginning of the test run; the rake was turned over to the University of Missouri test team who were gathering research data, then sampled again for approximately 15 minutes at the end of the test run.

Due to sample volume and method detection limit requirements, the aldehyde/ketone sample was composited over the 3-hour period. The other particulate matter and volatile samples ran for 1 hour. The engine had to be brought down to a safe operating level so that the test team personnel could access sampling equipment for approximately 10 minutes in between each sample run. All engine settings were defined by Pratt & Whitney so that the engine could be run continuously (or as long as practical) at idle, approach, intermediate, military and afterburner. EQ adjusted the sample collection procedure to accommodate the reduced operating time at the afterburner setting. Ambient air sampling was conducted only during emissions testing. Ambient samples were composited for each of the three 1-hour test runs at that power

setting. Table 3-5 lists engine type, number of power settings, and number and types of samples that were collected.

3.5.3 Engine Emission Trend Development

In addition to the settings listed in Table 3-5, an additional sample run from idle to military was conducted. The purpose of the run was to sample for gaseous pollutants throughout the engine power band. The engine throttle position was increased in small increments at approximately 10-minute intervals so that gaseous emission data could be collected at the slipstream rake to develop an emission trend for the engine.

3.6 EMISSION TEST SCHEDULE

Figure 3-1 shows the general time-line for engine testing at the LMAS facility. The time-lines depict activities and the time each activity required for equipment setup, shakedown runs, emissions testing, and demobilization at the test facility.

The following is a breakout of the general tasks conducted during each of the three phases:

- **Equipment setup** - Setup and calibration of sampling equipment was completed over 5 days (September 5 through September 10). This involved setting up the exhaust rake and slipstream sampling systems, sampling equipment, tracer gas systems, the flow measurement system, and the mobile laboratory. EQ set-up equipment outside the test stand while other testing was being conducted and the sound exposure was insignificant. There were times when test team personnel needed to enter the test exhaust tube. During this time the test cell was dedicated to equipment setup activities and remained inactive.

- **Shakedown** - During this important period, both the test team and engine test stand operators became familiar with the operational procedures of the test program. The test team gathered preliminary information at each of the engine test settings. This information was vital to ensure that the scheduled test runs were conducted accurately and efficiently. The Shakedown runs were completed on September 11.

TABLE 3-5. ENGINE EMISSION SAMPLING MATRIX

Pollutant/ Method	Sample Location				Sample Duration (A) (Minutes)	Number of Samples per Setting	Total Number of Samples	Engine Setting				
	Engine Rake(B)	Slipstream Rake	Slipstream	Ambient				Idle	Approach	Intermediate	Military	After-burner
Particulate/EPA Method 5202			X		60	3,3,2,2	10	X	X	X	X	
Particulate/Team Series 7000 (Real Time)			X		60	3,3,2,2	10	X	X	X	X	
Aldehydes and Ketones/EPA Method 0011			X		180	1	4	X	X	X	X	
VOST/EPA Method 0030			X		60	3,3,2,2	10	X	X	X	X	
Carbon Monoxide/EPA Method 10	X	X		X	60/30	3,3,2,2,1	11	X	X	X	X	X
Carbon Dioxide and Oxygen/ EPA Method 3A	X	X		X	60/30	3,3,2,2,1	11	X	X	X	X	X
Oxides of Nitrogen/EPA Method 7E	X	X			60/30	3,3,2,2,1	11	X	X	X	X	X
Total Hydrocarbons/ EPA Method 25A	X	X		X	60/30	3,3,2,2,1	11	X	X	X	X	X
Methane/EPA Method 25A	X	X			60/30	3,3,2,2,1	11	X	X	X	X	X
Particulate/40CFR Part 60, Appendix B				X	180	1	5	X	X	X	X	
Volatile Organic Compounds				X	180	1	5	X	X	X		

A – 30 minute samples were collected at the engine rake. A 10-minute sample was collected at afterburner.
B – The engine rake was removed prior to sampling at intermediate.

DAY	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F
DATE	9/04	9/05	9/06	9/07	9/08	9/09	9/10	9/11	9/12	9/13	9/14	9/15
	M	S	S	S	S	S	S	SD				
Engine Trend Curve Idle – Intermediate								SD				
Idle												
Approach												
Intermediate												
Military & Afterburner												
Equipment Teardown												D

Mobilize M
Setup S
Shakedown SD
Test T
Teardown D

Figure 3-1. Time-Line for F119-PW-100 Engine Testing at the Lockheed Martin Aeronautical Systems (LMAS Facility)

- **Testing** – Testing of the engine commenced on September 12. Three runs were completed at the idle and approach settings on this day. Testing at the intermediate setting was completed on September 13. Two runs were completed instead of three due to an oil leak in the engine, which contributed to downtime. The engine was tested at the military and afterburner settings on September 14. The engine could be operated for 35 minutes at military, but then had to be shut down to cool. In addition, after an hour of operation, refueling was required. Due to these time constraints and refueling needs, only two runs at military were completed. The afterburner test was limited to approximately 10 minutes due to fuel constraints and the attempt to limit engine time at afterburner.

- **Teardown** - Teardown of the equipment was accomplished in 1 day, September 15.

3.6.1 Personnel Responsibilities

The nature of this test program dictated that the members of the sampling team be highly skilled. The program was staffed at the appropriate level with the necessary skill levels to perform each task. Each team member was actively involved in the collection of emissions samples, fuel samples, sample recovery, data reduction, and sample shipment. Table 3-6 lists the personnel categories and the required qualifications and tasks. The test team functioned as an integrated unit to complete the test program efficiently and without compromising data quality or hush house utilization.

TABLE 3-6. EXAMPLE BREAKOUT OF FIELD TEAM PERSONNEL AND RESPONSIBILITIES

Personnel	Responsibilities/Qualifications
EQ Project Manager	Acted as liaison between LMAS personnel, sample team, Pratt & Whitney and AFIERA/RSEQ. Coordinated engine operation with testing. Assisted in equipment preparation and sample recovery. Collected fuel samples. Set up and constructed sampling equipment.
Weston Team Leader	Assumed technical responsibility for overall sampling effort, sample recovery, and ambient air monitoring. Set up and calibrated equipment. Collected samples and operated FTIR system.
CEM Operator	Operated and calibrated CEM system, electronic flow measurement system, and tracer gas system.
VOST Sample Train Operator	Operated VOST sampling train and assisted other sampling personnel as needed.
Particulate Matter Train Operator	Operated particulate matter sampling train and assisted in sample recovery.
Aldehyde and Ketone Train Operator	Operated aldehyde and ketone sampling train; supervised IATA/DOT certification of shipment of hazardous materials (hazardous sample media, i.e., acetone); and acted as field sample custodian.
Sampling Technician	Provided sampling support to the above personnel.

SECTION 4

CALCULATION OF AIRFLOW

The calculation of emission rates for this test program required accurate measurement of both inlet (ambient) airflow as well as total exhaust flow (combustion products plus excess air). The total exhaust flow was required to quantify mass emission rates for the parameters being measured. The inlet airflow was required to quantify mass rates of any parameter that was measured in the ambient sampling program so that mass rate could be subtracted from the engine emission rate.

Whenever possible, standard EPA flow measurement methods were used to quantify airflow. However, the test location did not provide adequate measurement locations for traditional flow measurements. The following three alternate flow measurement techniques were employed at the location:

- Tracer gas concentration for total exhaust flow.
- Carbon balance for the calculation of inlet and total exhaust flow.
- F-factor for the calculation of inlet and total exhaust flow.

Each method has advantages and disadvantages that vary in significance depending on the specific conditions of each test run. The objective of the test program was to ensure that at least two independent techniques for measuring airflow were available for each test run.

4.1 CALCULATION OF EXHAUST AIRFLOW USING TRACER GAS

4.1.1 Tracer Gas Methodology

Because exhaust flow could not be measured at this location using standard EPA methods, tracer gases were used. The amount of dilution that occurred was determined by inputting a known amount of tracer gas into the exhaust stream and measuring a

concentration at the outlet. The dilution rate was then used to calculate exhaust flow rates. This Section details these calculations.

Tracer gas was released from the outside of the hush house at the inlet air screen into the exhaust stream through the ambient air intakes on either side of the hush house.

The tracer gas release points were monitored for temperature. It was important to monitor for temperature since SF_6 is stable up to 500 °F before it degrades. The tracer gas injection apparatus included thermocouples to determine temperatures at the injection point. The 500 °F threshold was very conservative because SF_6 will not decompose until 932 °F. However, EQ intended to maintain the conservative threshold as the point where the tracer method was more seriously examined because of the more extreme conditions that were present in the exhaust stream. Based on test stand operation information gained during site visits conducted prior to testing, it was likely that the temperature in the silencer tube at the tracer release point would exceed 500 °F in intermediate and afterburner modes. However, the temperature limit was not exceeded during testing. Therefore, the alternate methods discussed in Sections 4.2 and 4.3 were completed for comparative purposes.

The tracer gas was released opposite the flow to prevent the exhaust gas pressure from impacting the tracer gas release tubes and possibly affecting tracer gas distribution. Tracer gas was introduced into the stainless steel tubes via a mass flow controller calibrated to SF_6. The gas flowed into adjustable flow meters that regulated equal amounts of tracer gas into each of the tracer release tubes. Temperature was measured by a Type K thermocouple and recorded by a data logger.

Tracer gas was collected from the same location as the gaseous samples at the slipstream rake (Figure 2-9) in conjunction with each sample run. During the manual sample run, the tracer gas pickup points pulled a sample of exhaust that was analyzed to determine SF_6 concentration. A heated sample line carried the SF_6 directly to the analyzer where it was measured.

The tracer gas flow methodology was not used to determine flow at the engine rake. Due to the proximity of the engine rake to the engine, the tracer gas did not have adequate time to mix with the engine exhaust.

This sample location had a single well-defined exhaust augmentor tube but due to its configuration it was difficult to measure by EPA Reference Methods. The exhaust flow was instead calculated from tracer gas dilution ratios. In the tracer gas flow measurement technique, a precise mass flow of the sulfur hexafluoride tracer gas (SF_6) was injected into the exhaust stream after the engine. The SF_6 was injected through four points to obtain good dispersion into the exhaust gas stream. An integrated sample collected at each sampling point at the exhaust location was analyzed for SF_6.

The tracer gas flow calculation is based on the assumption that the SF_6 was dispersed uniformly throughout the exhaust gas. If this assumption is valid, then the following determination is valid simply by mass balance.

$$S_m = Q_s \times C_s \times K$$

Where:

C_s = Average concentration of SF_6 in the exhaust gas.
K = Physical constants required to attain consistent units.

Since the SF_6 was distributed uniformly, then the concentration in any sample was equal to the average concentration; thus, by substitution and rearrangement, the following calculation was derived:

$$Q_s \frac{m^3}{min} = \frac{1.64795 \times 10^5 \, Sm}{C_f}$$

Where:

1.6745×10^3 = Conversion constants times standard molar volume divided by molecular weight of SF_6 $\left[\left(\frac{24.05 \times 10^{-3} \, m^3}{gm - mole}\right) x \left(\frac{gm - mole}{146 \, gm}\right) x \left(\frac{10^{-3} g}{mg}\right) x \left(\frac{ppb}{1 \times 10^{-9}}\right)\right]$

with units of $\frac{m^3 - ppb}{mg}$

Q_s = Total exhaust flow, cubic meters per minute (m^3/min), wet basis.
Sm = Metered injection of SF_6 , milligrams per minute (mg/min).
C_f = Concentration of SF_6 in sample, parts per billion (ppb).

The flow rate calculation was presented on a metric basis for clarity. All flow rates and emissions were presented in both English and metric units.

The assumption of uniform concentration of the tracer gas is not self-evident in this system and must be proven for each operating condition. The following subsections describe the steps required to prove the assumption, and use of the results to correct other measurements.

4.1.2 Sampling for SF_6 and Determining a Homogeneous Exhaust Mixture

It is not practical to sample the entire engine exhaust to show that the exhaust is homogeneous throughout. Twelve points at the slipstream rake (Figure 2-9) in the exhaust cross section were sampled. Sampling was conducted at each of those points at various engine settings to document that the exhaust stream remained well mixed under several flow scenarios.

4.1.3 Determination of Average SF_6 Concentration

The dilution flow measurement technique requires a well mixed exhaust stream. Simultaneous samples were taken at points in the augmentor tube for all engine operating conditions. The results of the sample analysis were used to calculate an average concentration. A statistical analysis of the data points around this sample average were used to validate this average using the Student's t distribution at a 95% confidence interval. If the sample average satisfied this criterion, the sample average was equal to the true average within the range of the confidence interval for 95 % of all measurements. The range for this evaluation was set at twice the limit of detection (LOD) for the sample analysis.

The SF_6 was injected at a rate sufficient to generate a 20-ppb concentration in the well mixed exhaust stream. The LOD for the SF_6 analysis was 0.5 ppb.

4.1.4 Evaluation of Average SF_6 Concentration

After the statistical analysis was completed, the following decision tree was employed:

If the permanent sample point average SF_6 concentrations satisfied the statistical criterion, then the gas stream was well mixed and the average SF_6 concentration measured at the permanent sample points were used to calculate flow rate.

If the sample average SF_6 concentration did not satisfy the statistical criterion, the number of SF_6 injection points were doubled to increase dispersion.

The test program continued on schedule (no further shakedown runs), but the tracer-gas-flow calculation was valid only for those subsequent test runs that met the statistical requirements.

4.1.5 Use of SF_6 Concentration to Adjust Other Sample Results

For those test concentrations where the permanent sampling point average SF_6 concentrations satisfied the statistical criterion, the ratio of the individual permanent sample point concentration to the valid run average was used to determine a corrected average emission rate for that sample.

4.2 CALCULATION OF INLET AND OUTLET AIRFLOW USING A CARBON BALANCE

This method calculates both inlet and outlet airflow rates using a carbon mass balance. This method was used to determine airflow at both the engine exhaust and the total exhaust flow from the hush house. Conservation of matter requires that the total carbon mass rate in the exhaust (MCE) equals the sum of the total carbon mass rate in the fuel (MCF) and the carbon mass rate in the inlet air (MCI).

$MCE = MCF + MCI$ *Equation 1*

A similar conservation of total mass states that the total mass rate in the exhaust (ME) equals the total mass rate in the fuel (MF) plus the total mass rate at the inlet (MI).

$ME = MF + MI$ *Equation 2*

Finally, the mass rate of carbon also can be derived as the total mass rate at each location times the percent carbon by weight (% C_x) in each stream.

$MCE = ME \times \% C_e/100$ *Equation 3*

$MCF = MF \times \% C_f/100$ *Equation 4*

$MCI = MI \times \% C_i/100$ *Equation 5*

The percent carbon by weight was measured in all streams and the mass rate of fuel burned also was measured. This leaves four unknown variables, ME, MI, MCE, and MCI, and five independent equations.

To solve for inlet mass flow rate, substitute Equation 2 into Equation 3.

$MCE = (MF \times \% C_e/100) + (MI \times \% C_e/100)$

Then substitute that equation into Equation 1.

$(MF \times \% C_e/100) + (MI \times C_e/100) = MCF + MCI$

Substitute Equations 4 and 5 to get:

$(MF \times \% C_e/100) + (MI \times \% C_e/100) = (MF \times \% C_f/100) + (MI \times \% C_i/100)$

Rearrange factors to get the inlet mass rate.

$$MI = MF\left(\frac{\% C_f - \% C_e}{100}\right)\Big/\left(\frac{\% C_e - \% C_i}{100}\right)$$

By similar derivation, rearrange Equation 2, substitute into Equation 5, substitute the results into Equation 1, and then substitute Equations 3 and 4 to get the following:

$MI = ME - MF$ *Equation 2*

$MCI = (ME \times \% C_i/100) - (MF \times \% C_i/100)$ *Equation 5 using Equation 2*

$MCE = MCF + (ME \times \% C_i/100) - (MF \times \% C_i/100)$ *Equation 1 using Equation 5*

$$\left(ME \times \frac{\% C_e}{100}\right) = \left(MF \times \frac{\% C_f}{100}\right) + \left(ME \times \frac{\% C_i}{100}\right) - \left(MF \times \frac{\% C_i}{100}\right)$$ *Substitute Equations 3 and 4*

$$ME = MF\left(\frac{\% C_f - \% C_i}{100}\right) \Big/ \left(\frac{\% C_e - \% C_i}{100}\right)$$

The mass emission rates can be converted to volumetric flow rates by dividing by molecular weight and multiplying by standard volume. For example:

$$QE = \frac{ME \times 385.35}{MW_e}$$

Where:

QE = Wet standard volumetric flow rate, $\frac{wscf}{min}$.

ME = Total exhaust flow rate, $\frac{lb}{min}$.

MW_e = Wet molecular weight exhaust stream, $\frac{lb}{lb\ mole}$.

385.35 = Standard molar volume, $\frac{scf}{lb\ mole}$.

The fuel mass rate was measured directly during each test run, and the % was determined by the fuel analysis.

The wet molecular weights of the exhaust gas streams were determined by EPA Reference Methods 3A and 4 (40 CFR 60). These methods measure the percent moisture (% M) of the gas stream and percent carbon dioxide (% CO_2) and oxygen (% O_2) in the gas stream on a dry basis, which were used to calculate the molecular weight as follows:

$$MW_e = \left[\left\{\left(\%\,CO_2 \times 0.48\right) + \left(\%\,O_2 \times 0.32\right) + \left(\left(\%\,CO + \%\,N_2\right) * 0.28\right)\right\} * \left(1 - \frac{\%\,M}{100}\right)\right] + \left(\%\,M \times 0.18\right)$$

Where:

% M = Moisture content as a percent.

For the purpose of calculating a molecular weight, (% CO + % N_2) was assumed to be (1 - % CO_2 - % O_2). Calculation of the carbon content of the exhaust gas stream used the %CO_2 as determined by Method 3A, plus additional measurements of carbon monoxide (% CO) and total hydrocarbons (% THC) by EPA Reference Methods 10 and 25A (40 CFR 60, Appendix A). The % THC was stated on the basis of methane (CH_4). The carbon monoxide (CO) and carbon dioxide (CO_2) concentrations were measured on a dry basis and converted to a wet basis using the measured moisture content of the exhaust gas. THC was measured on a wet basis.

$$\%\,CO_2\ (wet) = \%\,CO_2\ (dry) \times \left(1 - \frac{\%\ M}{100}\right)$$

$$\%\,CO\ (wet) = \%\,CO\ (dry) \times \left(1 - \frac{\%\ M}{100}\right)$$

The total carbon content of the exhaust gas stream is equal to the sum of % CO_2, % CO, and % THC on a wet basis times the ratio of carbon molecular weight to the total wet molecular weight of the gas stream.

$$\%\,C_e = \left(\%\,CO_2\ wet + \%\,CO\ wet + \%\,THC\right) \times \frac{12.01}{MW_e}$$

A similar calculation was required for the inlet air volumetric flow rate, but the following simplifying assumptions were made:

- Dry ambient air is composed of 20.9% oxygen and 79.1% nitrogen.
- Ambient humidity represents the moisture content of the inlet air.

The major drawback to this measurement method was the use of extremely low carbon concentration values at the inlet, and relatively low concentrations at the exhaust to modify the very high carbon concentrations in the fuel. As excess air increases, the inlet flow was indistinguishable from the outlet flow. The major advantage of this procedure was that the only additional data that are required to calculate flow are: the inlet flow; CO, CO_2, and THC values; and ambient humidity.

4.3 CALCULATION OF AIRFLOW USING F-FACTORS

F-factors relate the volume of combustion products to the heat content of fuel. F-factors generally are used for combustion sources when the exhaust stream flow rate is known but the fuel heat input must be determined. In this case, the fuel input was determined easily but the volumetric flow of combustion air was difficult to determine. The F-factor relationship was used to calculate the total exhaust flow at the engine rake and at the hush house exhaust based on a fuel firing rate.

F-factors are published for a variety of fuels and usually are expressed in units of dry standard cubic feet per British thermal unit (dscf/Btu or dscm)/joule (J). For this test program, specific F-factors were determined through historic ultimate analysis of the fuel components on a weight percent basis and fuel density.

- Ultimate analysis of jet fuel (i.e., hydrogen, carbon, sulfur, nitrogen, oxygen, and density (pounds per gallon [lb/gal]) on a mass basis (% wt).

To determine the air volumetric flow rate, the following additional information was required:

- The concentrations of oxygen, carbon monoxide, and moisture content in the exhaust stream after combustion.
- Fuel firing rate, gallons per minute (gal/min).

The F-factor, dry basis, was calculated from the ultimate analysis of the jet fuel as follows:

$$F_d = K[(K_{hd} \% H) + (K_c \% C) + (K_s \% S) + (K_n \% N) - (K_o \% O)]/GCV$$

(Equation 19-13, 40 CFR 60, Appendix A, Method 19)

If the heat input components (K, GCV) were eliminated from the equation, an F-factor based on fuel mass was derived.

$$F_{md} = [(K_{hd} \% H) + (K_c \% C) + (K_s \% S) + (K_n \% N) - (K_o \% O)]$$

Where:

F_d = Volume of combustion components per unit of heat content, scf/million Btu.
F_{md} = Volume of combustion component on a dry basis per pound of fuel, scf/lb.
% H, % C, % S, % N, % O = Weight percents of hydrogen, carbon, sulfur, nitrogen, and oxygen in the jet fuel.

GCV = Gross calorific value of the fuel consistent with the ultimate analysis, Btu/lb.
K = Conversion factor, 10^{-5}.
K_{hd} = 3.64 (scf/lb)/(%).
K_c = 1.53 (scf/lb)/(%).
K_s = 0.53 (scf/lb)/(%).
K_n = 0.14 (scf/lb)/(%).
K_o = 0.46 (scf/lb)/(%).

Stoichiometric combustion calculations assume that the carbon in the fuel is burned completely to produce carbon dioxide and water with no excess air (and no significant formation of nitrogen dioxide or carbon monoxide). The air stoichiometric volumetric flow rate (dry basis) was determined by simply multiplying the measured fuel firing rate by the F-factors.

$$\left(\text{Fuel firing rate, } \frac{\text{gal}}{\text{min}}\right)\left(\text{fuel density, } \frac{\text{lb}}{\text{gal}}\right)\left(F_{md}, \frac{\text{scf}}{\text{lb}}\right) = \text{dry combustion air flow, } \frac{\text{scf}}{\text{min}}$$

The percent excess air (EA) during actual combustion was calculated using the following formula:

$$\%\,EA = \left[\frac{\%\,O_2 - 0.5\%\,CO}{20.9 - (\%\,O_2 - 0.5\%\,CO)}\right] x\ 100$$

Where:

% O_2, % CO = Measured percents of oxygen, and carbon monoxide, in the exhaust gas. 20.9 is the percent dry oxygen in ambient air.

Total dry combustion flow (including) excess air equals:

$$\text{Total dry air flow} = \left[(\text{dry combustion air flow})\left(1 + \frac{\%\,EA}{100}\right)\right]$$

This simplifies to:

$$\text{Total dry combustion flow, } \frac{scf}{min} = (\text{dry combustion air}) * \left(\frac{20.9}{20.9 - \%\,O_2 + 0.5\%\,CO}\right)$$

The inlet airflow is equal to the total dry combustion air plus the fraction of oxygen in the inlet used for the combustion of hydrogen in the fuel. The nitrogen associated with this oxygen fraction of the inlet air was included in the F_d calculation.

This inlet oxygen fraction can be derived from the same F-factor calculations presented in EPA Method 19.

$$F_{mo} = K\,[K_{hi}\,\%\,H]$$

Where:

F_{mo} = Volume of inlet oxygen used to combust hydrogen per unit of fuel fired, scf/lb.
K_{hi} = 0.96 (scf/lb)/%.
% H = Weight percent of hydrogen in the fuel as stated previously.

Then the total dry inlet airflow is the following:

$$\text{Dry inlet air} = \left[\text{fuel firing rate, } \frac{\text{gal.}}{\text{min}}\right]\left[\text{fuel density, } \frac{\text{lb}}{\text{gal.}}\right]\left[F_{md} + F_{mo}\right] * \left[\frac{20.9}{20.9 - \%O_2 + 0.5\,\%CO}\right]$$

The inlet air then can be corrected back to actual conditions using the ambient temperature and humidity. The total exhaust flow can be adjusted to actual conditions using the measured exhaust moisture content and temperature.

There are limitations to the use of these F-factors for calculations of airflow from jet engines. The concentration of carbon monoxide in the combustion stream normally is so low that it is insignificant in the excess air calculation, but it has been included to cover operation during periods of incomplete combustion. If the combustion is so incomplete that large quantities of the fuel are exhausted as carbon (soot) or volatile hydrocarbons (THC), the % C of the fuel must be reduced to account for the reduced formation of combustion products.

The second limitation arises when high levels of excess air are present. At high excess air levels, the carbon monoxide concentration becomes zero, but the oxygen content of the combustion gas approaches ambient concentrations (20.9 % O_2). The excess air equation becomes unreliable at a concentration of 20.9 % oxygen as this equation is undefined due to division by zero. As a general rule, these F-factor calculations will be unreliable any time the combustion gas contains more than 18.5 % oxygen.

SECTION 5

QUALITY ASSURANCE PROCEDURES

5.1 QUALITY CONTROL PROCEDURES

As part of the engine testing program, EQ implemented a quality assurance (QA) and quality control (QC) program. QA/QC were defined as follows:

- Quality Control - The overall system of activities whose purpose was to provide a quality product or service (e.g., the routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process).

- Quality Assurance - A system of activities whose purpose was to provide assurance that the overall QC was being conducted effectively.

The Field Team Leaders for stack sampling were responsible for implementation of field QA/QC procedures. Individual laboratory managers were responsible for implementation of analytical QA/QC procedures. The overall Project Manager oversaw all QA/QC procedures to ensure that sampling and analyses met the QA/QC requirements and that accurate data results from the test program were obtained.

5.1.1 Field QC Sample Collection/Preparation Procedures

Table 5-1 provides a summary of the numbers and types of field and analytical QA/QC samples by parameter. General field QC procedures were the following:

- Collect only the number of samples needed to represent the media being sampled.

- To the extent possible, the quantities and types of samples and sample locations were determined prior to the actual field work.

- As few people as possible handled the samples.

TABLE 5-1. SUMMARY OF ANALYTICAL QA/QC SAMPLES

SAMPLE LOCATION	PARAMETER	NUMBER OF SAMPLES	TYPES OF QA/QC SAMPLES		
			FB	TB	MS
EXHAUST SAMPLES[1]:					
	Particulate	48	--	1	--
	Volatile organics[2]	48	1 pair	1 pair	12 pair
	Aldehydes and Ketones	4	1	1	--
AMBIENT (BACKGROUND)					
	Particulate	4	1	--	--
	Volatile organics	5	1	--	--

[1] Trip blanks for exhaust samples consisted of reagent blanks. See Subsection 5.1.2 for a description of exhaust blank samples.

[2] Four VOST tubes per test run.

FB = Field Blank
TB = Trip Blank
MB = Method Blank or Preparation Blank
MS = Matrix Spike

- The field sampler was personally responsible for the care and control of the samples collected until they were property transferred or dispatched.

- Sample records were completed for each sample, using black waterproof ink or other measures to ensure the legibility and integrity of sample identification.

- The Field Team Leader ensured that proper preservation, storage, and security procedures were followed during the field work and decided if additional samples were needed.

- Storage conditions of samples were documented on the sample forms or project records.

5.1.1.1 QC Procedures for Stack Gas Sample Collection

This subsection provides a list of QC procedures employed during the field sampling effort. Method-specific QC procedures are detailed in the method descriptions contained in Appendix A. General QC checks that apply to all methods include the following:

- Leak checks.
- Use of standardized forms, labels, and checklists.
- Ensure sample traceability.
- Collection of appropriate blanks.
- Use of calibrated instrumentation.
- Use of Protocol 1 and/or NIST-traceable calibration gases.
- Review of data sheets in the field to verify completeness.
- Use of validated spreadsheets for calculating results.

5.1.1.2 Velocity/Volumetric Flow Rate QC Procedures

Volumetric flow rates were determined during the isokinetic stack gas tests. The following QC procedures were followed during these tests:

- The S-type pitot tube was inspected visually before sampling.

- Both legs of the pitot tube were leak-checked before sampling.

- Proper orientation of the S-type pitot tube was maintained while making measurements. The yaw and pitch axes of the S-type pitot tube were maintained at 90° to the flow.

- The manometer oil was leveled and zeroed before each run.
- Cyclonic or turbulent flow checks were performed prior to testing the source.
- Pitot tube coefficients were determined based on physical measurement techniques as delineated in EPA Method 2.

5.1.1.3 Moisture Content and Sample Volume QC Procedures

Gas stream moisture was determined by EPA Method 4 as part of the isokinetic stack gas tests. The following QC procedures were followed in determining the volume of moisture collected:

- The balance zero was checked and rezeroed if necessary before each weighing.
- The balance was leveled and placed in a clean, motionless environment for weighings.
- The indicating silica gel was fresh for each run and was inspected periodically and replaced during runs, if needed.

The QC procedures that were followed to ensure accurate sample gas volume determination were the following:

- The dry gas meter was fully calibrated annually using an EPA-approved intermediate standard device.
- Pretest, port-change, and posttest leakchecks were completed (must be less than 0.02 cfm or 4 % of the average sample rate).
- The gas meter was read to the thousandth of a cubic foot for all initial and final readings.
- Readings of the dry gas meter, meter orifice pressure (Delta H), and meter temperatures were taken at every sampling point.
- Accurate barometric pressures were recorded at least once per day.
- Pre- and posttest program dry gas meter checks were completed to verify the accuracy of the meter calibration constant (Y).

The most critical operating parameter for ambient air-sampling equipment was the airflow rate during sampling, which determines the total volume of air sampled. Calibrations of the ambient air-sampling equipment were performed to accurately determine the operating flow rates of the samplers, and to verify that all method-based flow-rate requirements were met.

All ambient air samplers were calibrated upon installation to establish the means for determining operating flow rates, and as required throughout the monitoring program whenever field calibration checks or repairs required recalibration. All calibrations were conducted according to standard operating procedures (SOP), using materials traceable to NIST reference materials. Calibrations were conducted by qualified personnel thoroughly familiar with the sampling equipment. All calibration and audit results were recorded in a field logbook and/or the calibration/audit data sheets. Other specific QA/QC for particulate, VOST, aldehydes and ketones, and CEMS are included in Appendix B.

5.1.2 Exhaust Gas Blank Samples

Stack gas blank samples consisted primarily of reagent blanks collected in the on-site sample recovery area during the test program. Reagent blanks included solvents used to recover stack samples, absorbing solutions, filters, and resins (Tenax, Tenax/charcoal). All reagent blanks were collected by transferring directly from storage containers to sample jars, or labeling filters and resins as blank samples.

For the VOST Method 0030* sampling trains, additional blank samples were taken in the field according to the following procedures. Blank Tenax and Tenax/charcoal cartridges were taken to the sampling location and the end caps removed for a period of time equal to the time required to exchange one pair of VOST tubes on the VOST train. After this time period, the end caps were replaced on the blank tubes and these tubes were handled in a manner similar to the other VOST tube

* 40 CFR 60 Appendix A

A blank Method 0011* (aldehydes and ketones) sample train was taken to the stack sample location, leak checked, and then recovered in the same manner as the Method 0011* stack samples.

The sampling media may contain small amounts of the target compounds emitted from naturally occurring or anthropogenic emission sources. Contamination may be introduced to the sampling media during handling of the media in the laboratory, in the field, or during shipping. Blank samples were used to quantify these sources of contamination. A blank sample consisted of a complete set of sampling media (e.g., a PUF cartridge and a glass fiber filter, or a complete ADS sampling train) that has had no air drawn through it by the sampling equipment. Field blank samples were collected during the monitoring program.

The field blanks were used to identify contamination resulting from field sample handling procedures. A field blank was handled in the same manner as an actual sample, undergoing the same preparation, installation in the sampler module, and recovery procedures.

The following stack sample blank corrections were performed.

- Particulate — Acetone and methylene chloride blank.
- VOST — Field and trip blanks.
- Aldehydes and Ketones — Reagent blanks.

5.2 SAMPLING CONTAINERS, PRESERVATIVES, AND VOLUME REQUIREMENTS

Table 5-2 lists the holding times, storage containers and preservation requirements used for routine storage and handling of samples.

5.3 DECONTAMINATION PROCEDURES

Stack-gas sampling equipment was precleaned following standard source test method procedures. All stack-gas sampling equipment was cleaned on site as part of individual sample recovery procedures.

TABLE 5-2. RECOMMENDED SAMPLE CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

SAMPLE LOCATION	ANALYTE	MATRIX	CONTAINER TYPE AND SIZE	PRESERVATION	HOLDING TIME
ENGINE EXHAUST	Particulate Condensable particulate Volatile organics Aldehydes and Ketones	Liquids, Filters, and resins Liquid	AG/500 mL AG/1.0 L G/40 mL AG/1L AG/1.0 L	NA NA ≤4 °C ≤4 °C ≤4 °C	NA NA 14 days 14 days to exit/40 days to analysis 14 days
AMBIENT	Particulate Volatile organics	Filter Whole air Filter/PUF	E S G/A	NA NA 4 ± 2°C	NA 30 days 7 days to exit/40 days to analysis

Key:

A= Aluminum Foil
AG = Amberglass
D = Denuder Tube
E = Envelope/Folder
G = Glass
NA = Not Applicable
P = Plastic
S = Stainless Steel Canister.

Sample containers were purchased from a vendor with a certificate indicating that each lot of bottles was free of contaminants.

All personnel associated with sample collection used designated personal protective equipment (PPE). Personnel followed standard PPE decontamination procedures for each level of PPE required.

All personnel received the proper hazardous materials training as specified in 29 CFR 1910.

5.4 SAMPLING PACKAGING AND SHIPMENT

All samples were packaged and shipped according to the specifications detailed in the Hazardous Materials Transportation Regulations published by the U.S. Department of Transportation (DOT) (49 CFR 171-180) for ground transportation and the International Air of collection, shipment, laboratory receipt, and laboratory custody until disposal was documented to accomplish this objective. Documentation was accomplished through a chain-of-custody record that documents each sample and the individuals responsible for Transport Association (IATA) regulations for air shipment. These regulations contain detailed instructions on how hazardous materials must be identified, packaged, marked, labeled, documented, and placarded. All personnel involved with sample shipment were trained and certified for shipment of hazardous materials.

When transferring possession of samples, the individuals relinquishing and receiving those samples signed, dated, and noted the time on the sample chain-of-custody record. This record documents sample transfer from the sampler, often through another person or commercial carrier, to the sample custodian or analyst.

The procedure for shipping samples was as follows:

- A complete sample inventory form (chain-of-custody) was enclosed with the samples being shipped, and a copy retained by the Field Team Leader.

- DOT and IATA regulations were followed for shipping container requirements. The regulations require that the shipper make a reasonable determination whether the sample is classified as a hazardous material and, if so, that it is appropriately identified.

- Each package was designed and constructed, and its contents limited, so that under normal transportation conditions there was no significant release of materials to the environment and no potentially hazardous conditions.
- Samples were placed inside a shipping container for transport back to the laboratory.
- Preservation of the samples (e.g., refrigerant packs, ice, chemical preservatives, etc.) was performed as required by the test plan or analytical requirements and documented on the sample inventory record.

All freight bills and shipping records were retained as part of the permanent records by the Project Manager.

5.5 CUSTODY PROCEDURES

An overriding consideration for environmental measurement data was the ability to demonstrate that samples have been obtained from the locations stated using the prescribed methods and that they have reached the laboratory without alteration. Evidence of collection, shipment, laboratory receipt, and laboratory custody until disposal was documented to accomplish this objective. Documentation was accomplished through a chain-of-custody record that documents each sample and the individuals responsible for sample collection, shipment, and receipt. A sample was considered "in custody " under the following conditions:

- It was in a person's actual possession.
- It was in view after being in physical possession.
- It was secured in a locked compartment so that no one could tamper with it after it had been in physical custody.
- It was in a secured area, restricted to authorized personnel.

5.5.1 Field Custody Procedures

Sample custody was initiated by EQ during collection of the samples. Preformatted labels were used at the time of collection. Documents prepared specifically for monitoring

field sample collection and recovery were used for recording pertinent information about the types and numbers of samples collected and shipped for analysis. The samples collected first were assembled at an on-site location for batching and paperwork checks. This task included matching similar sample types (e.g., solids, liquids) from all sampling locations. Sample packaging procedures complied with all DOT and IATA requirements for shipment of environmental samples. Establishing or maintaining sample integrity involved numerous steps or considerations in addition to custody documentation. For example, major concerns in programs of this nature were contamination, cross-contamination, and/or degradation of sample containers; absorbing and filtration media; recovery materials; and actual samples, as applicable. These problems were avoided or minimized at all times by using the following procedure:

- The lid of each labeled jar was secured with a strip of custody tape.
- Individual sample jars were then sealed in plastic bags and placed in appropriate shipping containers.
- Volatile materials were stored, handled, and transported apart from sorbent materials (e.g., store, handle, and ship VOST tubes apart from solvents [methylene chloride, acetone, toluene, etc.] used to recover the other sample trains).
- Volatile, organic, and aldehyde and ketone samples were sealed and kept away from sources of solvents, gasoline, etc., during recovery, transportation, storage, and analysis (e.g., recovery of particulate samples where acetone is used was performed remote from preparation, recovery, and storage of VOST and aldehyde and ketone samples).
- Vermiculite was placed around the bags in the shipping container for protection from damage, if needed. Ice was placed in the shipping container, if required.
- One chain-of-custody form was completed for each shipping container, placed in a large plastic bag, and the bag taped to the inside lid of the shipping container.
- The container was taped closed with tape and sealed with custody tape on two sides such that opening the container broke the custody tape.

Collected samples were kept under lock and key or within sight at all times until their shipment to the laboratory. The field sampler acted as the sample custodian and the

document control officer in order to monitor the location of collected samples and to record vital sample information in field logbooks.

A unique system for individual sample identification was used. Table 5-3 provides a legend of the identification system for stack gas samples and some examples. The identification code was included on each sample label.

A uniform sample identification system was used in the ambient air-monitoring program. All samples were identified using the following format:

U*ssssss* - *mmddyy* - *ppp(n)* - *qq*

Where

U	Indicates United States Air Force;
ssssss	Monitoring site designator: Operation mode and engine type (e.g., ATF101 - Approach, Tinker, F101-GE-102)
mm	Sample month, two digits
dd	Sample day of month, two digits
yy	Sample year, last two digits
ppp	Pollutant/media identification code (two or three characters): VOC - Volatile Organic Compounds PM - Particulate Matter PAH - Polynuclear Aromatic Hydrocarbons DNP - DNPH-coated annular denuder (aldehydes and ketones)
n	Sequence number, only used for multimedia sampling trains
qq	Quality assurance sample identifier (one or two characters): FB - Field blank

For example, a sample identified as UP-110599-PM-FB indicates the first particulate matter filter field blank at Lockheed Martin, which ran on 05 November 1999.

This naming convention allows every sample to be completely and consistently identified on the field data sheets, sample media labels, chain-of-custody forms, and laboratory reports. The naming convention was designed to provide redundant

TABLE 5-3. LEGEND FOR SAMPLE IDENTIFICATION SYSTEM

PROJECT NAME	MODE	SAMPLE LOCATION	RUN NUMBER	SAMPLE TYPE STACK SAMPLES	
				METHOD	FRACTION
AF (United States Air Force)	I (idle)	PF119 (Pratt & Whitney F119-PW-100)	1	M5 (particulate)	FHA (front half acetone)
	A (approach)		2	M0030 (volatiles)	Filt (filter)
	N (intermediate)		3	M0011 (aldehydes and ketones)	BHW (back half water)
	M (military)		FB (field blank)		BH $MeCl_2$ (back half $MeCl_2$)
	B (after burner)		TB (trip blank)		FHS (front half solvent)
	01 (other power setting 1)		D (duplicate)		BHS (back half solvent)
	02 (other power setting 2)				TP (tube pair)
	03 (other power setting 3)				COND (VOST condensate)
					SB (stack blank)
					TB (trip blank)

EXAMPLES: AF-A-PF119-1-M5-FHA = United States Air Force, Approach, Pratt & Whitney, F119-PW-100, Run 1, Method 5, Front Half Acetone

information that can be used in conjunction with laboratory media identification numbers to verify sample identity.

The final evidence file includes at a minimum the following:

- Field logbooks.
- Field data and data deliverables.
- Photographs.
- Drawings.
- Laboratory data deliverables.
- Data validation reports.
- Data assessment reports.
- Progress reports, QA reports, interim project reports, etc.
- All custody documentation (i.e., tags, forms, airbills, etc.).

5.6 CALIBRATION PROCEDURES AND FREQUENCY

This subsection describes the calibration procedures and the frequency at which these procedures were performed for both field and laboratory instruments.

5.6.1 Field Instrument Calibration

The following equipment items were calibrated before and after field usage:

- Velocity measurement devices.
- Gas flow rate metering systems.
- Gas volume metering equipment.
- Gas composition measuring apparatus (Orsat).

The calibration records include device numbers, calibration dates, methods, and data and results, and are maintained on file at the Weston laboratory. Copies of applicable calibration records also were available at the job site for review.

Acceptance limits are shown for each equipment item in Table 5-4.

5.7 DATA REDUCTION, VALIDATION, AND REPORTING

Data was produced primarily from three sources, specifically the following:

- Engine operations during the test program (classified information that was gathered and retained by Pratt & Whitney).

- Field measurements data, including sampling records (volumes and duration), and observations.
- Sample analysis and characterization data.

All data generated by field activities or by the laboratory was reduced and validated prior to reporting. Specific data reduction, validation and reporting procedures are described in the following subsections.

5.7.1 Data Reduction

5.7.1.1 Field Data Reduction Procedures

The stages of data confirmation began with an initial series of calculations completed on the same day as the sampling effort to establish that the pretest assumptions were correct and that the test procedures completed to that point were performed in an acceptable manner. This enabled the on-site test team to correct any faulty procedures, and provided a greater understanding of immediate problems. The on-site data reduction and confirmation activities were performed by an experienced data management specialist.

5.7.1.2 Office Calculations

All data averages were "double-checked" to verify numerical accuracy by an experienced technician. Prior to utilization of the analytical data for calculation of test results, a check was applied to ascertain any obvious "out-of-line" results for reanalysis. All results of calculations were examined by another individual as assigned by the Field Team Leader. Depending on the complexity of the work, this person either spot-checked certain calculations or repeated the entire effort as assigned by the Field Team Leader. When all data was summarized, a check was made for test result correctness by the Field Team Leader and by the EQ Program Manager. The EQ or Weston QA Manager

TABLE 5-4. ACTIVITY MATRIX FOR CALIBRATION OF EQUIPMENT[a]

APPARATUS	ACCEPTANCE LIMITS	FREQUENCY AND METHOD OF MEASUREMENT	ACTION IF REQUIREMENTS WERE NOT MET
Wet test meter	Capacity 3.4 m^3/hr (120 ft/hr); accuracy within ±1.0%	Calibrate initially, and then yearly by liquid displacement.	Adjust until specifications are met, or return to manufacturer.
Dry gas meter	$Y_1 = Y \pm 0.02\ Y$	Calibrate vs. wet test meter initially, and when posttest check exceeds Y ±0.05 Y	Repair, or replace and then recalibrate.
Thermometers	Impinger thermometer ±1°C (2°F); dry gas meter thermometer ±3°C (5.4°F) over range; stack temperature sensor ±1.5% of absolute temperature	Calibrate each initially as a separate component against a mercury-in-glass thermometer. Then before each field trip compare each as part of the train with the mercury-in-glass thermometer.	Adjust to determine a constant correction factor, or reject.
Probe heating system	Capable of maintaining 120° ± 14°C (248° ± 25°F) at a flow rate of 20 l/min (0.71 ft^3/ min)	Calibrate component initially by APTD-0576(11) if constructed by APTD-0581(10), or use published calibration curves.	Repair or replace and then reverify the calibration.
Barometer	±2.5 mm (0.1 in.) Hg of mercury-in-glass barometer	Calibrate initially vs. mercury-in-glass barometer; check before and after each field test.	Adjust to agree with a certified barometer.
Probe nozzle	Average of three ID measurements of nozzle; difference between high and low 0.1 mm (0.004 in.)	Use a micrometer to measure to nearest 0.025 mm (0.001 in.); check before field test.	Recalibrate, reshape, and sharpen when nozzle becomes nicked, dented, or corroded.
Type S pitot tube and/or probe assembly	All dimension specifications met, or calibrate according to Subsection 3.1.2, and mount in an interference-free manner	When purchased, use method in Subsections 3.1.1 and 3.1.2; visually inspect after each field test.	Do not use pitot tubes that do not meet face opening specifications; repair or replace as required.
Stack gas temperature measurement system	Capable of measuring within 1.5% of minimum absolute stack temperature	When purchased and after each field test, calibrate against ASTM thermometer.	Adjust to agree with Hg bulb thermometer, or construct a calibration curve to correct the readings.
Analytical balance	±1 mg of Class-S weights	Check with Class-S weights upon receipt.	Adjust or repair.

(continued)

TABLE 5-4 (continued)

APPARATUS	ACCEPTANCE LIMITS	FREQUENCY AND METHOD OF MEASUREMENT	ACTION IF REQUIREMENTS WERE NOT MET
Differential pressure gauge (does not include inclined manometers)	Agree within ±5% of incline manometers	Initially and after each field use.	Adjust to agree with inclined manometer or construct calibration curve to correct the readings.
Orsat analyzer	Average of three replicates should be 20.9 ± 0.5% (absolute) or known concentration ±0.5 (absolute)	Upon receipt and before any test in which the analyzer has not been checked during the previous 3 mo; determine % O_2 in ambient air, or use a calibration gas with known CO, CO_2, and O_2 concentrations	Check Orsat analyzer for leaking valves, spent absorbing reagent, and/or operator techniques. Repair or replace parts or absorbing solutions, and/or modify operator techniques.
Rotameter or rate meter	Smooth curve of rotameter actual flow rates with no evidence of error. ±5% of known flow rate.	Check with wet test meter or volume meter at 6-month intervals or at indication of erratic behavior.	Repeat calibration steps until limits were attained.

[a] EPA-600/9-76-005, *Quality Assurance Handbook for Air Pollution Measurement Systems - Volume III,* U. S. EPA, Office of Research and Development, Environmental Monitoring and Support Laboratory, Research Triangle Park, NC, January 1976, as revised.

conducted routine audits to document that the checks were being performed and documented (with checker's initials and date).

The initial field test data and resulting calculations were performed on a portable PC at the end of each test day. In the office, final results and result tables were developed on a microcomputer. Standard EPA method programs have been developed and validated for the computational systems to ensure that correct equations were utilized to generate results. The programs list all entry items (for proofing purposes) and produce calculated results in hard copy form. Reference method equations were used to calculate the concentration and/or mass rate of each measured parameter.

5.7.2 Analytical Data Validation Evaluation

All data was compared to the acceptance criteria of the reference method. For example, particulate tests must be 100% isokinetic, ±10%, to be acceptable. Laboratory data was acceptable only if calibration standards fell within the established control limits.

Outliers were treated on a case-by-case basis. All questionable data were reviewed in an attempt to find a reason for rejection.

Analytical data was appropriately qualified in the scientific and technical report. Case narratives were prepared, which include information concerning data that fell outside acceptance limits, and any other anomalous conditions encountered during sample analysis. After the Laboratory QA Officer approved these data, they were considered ready for data validation.

5.7.2.1 Procedures Used To Evaluate Field Data

Procedures used to evaluate field data included posttest field instrument calibration checks, acceptable isokinetic sampling rates, and demonstration of acceptable posttest leak checks.

5.7.3 Data Reporting

Data reporting procedures were performed for field operations as indicated in the following subsections.

5.7.3.1 Field Data Reporting

Field data reporting were conducted principally through the generation of test data tables containing tabulated results of all measurements made in the field, and documentation of all field calibration activities.

5.8 PREVENTIVE MAINTENANCE REVIEW

Well-maintained equipment was an essential ingredient in ensuring the quality, completeness, and timeliness of the field and analytical data. This subsection reviews the schedules of preventive maintenance that were performed to minimize the downtime for critical measurement systems for each contracting company. Also, lists of critical spare parts that were available at the individual field and laboratory sites was developed and reviewed. This subsection represents a review of the preventive maintenance items that were required for the field operations.

5.8.1 Field Instrument Preventative Maintenance

Field source testing equipment and instrumentation that required maintenance and/or calibration were serviced immediately prior to conducting the test program.

Normal spare parts (e.g., control consoles, sample boxes, probes, glassware, sample bottles, etc.) as well as extra materials/supplies (e.g., filters, solutions, solvents, XAD traps, etc.) were scheduled to be available at the field site during testing.

Extra spare parts and equipment for process sample collection and compositing equipment, glassware, sample containers, etc. were scheduled to be available at the field site during testing. Extra materials/supplies (e.g., filters, solvents, etc.) required for the process sample collection were also available at the field site during testing.

Sufficient volumes of protocol and calibration gases for the CEM monitoring, extra fittings, sample lines, pumps, heating tapes, and analyzer cells, along with sufficient materials/supplies (e.g., pump oil, filters, etc.) were available at the field site during testing.

5.9 CORRECTIVE ACTION

Corrective action was the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or procedures out of QC performance that could affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation, and data assessment. All corrective actions proposed and implemented was documented in the regular QA reports to management. Corrective action was implemented only after approval by the EQ Project Manager or his designee. If immediate corrective action was required, approvals secured from the EQ Project Manager were documented in an additional memorandum.

Depending on the nature of the problem, the corrective action may be formal or informal. In either case, occurrence of the problem, the corrective action performed, and verification that the problem had been resolved were documented. Whenever a corrective action was required, documentation was completed by the individual noting the problem and a copy was filed with the EQ Project Manager.

The shared effort for implementing the corrective action was the responsibility of the EQ Project Manager, the EQ QA Managers, and the Field Team Leaders.

Corrective actions were initiated when data quality problems were determined during the program. These data quality problems were flagged "out of control" if they were outside the predetermined limits specified above for internal, performance, system, and data audits. When discovered, prompt action toward a solution was undertaken by the generator of the data. The corrective action was conducted through the following six activities:

- Define the quality problem.
- Notify the designated individuals listed in the work plan.
- Determine the cause of the problem.

- Determine the corrective action.
- Implement the corrective action.
- Verify the solution to the problem.

Corrective action was instituted immediately by the individual noting a problem in a measurement system. An unresolved problem was reported to the EQ Project Manager and the EQ QA Managers for further action.

SECTION 6

RESULTS

F119-PW-100 aircraft engine exhaust emissions were characterized to determine the concentration, mass emission rate and emission factor relative to fuel flow for criteria and select hazardous air pollutants. Sampling was performed for nitrogen oxides (NO_X), carbon monoxide (CO), carbon dioxide (CO_2), non-methane hydrocarbons (NMHC), particulate matter (PM), particle size characterization, aldehyde and ketones and volatile organic compounds. Exhaust emission measurements were corrected for background ambient pollutant concentrations. Semi-volatile organic compounds, metals and sulfur dioxide emissions were not part of the scope or work for this engine. Historical aircraft engine emission sampling has noted that the semi-volatile analysis have provided non-detected and scattered detected values. Metals analysis have also shown mainly non-detect values, this was confirmed by an analysis of the fuel and particulate matter. Sulfur dioxide emissions are reported based on the procedure documented by AFIERA. This procedure estimates that sulfur dioxide in the fuel undergoes complete oxidation to SO_2. The sulfur content in JP-8 fuel was determined during testing to assure consistency with published results. The emission factor for SO_2 is provided in the report.

As part of the F119-PW-100 emission testing program, samples were collected directly behind the aircraft engine, at the end of the Augmentor tube where the engine exhaust exits the hush house, and in the slipstream duct. As described in section 2 and shown in Figure 2-6, a stainless steel rake with multiple sampling nozzles was installed directly behind the engine to collect gaseous, benzene and formaldehyde emissions data at the idle and approach engine settings. Near the end of the Augmentor tube, where the emissions exhaust the hush house, a stainless steel slipstream sampling system was installed to transfer the engine exhaust out of the hush house to a safe location for sampling. The slipstream rake, shown in Figure 2-9, consists of twelve

sample intake nozzles that were used to determine pollutant distribution in the augmentor tube and to collect a gaseous emission sample from each of the twelve points. After the slipstream had exited the hush house, the slipstream duct was utilized to extract manual samples for PM, aldehyde and ketones and volatile organic compounds. These sampling locations are referred to as the engine rake, slipstream rake and slipstream duct accordingly. The purpose of sampling at multiple locations was to study the pollutant mass emission rates as they traveled from the engine to the atmosphere and note if any secondary chemistry occurred during the residence time in the augmentor tube. The emissions data are discussed in this section.

6.1 GASEOUS POLLUTANTS

Gaseous emissions were collected at the engine rake (idle and approach settings only), slipstream rake and slipstream duct (during the shakedown runs only). The results of the sampling at each location is provided in the following sections.

6.1.1 Shakedown Runs

Prior to the actual emission test runs at each engine setting, a series of shakedown runs were performed to note gaseous pollutant concentrations, and air flows and to refine communication logistics. During the shakedown runs gaseous emissions data was collected for NO_X, CO, CO_2, O_2 and NMHC at 10% (idle), 20% (approach), 70% (intermediate), 100% (military) and 150% (afterburner) engine power at each of the 12 points on the slipstream rake. These sample results were used to determine if pollutant emission rates varied across the augmentor tube. During the shakedown runs, gaseous emissions were also collected directly behind the engine using a multi-point engine sampling rake during the 10% and 20% engine settings only. The engine rake had to be removed at the higher power settings to eliminate the potential for engine and/or hush house damage. At all power settings, gaseous emissions data was collected at the slipstream rake (which is located at the end of the augmentor tube) just

prior to the exhaust to the atmosphere and at a downstream location in the slipstream duct.

Tables 6-1 and 6-2 present the gaseous emissions data collected at the 10% and 20% engine power settings during the shakedown runs. Ambient, engine rake (directly behind the engine), slipstream rake (near the end of the hush house) and stack (near the end of the slipstream duct) pollutant data are compared. Carbon monoxide (CO) concentrations were measured higher at the engine rake when compared to the slipstream rake, due to the reaction of ambient air with exhaust gas to convert CO to CO_2.

Pollutant reaction from the engine to the hush house exhaust was noted in the NO_X data. NO continued to react with dilution air to form NO_2. This can be seen in the NO/NO_2 ratio. At the 10% engine setting the NO/NO_2 ratio is 0.9 at the engine rake and 0.4 at the slipstream rake. This indicates that there is more NO_2 present in the exhaust stream near the end of the augmentor tube. This same NO_X conversion is seen at the 20% power setting.

As the engine power was increased above 20% the engine sampling rake was removed. Gaseous data collected outside the hush house (ambient), at the slipstream rake and at the slipstream duct are presented in Tables 6-3 through 6-5 for engine power settings 70%, 100% and 150%. These data sets showed strong correlation between sampling points and demonstrated the typical trend in aircraft engine emissions. The CO emissions decreased significantly above 20% power and the NO_X emissions began to increase at the 70% power setting. NMHC emissions were extremely low which is a characteristic of the low by-pass improved combustor technology.

Just prior to commencement of the shakedown campaign, a gaseous emission data collection effort was performed in an attempt to note the power setting when CO emissions decrease and NO_X emissions increase. The idle, approach, intermediate, military and afterburner settings are separated by a relatively large amount of throttle

position and power. Table 6-6 contains the gaseous emissions data collected at the additional settings. The CO emissions begin to trend downward at 12% power with the largest decrease at the 15% power setting. Also, the NO_X emissions begin to increase above 20% power. These data are important with respect to ground idle emissions. CO emissions can be reduced by approximately 64% (by weight) by increasing the engine idle speed from 10% to approximately 15%+.

6.1.2 Gaseous Emission Factors

The emission factors for the F119-PW-100 engine are presented in Tables 6-7 and 6-8. As discussed previously in section 4 of this report, the hush house exhaust rate was determined using three methods. Carbon balance, tracer gas and F-factor methodologies were employed so that each method could be evaluated to note the most representative data set. At all settings the exhaust flow calculated by tracer gas provided the data set most comparable to historic data collected by Pratt & Whitney for the F119-PW-100. The emissions data collected were typical for engines in this class. Historic emission indexes for the F119-PW-100 engine were approximately 7.7 and 17.1 lbs/1000 lbs fuel for NO_X at idle and approach respectively. The data collected during this test program indicated NO_X emission factors of 3.0 and 6.6 lbs/1000 lbs fuel respectively. This comparable trend was noted for the remaining criteria pollutants also. At the intermediate, military and afterburner settings, tracer gas was the most representative method to determine the exhaust flow. The emissions data determined using the tracer gas flow methodology compared well with data provided by Pratt & Whitney for the F119-PW-100. At intermediate and military the CO emission factors provided by Pratt & Whitney were 0.8 and 0.7 lbs/1000 lbs fuel respectively. The data collected during this program yielded emission factors of 2.1 and 0.8 lbs/1000 lbs fuel for CO. Once again, the remaining pollutants provided similar comparisons. The NMHC results at the military and afterburner settings were non- detect since the recorded value was detected near the instrument detection level and due to correction

of data for analyzer drift and the ambient concentration, the corrected value dropped to zero.

Table 6-8 presents the emission factors determined at the engine rake for the idle and approach engine settings. The NOx and CO emission factors at the slipstream rake and engine rake were very comparable. At idle the NOx emission factors were 3.0 lbs/1000 lbs fuel and 1.9 lbs/1000 lbs/fuel for the slipstream rake and engine rake respectively. The CO emission factors at idle were 48.2 lbs/1000 lbs fuel at the slipstream rake and 76.1 lbs/1000 lbs fuel at the engine rake. At approach, the NOX and CO emission factors at the slipstream rake were 6.6 lbs/1000 lbs fuel and 7.9 lbs/1000 lbs fuel respectively. The NOx and CO emission factors at approach at the engine rake were 5.4 lbs/1000 lbs fuel and 7.3 lbs/1000 lbs fuel. At the idle and approach settings the CO was continuing to react in the augmentor tube to form CO_2. This was noted by a decrease in the mass of CO from the engine rake to the slipstream rake and an increase in CO_2 at the slipstream rake.

6.2 VOLATILE ORGANIC COMPOUNDS

Speciation of volatile organic compounds was performed at the hush house exhaust for each engine setting with the exception of afterburner. The highest emission rate of volatiles was at the idle setting. This has been the typical trend in historic engine emission testing. Due to the inefficiencies in engine operation at idle, unburned hydrocarbons tend to be present in the exhaust stream resulting in higher organic emissions. The VOC HAP total at idle was 0.36 lbs/1000 lbs fuel. The detected compounds at each setting were similar to the speciated HAPs determined in historical test programs. Typically, naphthalene, benzene, toluene, ethylbenzene, xylene and styrene were detected in the exhaust stream. This is the same trend noted in the exhaust stream of the F100 family of engines. A summary of the volatile emissions is provided in Tables 6-9 through 6-12.

6.2.1 Speciated Pollutant Comparison

Samples for benzene and formaldehyde were collected directly behind the engine and at the slipstream duct to note the variation in emissions at the idle and approach settings. The benzene emissions determined directly behind the engine are summarized in Table 6-14. These data compare very well to the benzene emission at the slipstream shown in Table 6-9. At idle the emission factor for benzene behind the engine was 0.12 lbs/1000 lbs fuel and 0.11 lbs/1000 lbs fuel at the slipstream. At the approach engine setting, the benzene emission factor was 0.003 lbs/1000 lbs fuel at the slipstream and the engine exhaust. Formaldehyde samples collected at the idle and approach setting behind the engine were compared to the formaldehyde data collected at the slipstream duct. These data are presented in Tables 6-13 and 6-15. The formaldehyde data collected behind the engine, shown in Table 6-15, provided an engine emission factor of 1.29 lbs/1000 lbs fuel at idle and 0.05 lbs/1000 fuel at approach. These data are very comparable to the formaldehyde data collected at the slipstream duct, which indicated an engine emission factor of 1.00 lbs/1000 lbs fuel at idle and 0.04 lbs/1000 lbs fuel at approach. Therefore both volatile compounds and aldehydes can be considered stable during mixing in the Augmentor tube and measurements collected at the slipstream duct can be considered representative of the engine emissions.

6.3 ALDEHYDE AND KETONES

Aldehyde and ketone data was collected at the slipstream duct for the idle, approach, intermediate and military settings. These data are summarized in Table 6-13. The emission rates were highest at the idle setting, which is consistent with the data trends seen in this program. Formaldehyde was the pollutant emitted in the highest quantity at 1.00 lbs/1000 lbs fuel at idle. As the engine moved from idle to the higher engine settings the emissions decreased accordingly. Formaldehyde emissions were 0.008 lbs/1000 lbs fuel at military.

6.4 POLLUTANT MIXING IN THE AUGMENTOR TUBE

Pollutant mixing in the Augmentor tube was examined through the use of 12 sampling points within the Augmentor tube fixed to the slipstream rake. The points were positioned according the to procedures in EPA Method 1 and are provided in Figure 6-1. By investigating the relationship between the tracer gas and emissions from the engine we could define the profile within the augmentor tube (at the point of collection, the slipstream rake) for both tracer gas mixing and engine emissions. At idle and approach CO was compared to SF_6, CO was chosen because of relative high concentration and resolution. NO_x was selected at intermediate and military because of its high concentration and resolution. The concentrations of SF_6 varied by 9%, 5% and 4% between the highest and lowest value observed from the 12 sampling points at idle, approach and intermediate, respectively. This indicated that SF_6 was well distributed with the ambient air entering the hush house and into the augmentor tube. The variance in CO concentrations was 17% and 12%, and for NO_X, 15% between high and low with the highest concentrations in the lower and central portion of the slipstream rake at idle, approach and intermediate, respectively. This indicated that exhaust flow from the engine was more laminar and combustion gas was centered in the augmentor tube. The variance in emissions does not impact sample collection since the gaseous emissions were collected at all 12 slipstream rake intake points and averaged and the inorganic and volatile samples were collected from the slipstream duct where there was a slight increase in concentration. The data showed at the tested conditions, that stratification of the engine exhaust was not significant.

At military, SF_6 showed stratification, as there was a 14% difference between the highest and lowest value observed from the 12 sampling points. NO_X show a 20% difference with the highest concentrations observed at the lower and central portion of the slipstream rake. At the military setting, the force of the engine exhaust developed a more stratified flow structure through the augmentor tube and the hush house as well, as indicated by the degraded mixing of SF_6 with the ambient air.

Though minimal stratification was present at all engine settings the data was not significantly biased (and if a bias exists it would generally favor higher emission rates) because for gaseous pollutants the integration of results from the 12 points was used and the inorganic and volatile samples were collected from the slipstream duct where there was a slight increase in concentration.

6.5 PARTICULATE MATTER

The total particulate emissions are presented in Tables 6-17 through 6-20. The results represent the total particulate, condensable and filterable, exiting the hush house. EQ was successful in capturing the entire particulate size range in the emission stream. A discussion of the method abnormalities is provided.

The particulate sampling methodology was improved in several ways over past sampling campaigns in order to improve the detection limit in the exhaust stream. EQ, USAF and Navy (SPAWAR SYSCEN D3621) personnel reviewed the historic sampling procedures and developed the following improvements:

- A smaller 47 mm diameter filter was used in the EPA Method 5 train. The intent was to have a lower filter tare weight and therefore have the ability to detect a small particulate gain since the gain in total weight would be a larger percentage of the filter tare weight.
- An analytical balance accurate to 5 decimal places (0.00001 grams) was used. This allowed for a more accurate gravimetric analysis since the method balance was accurate to 4 decimal places.
- The humidity of the weighing room was below 50% humidity.
- A real time particulate analyzer was used as a backup to the EPA Method 5 train to confirm particulate emission results.

The improvements made in the sampling and analytical scheme did not provide improved results. Due to the extremely low concentration of particulate matter in the engine exhaust stream, the filter gain after an extended test run with a large sample volume, was still insignificant using EPA Method 5. The EPA reference method is at or

below the detection limit in this application. The filter fraction of the sample resulted in negative particulate gain for two reasons. The recovery procedure, per the EPA Reference Method, requires the filter sample to be removed from the support frit and associated gasket which seals the filter holder. Due to the high sample vacuum in order to meet the extended sample volume requirements, the gasket would seal to the filter and pieces of the filter remained on the gasket during sample recovery. Therefore the filter material had to be scraped from the gasket. The second reason for the low weight gain from the filter analysis was that during sample collection, following the EPA Reference Method, the filter material was removed and deposited into the impinger solution during sample collection. The heating of the filter and the large volume of sample and vacuum applied to the filter resulted in minor filter loss. This was simulated at the WESTON laboratory and confirmed that filter material was lost and deposited in the impinger solution and appeared in the inorganic faction analysis results. Since filter material appears to have been lost and recovered in the impinger solution it is not known if the filters collection efficiency was also affected. This was also seen in the particulate sample results, when the filter lost weight, there was generally a proportional increase in the inorganic fraction of the condensable particulate matter.

The total particulate matter is presented and provides the best results based on the sampling anomalies. The filterable fraction consists only of the probe rinse and the condensable fraction (organic and inorganic) consists of the particulate that passes through the probe and filter, which also contains a small portion of the filter. Therefore the total particulate (consisting of probe rinse, inorganic and organic condensable sample factions) results may be the most representative emission index accounting for a portion the loss in filter material and potential particulates that could have migrated through the filter due to the potential decrease in collection efficiency.

Particulate emission results for this engine were comparable to historic data sets. The engine also noted a similar emission trend pattern. The emission index was highest at idle 2.5 lbs/1000 lbs fuel and averaged near 1.5 lbs/1000 lbs fuel for the

remaining settings. The variation in the data is the result of normal method variability. As a comparison, the particulate data for the F100-PW-100 engine was reviewed to note the similarities in the data sets. At idle the F100-PW-100 engine had and emission index of 2.8 lbs/1000 lbs fuel and for the test engine the factor is 2.5 lbs/1000 lbs fuel. At approach the F100-PW-100 emission factor is 1.97 lbs/1000 lbs fuel and for the test engine it is 2 lbs/1000 lbs fuel. At intermediate the emission factors were both 1.5 lbs/1000 lbs fuel for the F100-PW-100 and test engine respectively. At military the emission factors were 1.5 and 2.1 lbs/1000 lbs fuel for the F100-PW-100 and test engine respectively.

The real time particulate analyzer was unable to operate in the engine exhaust environment as set-up during this program. The vibration generated by the engine was amplified through the temporary structure the instrument was mounted on (temporary ductwork and scaffolding). This created difficulties in data collection and equipment operation as the instruments measurement principal is based on measurement of vibration. It is much more likely this method would have succeeded if the instrument would be been mounted in more stable test facility (engine test cell). The equipment failed in the field and was unable to record data. The equipment was able to collect, on an auxiliary filter, an isokinetic particulate sample for particle size distribution analysis.

6.5.1 Particle Characterization

As discussed earlier in this section, the real time particulate analyzer was used to collect an isokinetic sample for particle size analysis. The sample was collected on a silver membrane filter for analysis via scanning electron microscopy to count the particles in each size range. The results of the particle counts are provided in Table 6-18. The analysis determined that the majority of particulate matter (>97%) was below 10 microns in size with >70% of the particles at a diameter <2.5 microns. The pore size of the filter was 0.5 microns, therefore particles less than 0.5 microns in diameter may have passed through the filter. Additional analysis was performed to examine particles

less than 0.5 microns by transmission electron microscopy (TEM) and elemental analysis of particles less than 10 microns by automated SEM.

The relatively large particles (7.5 microns and larger) were determined to be angular brittle carbon particles which most likely have been heated and cooled and deposited on a surface such as the engine tail section or hush house augmentor tube and suspended during testing and deposited on the filter. These particles are not a combustion product during emission testing but a disturbed particle. Some of the remaining relatively large particles (1 to several microns) were carbon soot agglomerates. The "bundles" of particles consisted of carbon spheres with a diameter of 0.03 to 0.05 microns. Therefore, even though the size distribution indicates particles greater than 0.5 microns in diameter, a number of the particles are groups of smaller particles in the submicron size range. It appears that the majority of the particles >2.5 microns are groups of smaller particles in the 0.03 to 0.05 micron size range. As the fuel firing rate increases, the percentage of particles less than 2.5 microns also increases. These particles are primarily carbon soot. The submicron particles would be captured in the impinger solution of the EPA Method 5 sampling train.

The particle types consisted of silicon, sulfur and iron. There were small quantities of chrome and titanium present in select samples. There was large quantities of aluminum and silver present but these were thought to be a result of the silver membrane filter since a large quantity of these materials were verified on the filter blanks.

6.6 EXHAUST FLOW DETERMINATION

The engine exhaust flow was determined using several methods in order to provide an opportunity to review data sets and disregard outliers. Carbon balance, tracer gas and F-factor were used to determine the exhaust flow rate. The tracer gas methodology was not used to determine emissions directly behind the engine since the tracer gas could not be measured at the engine rake. The F-factor methodology tended

to fail at oxygen concentrations greater than 18.5%. The carbon balance and tracer gas flow calculation methods provided good correlation. The tracer gas data tended to provide a better comparison with historical flow and emissions data at all settings.

6.7 FUEL ANALYSIS

Fuel samples were collected during the emission test program from the fuel line feeding the engine. The fuel was analyzed to determine the presence of select metals. In each sample, small quantities of copper, zinc and phosphorous were present. In one sample a small quantity of nickel and thallium was present. The fuel analysis results represented in Table 6-22.

6.8 ENGINE OPERATION

During the emission test program, specific engine parameters were monitored to note engine performance. Pratt & Whitney personnel were responsible for collecting and maintaining the operating data and for operating the engine in a safe manner. A summary of the engine operation is provided in Table 6-23.

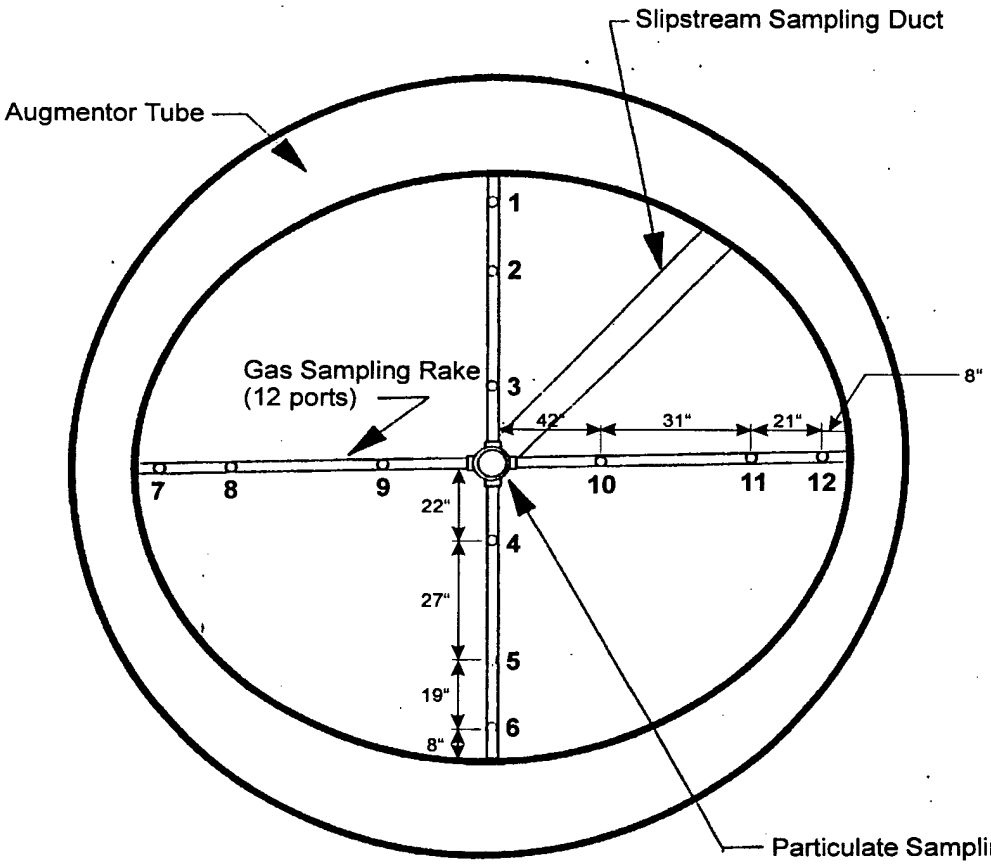


Figure 6-1. Augmentor Tube Sampling Rake (View from Test Engine)

EQ ENVIRONMENTAL QUALITY MANAGEMENT, INC.

TABLE 6-1.
F119-PW-100
GASEOUS EMISSIONS SUMMARY
10% POWER SETTING

Sampling Location	O_2	High CO_2	Low CO_2	NO	NO_2	NO_x	THC	NMHC	CH_4	CO	Amb. THC	Amb. CH_4	Virtual Ambient NMHC	Amb. CO_2
	dry %	dry %	dry ppm	dry ppm	dry ppm	dry ppm	wet ppm (as C_3H_8)	wet ppm (as C_3H_8)	wet ppm (as CH_4)	dry ppm	wet ppm (as C_3H_8)	wet ppm (as CH_4)	wet ppm (as C_3H_8)	wet ppm
Ambient	20.4	0.4	395	0.5	0.5	1.0	2.3	**1.4**	2.5	0.0	1.0	0.5	**0.8**	524
Engine Rake	18.4	1.6	Saturated	4.3	**4.8**	9.1	29.6	**28.2**	4.3	439.8	1.5	2.0	0.7	396
Slip Stream Rake	20.1	0.5	Saturated	0.5	1.4	2.0	6.1	**4.9**	3.5	52.6	1.0	2.1	**0.3**	370
Slip Stream Duct	20.2	0.5	Saturated	0.5	1.4	2.0	6.0	**4.8**	3.5	54.4	1.0	2.5	**0.2**	331

NOTE: Values entered in **BOLD** have been adjusted for internal consistentcy as follows;
Negative values (after calibration bias correction) have been increased to zero.
NMHC values have been adjusted to reflect the difference between the THC and methane values for both source and ambient locations.
NO2 values have been adjusted to reflect the difference between the measured Nox and NO values., except when ambient measurements are made.
For ambient measurements, the NO number was adjusted to reflect the difference between the NO2 and NOx values.

TABLE 6-2.
F119-PW-100
GASEOUS EMISSIONS SUMMARY
20% POWER SETTING

Sampling Location	O_2	High CO_2	Low CO_2	NO	NO_2	NO_x	THC	NMHC	CH_4	CO	Amb. THC	Amb. CH_4	Virtual Ambient NMHC	Amb. CO_2
	dry %	dry %	dry ppm	dry ppm	dry ppm	dry ppm	wet ppm (as C_3H_8)	wet ppm (as C_3H_8)	wet ppm (as CH_4)	dry ppm	wet ppm (as C_3H_8)	wet ppm (as CH_4)	wet ppm (as C_3H_8)	wet ppm
Ambient	20.7	0.3	367	**0.1**	0.9	1.0	1.3	**0.4**	2.5	**0.0**	1.0	4.2	**0.0**	416
Engine Rake	18.5	1.8	Saturated	23.7	**5.2**	28.9	4.0	**3.5**	1.5	63.9	1.0	3.9	**0.0**	368
Slip Stream Rake	20.3	0.5	Saturated	2.4	**1.4**	3.8	1.9	**1.0**	2.6	7.5	1.3	3.5	0.2	375
Slip Stream Duct	20.4	0.5	Saturated	2.8	**1.3**	4.1	2.0	**1.2**	2.5	4.9	1.0	4.4	**0.0**	320

NOTE: Values entered in **BOLD** have been adjusted for internal consistentcy as follows;
Negative values (after calibration bias correction) have been increased to zero.
NMHC values have been adjusted to reflect the difference between the THC and methane values for both source and ambient locations.
NO2 values have been adjusted to reflect the difference between the measured Nox and NO values., except when ambient measurements are made.
For ambient measurements, the NO number was adjusted to reflect the difference between the NO2 and NOx values.

TABLE 6-3.
F119-PW-100
GASEOUS EMISSIONS SUMMARY
70% POWER SETTING

Sampling Location	O_2	High CO_2	Low CO_2	NO	NO_2	NO_x	THC	NMHC	CH_4	CO	Amb. THC	Amb. CH_4	Virtual Ambient NMHC	Amb. CO_2
	dry %	dry %	dry ppm	dry ppm	dry ppm	dry ppm	wet ppm (as C_3H_8)	wet ppm (as C_3H_8)	wet ppm (as CH_4)	dry ppm	wet ppm (as C_3H_8)	wet ppm (as CH_4)	wet ppm (as C_3H_8)	wet ppm
Ambient	21.5	0.2	434	**0.6**	0.5	1.1	1.9	**0.9**	3.1	15.8	1.0	4.1	**0.0**	565
Slip Stream Rake	20.6	0.4	Saturated	10.4	**1.6**	12.0	1.5	**0.5**	3.1	3.4	1.3	5.5	**0.0**	453
Slip Stream Duct	21.0	0.5	Saturated	10.6	**1.7**	12.3	1.5	**0.5**	3.1	0.5	2.0	6.1	0.0	563

NOTE: Values entered in **BOLD** have been adjusted for internal consistentcy as follows;
Negative values (after calibration bias correction) have been increased to zero.
NMHC values have been adjusted to reflect the difference between the THC and methane values for both source and ambient locations.
NO2 values have been adjusted to reflect the difference between the measured Nox and NO values., except when ambient measurements are made.
For ambient measurements, the NO number was adjusted to reflect the difference between the NO2 and NOx values.

TABLE 6-4.
F119-PW-100
GASEOUS EMISSIONS SUMMARY
100% POWER SETTING

Sampling Location	O_2	High	Low	NO	NO_2	NO_x	THC	NMHC	CH_4	CO	Amb.	Amb.	Virtual	Amb.
		CO_2	CO_2								THC	CH_4	Ambient NMHC	CO_2
	dry %	dry %	dry ppm (Ambient)	dry ppm	dry ppm	dry ppm	wet ppm (as C_3H_8)	wet ppm (as C_3H_8)	wet ppm (as CH_4)	dry ppm	wet ppm (as C_3H_8)	wet ppm (as CH_4)	wet ppm (as C_3H_8)	wet ppm
Ambient	21.0	0.1	338	**0.2**	0.9	1.1	1.3	**0.4**	2.6	**0.0**	2.0	4.5	**0.5**	383
Slip Stream Rake	20.2	0.6	333	33.9	**1.4**	35.3	0.9	**0.4**	1.7	2.2	1.3	2.3	**0.6**	544
Slips Stream Duct	20.1	0.6	334	35.8	**1.7**	37.6	1.3	**0.4**	2.6	**0.0**	1.0	1.0	**0.7**	483

NOTE: Values entered in **BOLD** have been adjusted for internal consistentcy as follows;
Negative values (after calibration bias correction) have been increased to zero.
NMHC values have been adjusted to reflect the difference between the THC and methane values for both source and ambient locations.
NO2 values have been adjusted to reflect the difference between the measured Nox and NO values., except when ambient measurements are made.
For ambient measurements, the NO number was adjusted to reflect the difference between the NO2 and NOx values.

TABLE 6-5.
F119-PW-100
GASEOUS EMISSIONS SUMMARY
150% POWER SETTING

Sampling Location	O_2	High	Low	NO	NO_2	NO_x	THC	NMHC	CH_4	CO	Amb.	Amb.	Virtual	Amb.
		CO_2	CO_2								THC	CH_4	Ambient NMHC	CO_2
	dry %	dry %	dry ppm (Ambient)	dry ppm	dry ppm	dry ppm	wet ppm (as C_3H_8)	wet ppm (as C_3H_8)	wet ppm (as CH_4)	dry ppm	wet ppm (as C_3H_8)	wet ppm (as CH_4)	wet ppm (as C_3H_8)	wet ppm
Ambient	21.0	0.1	321	**0.2**	0.9	1.1	0.6	**0.0**	2.6	**0.0**	1.0	2.0	0.3	360
Slip Stream Duct	18.9	1.4	326	**0.0**	7.7	35.4	0.6	**0.0**	1.5	**127.3**	1.0	2.0	0.3	552

NOTE: Values entered in **BOLD** have been adjusted for internal consistentcy as follows;
Negative values (after calibration bias correction) have been increased to zero.
NMHC values have been adjusted to reflect the difference between the THC and methane values for both source and ambient locations.
NO2 values have been adjusted to reflect the difference between the measured Nox and NO values., except when ambient measurements are made.
For ambient measurements, the NO number was adjusted to reflect the difference between the NO2 and NOx values.

TABLE 6-6.
F119-PW-100
GASEOUS EMISSIONS SUMMARY
VARIOUS POWER SETTINGS
SLIPSTREAM RAKE

Power Setting	O_2	High CO_2	Low CO_2	NO	NO_2	NO_x	THC	NMHC	CH_4	CO	Amb. THC	Amb. CH_4	Virtual Ambient NMHC	Amb. CO_2
	dry %	dry %	dry ppm	dry ppm	dry ppm	dry ppm	wet ppm (as C_3H_8)	wet ppm (as C_3H_8)	wet ppm (as CH_4)	dry ppm	wet ppm (as C_3H_8)	wet ppm (as CH_4)	wet ppm (as C_3H_8)	wet ppm
10%	20.6	0.5	Saturated	**0.0**	2.0	2.0	12.0	**10.7**	3.9	59.0	2.3	5.6	**0.4**	348
12%	20.6	0.5	Saturated	0.0	2.0	2.0	5.4	**4.1**	3.9	35.6	2.3	4.5	**0.7**	451
15%	20.6	0.5	Saturated	0.5	**2.4**	2.9	3.6	**2.3**	3.9	21.4	2.3	5.6	**0.4**	410
20%	20.6	0.5	Saturated	1.6	**2.4**	3.9	1.8	**0.5**	3.9	4.6	1.9	4.0	**0.5**	475
65%	20.4	0.7	Saturated	9.8	**2.4**	12.2	1.8	**0.5**	3.9	**0.0**	2.3	4.5	**0.7**	469
70%	20.4	0.7	Saturated	11.9	**2.3**	14.2	1.8	**0.8**	2.9	**0.0**	1.9	4.5	**0.4**	324
80%	20.3	0.8	Saturated	17.1	**2.4**	19.5	1.8	**0.8**	2.9	**0.0**	2.3	4.0	**0.9**	416
100%	20.3	0.9	Saturated	38.9	**2.2**	41.0	1.8	**0.8**	2.9	**0.0**	1.9	4.5	**0.4**	317
150%	19.1	1.5	Saturated	32.6	**6.5**	39.1	11.4	**10.4**	2.9	87.5	2.3	4.5	**0.7**	390

NOTE: Values entered in **BOLD** have been adjusted for internal consistentcy as follows;
Negative values (after calibration bias correction) have been increased to zero.
NMHC values have been adjusted to reflect the difference between the THC and methane values for both source and ambient locations.
NO2 values have been adjusted to reflect the difference between the measured Nox and NO values., except when ambient measurements are made.
For ambient measurements, the NO number was adjusted to reflect the difference between the NO2 and NOx values.
All data collected at the slipstream rake.

TABLE 6-7.
F119-PW-100
SLIPSTREAM RAKE
EMISSION FACTOR SUMMARY

	Engine Mode																
	Idle			Approach			Intermediate			Military				Afterburner			
Flow Rate, dscfm	269029			663582			1458213			1823426				1832439			
Analyte	ppmvd	lb/hr	lbs/1,000 lbs fuel	ppmvd	lb/hr	lbs/1,000 lbs fuel	ppmvd	lb/hr	lbs/1,000 lbs fuel	ppmvd	lb/hr	lbs/1,000 lbs fuel		ppmvd	lb/hr	lbs/1,000 lbs fuel	
Nitrogen Oxide (NO)	0.5	0.68	0.49	2.4	7.44	2.72	10.4	70.86	7.01	33.9	230.98	12.41		28.0	190.78	3.80	
Nitrogen Dioxide (NO_2)	1.4	2.90	2.11	1.4	6.66	2.43	1.6	16.71	1.65	1.4	14.63	0.79		7.7	80.44	1.60	
Nitrogen Oxides (NO_x)	2	4.14	3.01	3.8	18.06	6.59	12.0	125.36	12.40	35.3	368.76	19.81		35.4	369.80	7.37	
Carbon Monoxide (CO)	52.6	66.30	48.15	7.5	21.71	7.92	3.4	21.62	2.14	2.2	13.99	0.75		127.0	807.67	16.10	
Net NMHC (as C_3H_8)	4.6	9.41	6.83	0.2	0.94	0.34	0.5	5.35	0.53	0.0	0.00	0.00	ND	0.7	9.27	0.18	ND
Carbon Dioxide (CO_2), a	0.5	4662	3386	0.5	9387	3426	0.4	36208	3581	0.6	54312	2918		1.4	126728	2526	
Sulfur Dioxide (SO_2)	NA	0.52	0.38	NA	1.04	0.38	NA	3.84	0.38	NA	7.07	0.38		NA	19.06	0.38	

ND - Value represents method detection limit. Compound may be present at a value less than the detection limit.
NA - SO2 rates determined from fuel sulfur content.
a - CO_2 data based on carbon balance flow determination.

(Flow By Tracer)

TABLE 6-8.
F119-PW-100
ENGINE RAKE
EMISSIONS FACTOR SUMMARY
(Flow By Carbon Balance)

	Engine Mode					
	Idle			Approach		
Flow Rate, dscfm	39648			71637		
Analyte	ppmvd[a]	lb/hr	lbs/1,000 lbs fuel	ppmvd[a]	lb/hr	lbs/1,000 lbs fuel
Nitrogen Oxide (NO)	4.3	0.80	0.58	23.7	7.93	2.90
Nitrogen Dioxide (NO_2)	4.8	1.36	0.99	5.2	2.67	0.97
Nitrogen Oxides (NO_X)	9.1	2.58	1.88	28.9	14.83	5.41
Carbon Monoxide (CO)	439.8	76.05	55.23	63.9	19.96	7.29
Net NMHC (as C_3H_8)	27.5	7.60	5.52	3.50	1.75	0.64
Carbon Dioxide (CO_2)	1.6	4347	3157	1.8	8836	3225
Sulfur Dioxide (SO_2)	NA	0.26	0.19	NA	0.52	0.19
a = ppm by volume, dry						
NA = Emissions determined by fuel sulfur content.						
Note: Engine Rake was used only at the Idle and Approach conditions.						

TABLE 6-9.
F119-PW-100
EMISSIONS FACTOR SUMMARY
VOLATILE ORGANIC COMPOUNDS (VOCs)
Idle
(Flow by Tracer)

Flow Rate, dscfm		Run Number 1					Run Number 2					Run Number 3					Average	
		280028					280029					280029						
Analyte	CAS Number	lb/hr Detected	lb/hr Detection Limit	lbs/1,000 lbs fuel Detected	lbs/1,000 lbs fuel Detection Limit		lb/hr Detected	lb/hr Detection Limit	lbs/1,000 lbs fuel Detected	lbs/1,000 lbs fuel Detection Limit		lb/hr Detected	lb/hr Detection Limit	lbs/1,000 lbs fuel Detected	lbs/1,000 lbs fuel Detection Limit		lb/hr	lbs/1,000 lbs fuel
Chloromethane H	74-87-3	0.00E+00		0.00E+00		J		0.00E+00		0.00E+00	UJ	0.00E+00		0.00E+00		J	0.00E+00	0.00E+00
Vinyl Chloride H	75-01-4		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.36E-04		4.79E-04	UJ	ND	ND
Bromomethane H	74-83-9		2.56E-03		2.33E-03	UJ		2.40E-03		2.19E-03	UJ		2.63E-03		2.40E-03	UJ	ND	ND
Chloroethane H	75-00-3		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
Freon 11 (Trichlorofluoromethane)	75-69-4	1.69E-03		1.73E-03		J	2.31E-03		2.10E-03		J	3.47E-03		3.18E-03		J	2.56E-03	2.33E-03
1,1-Dichloroethene H	75-35-4		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
Methylene Chloride H	75-09-2	9.29E-04		8.46E-04		J	0.00E+00		0.00E+00		J	1.15E-03		1.05E-03		J	6.93E-04	6.32E-04
1,1-Dichloroethane H	75-34-3		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
Chloroform H	67-66-3		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
1,1,1-Trichloroethane H	71-55-6		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
Carbon Tetrachloride H	56-23-5	4.40E-04		4.01E-04		J	3.75E-04		3.42E-04		J	5.15E-04		4.70E-04		J	4.43E-04	4.04E-04
Benzene H	71-43-2	1.54E-01		1.40E-01		J	1.30E-01		1.18E-01		J	1.52E-01		1.39E-01		J	1.45E-01	1.32E-01
1,2-Dichloroethane H	107-06-2		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
Trichloroethene H	79-01-6		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
1,2-Dichloropropane H	78-87-5		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
trans-1,3-Dichloropropene H	10061-02-6		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
Toluene H	108-88-3	9.21E-03		8.40E-03		J	8.17E-03		7.45E-03		J	8.94E-03		8.15E-03		J	8.77E-03	8.00E-03
cis-1,3-Dichloropropene H	10061-01-5		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
1,1,2-Trichloroethane H	79-00-5		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
Tetrachloroethene H	127-18-4	7.17E-04		6.53E-04		J	2.69E-04		2.45E-04		J		5.26E-04		4.79E-04	UJ	5.04E-04	4.59E-04
Chlorobenzene H	108-90-7		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
Ethyl Benzene H	100-41-4	2.35E-02		2.15E-02		J	2.21E-02		2.01E-02		J	2.21E-02		2.01E-02		J	2.26E-02	2.06E-02
m,p-Xylene H	108-38-3	5.63E-02		5.13E-02			5.29E-02		4.82E-02			5.26E-03		4.79E-03			5.39E-02	4.91E-02
o-Xylene H	95-47-6	3.84E-02		3.50E-02			3.84E-02		3.50E-02			3.84E-02		3.50E-02			3.84E-02	3.50E-02
Styrene H	100-42-5	4.40E-02		4.01E-02		J	4.18E-02		3.81E-02		J	4.31E-02		3.93E-02		J	4.30E-02	3.97E-02
1,1,2,2-Tetrachloroethane H	79-34-5		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
Acetone	67-64-1	0.00E+00		0.00E+00		J	0.00E+00		0.00E+00		J	0.00E+00		0.00E+00		J	0.00E+00	0.00E+00
Carbon Disulfide H	75-15-0		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
trans-1,2-Dichloroethene	156-60-5		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
Vinyl Acetate H	108-05-4		2.56E-03		2.33E-03	UJ		2.40E-03		2.19E-03	UJ		2.63E-03		2.40E-03	UJ	ND	ND
2 Butanone (MEK) H	78-93-3	0.00E+00		0.00E+00		J	0.00E+00		0.00E+00		J	0.00E+00		0.00E+00		J	0.00E+00	0.00E+00
Bromodichloromethane	75-27-4		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
4-Methyl-2-pentanone (MIBK) H	108-10-1		2.56E-03		2.33E-03	UJ		2.40E-03		2.19E-03	UJ		2.63E-03		2.40E-03	UJ	ND	ND
2 Hexanone	591-78-6		2.56E-03		2.33E-03	UJ		2.40E-03		2.19E-03	UJ		2.63E-03		2.40E-03	UJ	ND	ND
Dibromochloromethane (Chlorodibromomethane)	124-48-1		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
Bromoform H	75-25-2		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
cis-1,2-Dichloroethene	156-59-2		5.12E-04		4.67E-04	UJ		4.80E-04		4.38E-04	UJ		5.26E-04		4.79E-04	UJ	ND	ND
1,3 Butadiene H	106-99-0	3.99E-02		3.64E-02		J	7.68E-02		7.01E-02		J	8.94E-02		8.15E-02		J	6.87E-02	6.26E-02
BAP Total		4.59E-01		4.18E-01			4.44E-01		4.05E-01			4.89E-01		4.46E-01			4.61E-01	4.20E-01

ND - Compound not detected at this detection limit. Compound may be present at a value less than the detection limit
B - Compound present in the laboratory blank greater than reporting limit
E - Results are estimated, value reported is outside linear working range
Q - Exceeds quality control limits. (An example of this is the % spike recovery limit was not met.)
J - The associated numerical value is an estimated quantity because the reported concentrations were less than the required detection limits or quality control criteria were not met.
UJ - The analyte was not detected above the reported sample quantitation limit (reporting limit for the analytical method). However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample. This is due to the quality criteria not being met.
bb - The sample media blank and/or sample field blank value with bias times the sample value. Sample result should be considered suspect due to contamination.
H - This compound is listed as a hazardous air pollutant (HAP)

Results reported as 0.00 indicate a detected ambient pollutants concentration greater than the detected pollutant concentration in the exhaust stream.
Note: Compounds analyzed in this pollutant group are a standard compound target list for the analytical method and are not necessarily combustion by products from this engine

TABLE 6-10.
F119-PW-100
EMISSIONS FACTOR SUMMARY
VOLATILE ORGANIC COMPOUNDS (VOCs)
Approach
(Flow by Tracer)

		Run Number															
Flow Rate, dscfm		1 663582				2 663582				3 663582				Average	
		lb/hr		lbs/1,000 lbs fuel		lb/hr		lbs/1,000 lbs fuel		lb/hr		lbs/1,000 lbs fuel			
Analyte	CAS Number	Detected	Detection Limit	Detected	Detection Limit	Detected	Detection Limit	Detected	Detection Limit	Detected	Detection Limit	Detected	Detection Limit	lb/hr	lbs/1,000 lbs fuel
Chloromethane H	74-87-3	0.00E+00		0.00E+00		0.00E+00		0.00E+00		0.00E+00		0.00E+00	J	0.00E+00	0.00E+00
Vinyl Chloride H	75-01-4		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
Bromomethane H	74-83-9		6.33E-03		2.30E-03 ND		7.49E-03		2.73E-03 ND		6.51E-03		2.37E-03 ND	ND	ND
Chloroethane H	75-00-3		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
Freon 11 (Trichlorofluoromethane)	75-69-4	1.62E-03		5.89E-04		8.15E-03		2.97E-03		3.47E-03		1.26E-03		4.41E-03	1.61E-03
1,1-Dichloroethene H	75-35-4		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
Methylene Chloride H	75-09-2	0.00E+00		0.00E+00		0.00E+00		0.00E+00		0.00E+00		0.00E+00		0.00E+00	0.00E+00
1,1-Dichloroethane H	75-34-3		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
Chloroform H	67-66-3		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
1,1,1-Trichloroethane H	71-55-6		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
Carbon Tetrachloride H	56-23-5	1.04E-03		3.78E-04	J	1.35E-03		4.91E-04	J	8.34E-04		3.04E-04	J	1.07E-03	3.91E-04
Benzene H	71-43-2	8.36E-03		3.04E-03		1.12E-02		4.09E-03		7.82E-03		2.86E-03		9.13E-03	3.33E-03
1,2-Dichloroethane H	107-06-2		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
Trichloroethene H	79-01-6		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
1,2-Dichloropropane H	78-87-5		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
trans-1,3-Dichloropropene H	10061-02-6		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
Toluene H	108-88-3	8.11E-04		2.95E-04		1.39E-03		5.07E-04		0.00E+00		0.00E+00		7.35E-04	2.68E-04
cis-1,3-Dichloropropene H	10061-01-5		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
1,1,2-Trichloroethane H	79-00-5		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
Tetrachloroethene H	127-18-4		1.27E-03		4.61E-04 ND	1.09E-03		3.98E-04	J		1.30E-03		4.74E-04 ND	1.22E-03	4.45E-04
Chlorobenzene H	108-90-7		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
Ethyl Benzene H	100-41-4	6.96E-04		2.54E-04	J		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	1.17E-03	4.24E-04
m,p-Xylene H	108-38-3	1.65E-03		5.99E-04		1.65E-03		6.00E-04		1.30E-03		4.74E-04		1.53E-03	5.58E-04
o-Xylene H	95-47-6	1.01E-03		3.69E-04	J	9.13E-04		3.33E-04	J	7.17E-04		2.61E-04	J	8.81E-04	3.21E-04
Styrene H	100-42-5	6.96E-04		2.54E-04	J		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	1.17E-03	4.24E-04
1,1,2,2-Tetrachloroethane H	79-34-5		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
Acetone	67-64-1	0.00E+00		0.00E+00	J	0.00E+00		0.00E+00	J	0.00E+00		0.00E+00	J	0.00E+00	0.00E+00
Carbon Disulfide H	75-15-0		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
trans-1,2-Dichloroethene	156-60-5		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
Vinyl Acetate H	108-05-4		6.33E-03		2.30E-03 UJ		7.49E-03		2.73E-03 UJ		6.51E-03		2.37E-03 UJ	ND	ND
2-Butanone (MEK) H	78-93-3	0.00E+00		0.00E+00	R	0.00E+00		0.00E+00	R	0.00E+00		0.00E+00	R	0.00E+00	0.00E+00
Bromodichloromethane	75-27-4		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
4-Methyl-2-pentanone (MIBK) H	108-10-1		6.33E-03		2.30E-03 UJ		7.49E-03		2.73E-03 UJ		6.51E-03		2.37E-03 UJ	ND	ND
2-Hexanone	591-78-6		6.33E-03		2.30E-03 ND		7.49E-03		2.73E-03 ND		6.51E-03		2.37E-03 ND	ND	ND
Dibromochloromethane (Chlorodibromomethane)	124-48-1		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
Bromoform H	75-25-2		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
cis-1,2-Dichloroethene	156-59-2		1.27E-03		4.61E-04 ND		1.50E-03		5.45E-04 ND		1.30E-03		4.74E-04 ND	ND	ND
1,3-Butadiene H	106-99-0		6.33E-03		2.30E-03 ND		7.49E-03		2.73E-03 ND		6.51E-03		2.37E-03 ND	ND	ND
HAP Total		1.43E-02		5.19E-03		1.76E-02		6.42E-03		1.07E-02		3.89E-03		1.59E-02	6.16E-03

ND - Compound not detected at this detection limit. Compound may be present at a value less than the detection limit.
B - Compound present in the laboratory blank greater than reporting limit.
E - Results are estimated, value reported is outside linear working range.
Q - Exceeds quality control limits. (An example of this is the % spike recovery limit was not met.)
J - The associated numerical value is an estimated quantity because the reported concentrations were less than the required detection limits or quality control criteria were not met.
UJ - The analyte was not detected above the reported sample quantitation limit (reporting limit for the analytical method). However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample. This is due to the quality criteria not being met.
bb - The sample media blank and/or sample field blank value with two times the sample value. Sample result should be considered suspect due to contamination.
H - This compound is listed as a hazardous air pollutant (HAP).

Results reported as 0.00 indicate a detected ambient pollutant concentration greater than the detected pollutant concentration in the exhaust stream.
Note: Compounds analyzed in this pollutant group are a standard compound target list for the analytical method and are not necessarily combustion by-products from this engine.

TABLE 6-11.
F119-PW-100
EMISSIONS FACTOR SUMMARY
VOLATILE ORGANIC COMPOUNDS (VOCs)
Intermediate
(Flow by Tracer)

		Run Number											
		1					2					Average	
Flow Rate, dscfm		1458213					1458213						
		lb/hr		lbs/1,000 lbs fuel			lb/hr		lbs/1,000 lbs fuel				
Analyte	CAS Number	Detected	Detection Limit	Detected	Detection Limit		Detected	Detection Limit	Detected	Detection Limit		lb/hr	lbs/1,000 lbs fuel
Chloromethane [H]	74-87-3	0.00E+00		0.00E+00			0.00E+00		0.00E+00			0.00E+00	0.00E+00
Vinyl Chloride [H]	75-01-4		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
Bromomethane [H]	74-83-9		1.23E-02		1.21E-03	ND		1.39E-02		1.38E-03	ND	ND	ND
Chloroethane [H]	75-00-3		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
Freon 11 (Trichlorofluoromethane)	75-69-4	0.00E+00		0.00E+00			0.00E+00		0.00E+00			0.00E+00	0.00E+00
1,1-Dichloroethene [H]	75-35-4		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
Methylene Chloride [H]	75-09-2	0.00E+00		0.00E+00			0.00E+00		0.00E+00			0.00E+00	0.00E+00
1,1-Dichloroethane [H]	75-34-3		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
Chloroform [H]	67-66-3		2.45E-03		2.43E-04	ND	8.64E-04		8.54E-05		J	1.86E-03	1.64E-04
1,1,1-Trichloroethane [H]	71-55-6		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
Carbon Tetrachloride [H]	56-23-5	2.36E-03		2.33E-04		J	2.79E-03		2.76E-04			2.57E-03	2.54E-04
Benzene [H]	71-43-2	6.63E-03		6.56E-04			7.25E-03		7.17E-04			6.94E-03	6.86E-04
1,2-Dichloroethane [H]	107-06-2		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
Trichloroethene [H]	79-01-6		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
1,2-Dichloropropane [H]	78-87-5		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
trans-1,3-Dichloropropene [H]	10061-02-6		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
Toluene [H]	108-88-3	0.00E+00		0.00E+00			0.00E+00		0.00E+00			0.00E+00	0.00E+00
cis-1,3-Dichloropropene [H]	10061-01-5		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
1,1,2-Trichloroethane [H]	79-00-5		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
Tetrachloroethene [H]	127-18-4		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
Chlorobenzene [H]	108-90-7		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
Ethyl Benzene [H]	100-41-4	3.68E-03		3.64E-04			6.41E-03		6.34E-04			5.05E-03	4.99E-04
m,p-Xylene [H]	108-38-3	0.00E+00		0.00E+00			0.00E+00		0.00E+00			0.00E+00	0.00E+00
o-Xylene [H]	95-47-6	3.19E-03		3.16E-04			6.69E-03		6.62E-04			4.94E-03	4.89E-04
Styrene [H]	100-42-5		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
1,1,2,2-Tetrachloroethane [H]	79-34-5		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
Acetone	67-64-1	0.00E+00		0.00E+00		J	0.00E+00		0.00E+00		J	0.00E+00	0.00E+00
Carbon Disulfide [H]	75-15-0		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
trans-1,2-Dichloroethene	156-60-5		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
Vinyl Acetate [H]	108-05-4		1.23E-02		1.21E-03	ND		1.39E-02		1.38E-03	ND	ND	ND
2-Butanone (MEK) [H]	78-93-3	0.00E+00		0.00E+00		R	0.00E+00		0.00E+00		J	0.00E+00	0.00E+00
Bromodichloromethane	75-27-4		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
4-Methyl-2-pentanone (MIBK) [H]	108-10-1		1.23E-02		1.21E-03	ND		1.39E-02		1.38E-03	ND	ND	ND
2-Hexanone	591-78-6		1.23E-02		1.21E-03	ND		1.39E-02		1.38E-03	ND	ND	ND
Dibromochloromethane (Chlorodibromomethane)	124-48-1		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
Bromoform [H]	75-25-2		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
cis-1,2-Dichloroethene	156-59-2		2.45E-03		2.43E-04	ND		2.79E-03		2.76E-04	ND	ND	ND
1,3-Butadiene [H]	106-99-0	4.17E-03		4.13E-04		J	4.46E-03		4.41E-04		J	4.32E-03	4.27E-04
HAP Total		**2.00E-02**		**1.98E-03**			**2.85E-02**		**2.81E-03**			**2.55E-02**	**2.52E-03**

ND - Compound not detected at this detection limit. Compound may be present at a value less than the detection limit.
B - Compound present in the laboratory blank greater than reporting limit.
E - Results are estimated, value reported is outside linear working range.
Q - Exceeds quality control limits. (An example of this is the % spike recovery limit was not met.)
J - The associated numerical value is an estimated quantity because the reported concentrations were less than the required detection limits or quality control criteria were not met.
UJ - The analyte was not detected above the reported sample quantitation limit (reporting limit for the analytical method). However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample. This is due to the quality criteria not being met.
bb - The sample media blank and/or sample field blank value with two times the sample value. Sample result should be considered suspect due to contamination.
H - This compound is listed as a hazardous air pollutant (HAP).

Results reported as 0.00 indicate a detected ambient pollutant concentration greater than the detected pollutant concentration in the exhaust stream.
Note: Compounds analyzed in this pollutant group are a standard compound target list for the analytical method and are not necessarily combustion by-products from this engine.

TABLE 6-12.
F119-PW-100
EMISSIONS FACTOR SUMMARY
VOLATILE ORGANIC COMPOUNDS (VOCs)
Military
(Flow by Tracer)

		Run Number											
		1					2					Average	
Flow Rate, dscfm		1823426					1823426						
		lb/hr		lbs/1,000 lbs fuel			lb/hr		lbs/1,000 lbs fuel				
Analyte	CAS Number	Detected	Detection Limit	Detected	Detection Limit		Detected	Detection Limit	Detected	Detection Limit		lb/hr	lbs/1,000 lbs fuel
Chloromethane [H]	74-87-3	0.00E+00		0.00E+00			0.00E+00		0.00E+00		J	0.00E+00	0.00E+00
Vinyl Chloride [H]	75-01-4		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
Bromomethane [H]	74-83-9		1.61E-02		8.67E-04	ND		1.81E-02		9.72E-04	ND	ND	ND
Chloroethane [H]	75-00-3		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
Freon 11 (Trichlorofluoromethane)	75-69-4	1.94E-02		1.04E-03			2.24E-02		1.21E-03			2.09E-02	1.12E-03
1,1-Dichloroethene [H]	75-35-4		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
Methylene Chloride [H]	75-09-2	0.00E+00		0.00E+00			0.00E+00		0.00E+00			0.00E+00	0.00E+00
1,1-Dichloroethane [H]	75-34-3		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
Chloroform [H]	67-66-3		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
1,1,1-Trichloroethane [H]	71-55-6		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
Carbon Tetrachloride [H]	56-23-5	2.62E-03		1.41E-04		J	3.40E-03		1.83E-04		J	3.01E-03	1.62E-04
Benzene [H]	71-43-2	1.13E-02		6.07E-04			6.88E-03		3.70E-04			9.09E-03	4.88E-04
1,2-Dichloroethane [H]	107-06-2		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
Trichloroethene [H]	79-01-6		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
1,2-Dichloropropane [H]	78-87-5		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
trans-1,3-Dichloropropene [H]	10061-02-6		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
Toluene [H]	108-88-3	0.00E+00		0.00E+00			0.00E+00		0.00E+00			0.00E+00	0.00E+00
cis-1,3-Dichloropropene [H]	10061-01-5		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
1,1,2-Trichloroethane [H]	79-00-5		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
Tetrachloroethene [H]	127-18-4		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
Chlorobenzene [H]	108-90-7		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
Ethyl Benzene [H]	100-41-4	3.16E-03		1.70E-04		J		3.62E-03		1.94E-04	ND	3.39E-03	1.82E-04
m,p-Xylene [H]	108-38-3	7.75E-03		4.16E-04				3.62E-03		1.94E-04	ND	6.68E-03	3.05E-04
o-Xylene [H]	95-47-6	2.65E-03		1.42E-04				3.62E-03		1.94E-04	ND	3.13E-03	1.68E-04
Styrene [H]	100-42-5		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
1,1,2,2-Tetrachloroethane [H]	79-34-5		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
Acetone	67-64-1	0.00E+00		0.00E+00		J	0.00E+00		0.00E+00		J	0.00E+00	0.00E+00
Carbon Disulfide [H]	75-15-0	1.23E-03		6.59E-05		J	1.38E-03		7.39E-05		J	1.30E-03	6.99E-05
trans-1,2-Dichloroethene	156-60-5		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
Vinyl Acetate [H]	108-05-4		1.61E-02		8.67E-04	ND		1.81E-02		9.72E-04	ND	ND	ND
2-Butanone (MEK) [H]	78-93-3	0.00E+00		0.00E+00		R	0.00E+00		0.00E+00		R	0.00E+00	0.00E+00
Bromodichloromethane	75-27-4		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
4-Methyl-2-pentanone (MIBK) [H]	108-10-1		1.61E-02		8.67E-04	ND		1.81E-02		9.72E-04	ND	ND	ND
2-Hexanone	591-78-6		1.61E-02		8.67E-04	ND		1.81E-02		9.72E-04	ND	ND	ND
Dibromochloromethane (Chlorodibromomethane)	124-48-1		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
Bromoform [H]	75-25-2		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
cis-1,2-Dichloroethene	156-59-2		3.23E-03		1.73E-04	ND		3.62E-03		1.94E-04	ND	ND	ND
1,3-Butadiene [H]	106-99-0		1.61E-02		8.67E-04	UJ		1.81E-02		9.72E-04	UJ	1.71E-02	9.20E-04
HAP Total		**2.87E-02**		**1.54E-03**			**1.17E-02**		**6.26E-04**			**4.27E-02**	**2.30E-03**

ND - Compound not detected at this detection limit. Compound may be present at a value less than the detection limit.
B - Compound present in the laboratory blank greater than reporting limit.
E - Results are estimated, value reported is outside linear working range.
Q - Exceeds quality control limits. (An example of this is the % spike recovery limit was not met.)
J - The associated numerical value is an estimated quantity because the reported concentrations were less than the required detection limits or quality control criteria were not met.
UJ - The analyte was not detected above the reported sample quantitation limit (reporting limit for the analytical method). However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample. This is due to the quality criteria not being met.
bb - The sample media blank and/or sample field blank value with two times the sample value. Sample result should be considered suspect due to contamination.
H - This compound is listed as a hazardous air pollutant (HAP).

Results reported as 0.00 indicate a detected ambient pollutant concentration greater than the detected pollutant concentration in the exhaust stream.
Note: Compounds analyzed in this pollutant group are a standard compound target list for the analytical method and are not necessarily combustion by-products from this engine.

TABLE 6-13.
F119-PW-100
EMISSIONS FACTOR SUMMARY
SLIPSTREAM DUCT
ALDEHYDE/KETONES
(Flow by Tracer)

		Engine Mode																	
		Idle					Approach					Intermediate					Military				
Flow Rate, dscfm		269029					663682					1458213					1823426				
		lb/hr		lbs/1,000 lbs fuel			lb/hr		lbs/1,000 lbs fuel			lb/hr		lbs/1,000 lbs fuel			lb/hr		lbs/1,000 lbs fuel		
Analyte	CAS Number	Detected	Detection Limit	Detected	Detection Limit		Detected	Detection Limit	Detected	Detection Limit		Detected	Detection Limit	Detected	Detection Limit		Detected	Detection Limit	Detected	Detection Limit	
Formaldehyde [H]	50-00-0	1.37E+00		9.98E-01		J	9.75E-02		3.66E-02		J	2.47E-01		2.45E-02		J	1.41E-01		7.59E-03		J
Acetaldehyde [H]	75-07-0	1.53E-01		1.11E-01		J	1.85E-02		6.76E-03		J	2.64E-02		2.61E-03		J	1.55E-02		8.31E-04		J
Acrolein [H]	107-02-8	4.96E-02		3.60E-02		J		3.66E-02		1.33E-02	UJ		1.65E-02		1.63E-03	UJ		3.44E-02		1.85E-03	UJ
Acetone	67-64-1	3.21E-01		2.33E-01		J	1.17E+00		4.27E-01		J	6.26E-01		6.20E-02		J	9.93E-01		5.33E-02		J
Propanal	123-38-6	2.21E-02		1.61E-02		J		3.66E-02		1.33E-02	UJ	9.89E-03		9.78E-04		J	7.64E-03		4.10E-04		J
Crotonaldehyde	4170-30-3	3.66E-02		2.66E-02		J		3.66E-02		1.33E-02	UJ		1.65E-02		1.63E-03	UJ		3.44E-02		1.85E-03	UJ
Isobutyraldehyde / Methyl Ethyl Ketone [H]	78-93-3	9.16E-02		6.65E-02		J		3.66E-02		1.33E-02	UJ		1.65E-02		1.63E-03	UJ		3.44E-02		1.85E-03	UJ
Benzaldehyde	100-52-7	5.72E-02		4.16E-02		J		3.66E-02		1.33E-02	UJ		1.65E-02		1.63E-03	UJ		3.44E-02		1.85E-03	UJ
Isopentanal (Isovaleraldehyde)	590-86-3		6.49E-02		4.71E-02	UJ		3.66E-02		1.33E-02	UJ		1.65E-02		1.63E-03	UJ		3.44E-02		1.85E-03	UJ
Pentanal (Valeraldehyde)	110-62-3		6.49E-02		4.71E-02	UJ		3.66E-02		1.33E-02	UJ		1.65E-02		1.63E-03	UJ		3.44E-02		1.85E-03	UJ
o-Tolualdehyde	529-20-4	3.82E-02		2.77E-02		J		3.66E-02		1.33E-02	UJ		1.65E-02		1.63E-03	UJ	8.02E-03		4.31E-04		J
m,p-Tolualdehyde	620-23-5	2.63E-02		1.91E-02		J		3.66E-02		1.33E-02	UJ	1.19E-02		1.17E-03		J	3.05E-03		1.64E-04		J
Hexanal (Hexaldehyde)	104-87-0		6.49E-02		4.71E-02	UJ		3.66E-02		1.33E-02	UJ		1.65E-02		1.63E-03	UJ		3.44E-02		1.85E-03	UJ
HAP Total		**1.67E+00**		**1.21E+00**			**1.16E-01**		**4.24E-02**			**2.74E-01**		**2.71E-02**			**1.57E-01**		**8.42E-03**		

ND - Compound not detected at this detection limit. Compound may be present at a value less than the detection limit.
A - The associated numerical value is accepted. Procedures from which value was obtained meets the quality control criteria as defined by the DQAP.
B - Compound present in the laboratory blank greater than reporting limit.
E - Results are estimated, value reported is outside linear working range.
Q - Exceeds quality control limits. (An example of this is the % spike recovery limit was not met.)
J - The associated numerical value is an estimated quantity because the reported concentrations were less than the required detection limits or quality control criteria were not met.
UJ - The analyte was not detected above the reported sample quantitation limit (reporting limit for the analytical method). However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample. This is due to the quality criteria not being met.
bb - The sample media blank and/or sample field blank value with two times the sample value. Sample result should be considered suspect due to contamination.
H - This compound is listed as a hazardous air pollutant (HAP).

Results reported as 0.00 indicate a detected ambient pollutant concentration greater than the detected pollutant concentration in the exhaust stream.
Note: Compounds analyzed in this pollutant group are a standard compound target list for the analytical method and are not necessarily combustion by-products from this engine.

TABLE 6-14.
F119-PW-100
EMISSIONS FACTOR SUMMARY
ENGINE RAKE
BENZENE
(Flow by Carbon Balance)

	Engine Mode			
	Idle		Approach	
Flow Rate, dscfm	39646		71633	
Analyte	lb/hr	lbs/1,000 lbs fuel	lb/hr	lbs/1,000 lbs fuel
Benzene	1.66E-01	1.21E-01	8.31E-03	3.03E-03

ND - Compound not detected. Value is the method detection limit.
A - The associated numerical value is accepted. Procedures from which value was obtained meets the quality control criteria as defined by the DQAP.
B - Compound present in the laboratory blank greater than reporting limit.
E - Results are estimated, value reported is outside linear working range.
Q - Exceeds quality control limits.
J - The associated numerical value is an estimated quantity because the reported concentrations were less than the required, detection limits or quality control criteria were not met.
UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample. This is due to the quality criteria not being meet.
bb - The sample media blank and/or sample field blank value with two times the sample value. Sample result should be considered suspect due to contamination.

TABLE 6-15.
F119-PW-100
EMISSIONS FACTOR SUMMARY
ENGINE RAKE
ALDEHYDE/KETONES
(Flow by Carbon Balance

		Engine Mode								
		Idle				Approach				
Flow Rate, dscfm		39646				71633				
Analyte		lb/hr		lbs/1,000 lbs fuel		lb/hr		lbs/1,000 lbs fuel		
Formaldehyde		1.78E+00		1.29E+00		1.40E-01		5.09E-02		
Acetaldehyde		6.68E-01	B	4.85E-01	B	6.44E-02	B	2.35E-02	B	
Acrolein		0.00E+00		0.00E+00		0.00E+00		0.00E+00		
Acetone		1.63E-01		1.19E-01		1.40E-02		5.09E-03		
Propanal		1.49E-01	<	1.08E-01	<	2.25E-02	J	8.23E-03	J	
Crotonaldehyde		1.63E-02	J	1.19E-02	J	7.41E-03		2.70E-03		
Isobutyraldehyde / Methyl Ethyl Ketone	c	1.19E-01		8.63E-02		1.93E-02	J	7.05E-03	J	
Benzaldehyde		1.35E-01		9.81E-02		1.18E-02		4.31E-03		
Isopentanal (Isovaleraldehyde)		3.71E-02	U	2.70E-02	U	2.68E-03	U	9.79E-04	U	
Pentanal (Valeraldehyde)		3.71E-02	U	2.70E-02	U	2.15E-03	J	7.83E-04	J	
o-Tolualdehyde		1.05E-01		7.66E-02		3.11E-03		1.14E-03		
m,p-Tolualdehyde		6.24E-02		4.53E-02		9.34E-03		3.41E-03		
Hexanal (Hexaldehyde)		6.09E-02		4.42E-02		3.97E-03		1.45E-03		

ND - Compound not detected. Value is the method detection limit.
A - The associated numerical value is accepted. Procedures from which value was obtained meets the quality control criteria as defined by the DQAP.
B - Compound present in the laboratory blank greater than reporting limit.
E - Results are estimated, value reported is outside linear working range.
Q - Exceeds quality control limits.
J - The associated numerical value is an estimated quantity because the reported concentrations were less than the required, detection limits or quality control criteria were not met.
UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample. This is due to the quality criteria not being meet.
bb - The sample media blank and/or sample field blank value with two times the sample value. Sample result should be considered suspect due to contamination.
Results reported as 0.00 indicate a detected ambient pollutant concentration greater than the detected pollutant in the exhaust stream.
MEK and isobutyraldehyde result in overlapping peaks during analysis. Result could be either compound or combination of both.
c- Analytical "peaks" overlap preventing determination of a single compound. Result could be either compound or combination of both.

TABLE 6-16.
F119-PW-100
SLIPSTREAM RAKE INTAKE
SAMPLE POINT DATA COMPARISON

	Idle		Approach		Intermediate		Military	
Sample Point	CO (ppm)	SF_6 (ppm)	CO (ppm)	SF_6 (ppm)	NOx (ppm)	SF_6 (ppm)	NOx (ppm)	SF_6 (ppm)
1	53.0	0.265	8.5	0.104	11.0	0.102	29.5	0.097
2	53.5	0.259	8.5	0.107	10.0	0.104	30.0	0.086
3	55.5	0.260	9	0.111	11.0	0.104	32.0	0.084
4	58.0	0.249	9	0.109	12.0	0.103	36.5	0.083
5	60.0	0.247	9	0.108	12.0	0.103	37.5	0.084
6	62.0	0.249	9	0.109	12.0	0.103	37.0	0.083
7	54.0	0.250	8	0.109	10.0	0.107	30.0	0.085
8	53.0	0.255	8.5	0.112	10.0	0.105	30.0	0.086
9	54.5	0.248	8.5	0.112	10.0	0.106	32.0	0.083
10	54.0	0.245	8.5	0.109	10.0	0.105	34.0	0.079
11	49.5	0.234	8	0.107	10.0	0.103	32.0	0.080
12	47.5	0.239	8.5	0.107	10.0	0.103	31.5	0.077
Maximum	62.0	0.265	9.0	0.112	12.0	0.107	37.5	0.097
Minimum	47.5	0.234	8.0	0.104	10.0	0.102	29.5	0.077

TABLE 6-17.
F119-PW-100
EMISSIONS FACTOR SUMMARY
PARTICULATES
Idle
(Flow by Tracer)

	Run Number							
	1		2		3		Average	
Flow Rate, dscfm	289029		289029		289029			
Analyte	lb/hr	lbs/1,000 lbs fuel	lb/hr	lbs/1,000 lbs fuel	lb/hr	lbs/1,000 lbs fuel	lb/hr	lbs/1,000 lbs fuel
Particulate (total)	3.999	2.904	3.216	2.336	3.082	2.238	3.433	2.493

TABLE 6-18.
F119-PW-100
EMISSIONS FACTOR SUMMARY
PARTICLES
Approach
(Flow by Tracer)

	Run Number							
	1		2		3		Average	
Flow Rate, dscfm	663582		663582		663582			
Analyte	lb/hr	lbs/1,000 lbs fuel	lb/hr	lbs/1,000 lbs fuel	lb/hr	lbs/1,000 lbs fuel	lb/hr	lbs/1,000 lbs fuel
Total Particulate	4.339	1.580	8.242	3.001	3.894	1.418	5.492	2.000

TABLE 6-19.
F119-PW-100
EMISSIONS FACTOR SUMMARY
PARTICULATES
Intermediate
(Flow by Tracer)

	Run Number					
	1		2		Average	
Flow Rate, dscfm	1458213		1458213			
Analyte	lb/hr	lbs/1,000 lbs fuel	lb/hr	lbs/1,000 lbs fuel	lb/hr	lbs/1,000 lbs fuel
Particulate (total)	15.091	1.493	13.387	1.324	14.239	1.408

TABLE 6-20.
F119-PW-100
EMISSIONS FACTOR SUMMARY
PARTICULATES
MILITARY
(Flow by Tracer)

	Run Number					
	1		2		Average	
Flow Rate, dscfm	1823426		1823426			
Analyte	lb/hr	lbs/1,000 lbs fuel	lb/hr	lbs/1,000 lbs fuel	lb/hr	lbs/1,000 lbs fuel
Particulate (total)	15.686	0.843	26.157	1.405	20.921	1.124

TABLE 6-21
F119-PW-100
PARTICLE SIZE DISTRIBUTION

Particle Size	Engine Setting					
Range (um) [a]	Idle (%)	Approach (%)	Intermediate (%)	Military (%)		
0.5 - < 2.5	70.5	86.3	77.8	86.6		
2.5 - < 5	15.8	5.8	14.7	8.6		
5 - < 7.5	6.5	2.9	4.3	2.4		
7.5 - <= 10	4.3	2.7	3	1.7		
> 10	2.9	2.4	0.7	0.7		
a - Based on aerodynamic particle diameter.						
NOTES:						
Percentages shown based on particle count in each size range.						
Blank analysis showed no filter contamination.						
The majority of the particles > 2.5 um appear to be groups of smaller particles in the 0.03 - 0.05 um range.						

TABLE 6-22
F119-PW-100
JP-8 FUEL METALS ANALYSIS

Compound	Sample Number JP8-1 (PPM)	JP8-2 (PPM)
Antimony	ND	ND
Arsenic	D	ND
Barium	ND	ND
Beryllium	ND	ND
Cadmium	ND	ND
Chromium	ND	ND
Cobalt	ND	ND
Copper	0.054	0.03
Lead	ND	ND
Manganese	ND	ND
Mercury	ND	ND
Nickel	0.038	ND
Selenium	ND	ND
Silver	ND	ND
Thallium	ND	0.0075
Zinc	0.058	0.029
Phosphorus	0.35	0.17

TABLE 6-23.
F119-PW-100
EMISSIONS OPERATIONS SUMMARY

Engine Type	Operation Mode	Fuel flow, lbs/hr	Average Thrust, lbs 1	% Maximum Thrust 1	Engine Pressure Ratio 1
F119-PW-100	Idle	1,377			
	Approach	2,740			
	Intermediate	10,110			
	Military	18,612			
	Afterburner	50,170			
1 Not included as part of this report.					

APPENDIX A

RAW FIELD DATA

THIS PAGE INTENTIONALLY LEFT BLANK

FIELD DATA SHEET

Method 0030 - Volatile Organics

Page ___ of ___

Client	USAF/EQM	Run No.	1	Meter Box ID	Vost 4	TENAX Tube Sample Numbers	
W.O.#	3214-008-040	Test Method	M0030	Meter Box Y	0.9947	Set One	15007
Project ID	AF	Date	4-12-00	Probe ID/Length	3	Set Two	
Mode/Source ID	I	Baro. Press (in Hg)	29.06	Probe Material	Boro	Set Three	
Samp. Loc.	LMF119	Ambient Temp (°F)	87			Set Four	
Source	F22 Engine	Operator	[illegible]			Set Five	
		Sample Time	40			Set Six	

Comments:

Leak Checks (liters/min @ in Hg Vac)

	Set One	Set Two	Set Three	Set Four	Set Five	Set Six	Stack Blank
Initial	0.0@5"						
Final	0.0@2"						

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	ROTOMETER SETTING	ORIFICE PRESSURE Delta H (in H_2O)	DRY GAS METER READING (liters)	DGM INLET TEMP (°C)	DGM OUTLET TEMP (°C)	PROBE TEMP (°C)	SAMPLE TRAIN VAC (in Hg)	FIRST COND. EXIT TEMP (°C)	SECOND COND. EXIT TEMP (°C)		COMMENTS
	0	1047			1963.86								
	5		54	1.2	1967.50	33	N/A	131	1	14	19		
	10		41	1.2	1970.61	34		130	1	15	20		
	15		41	1.2	1973.5	35		132	1	16	20		
	20		41	1.2	1976.5	37		135	1	17	21		
	25		41	1.2	1979.6	38		137	1	16	21		
	30		40	1.2	1982.0	39		138	1	16	20		
	35		35	1.2	1984.56	40		141	1	15	20		
	40	1127	35	1.2	1986.97	41		142	1	16	21		
				Avg Delta H	Total Volume	Avg Tm		Max Temp	Max Vac	Max Temp	Max Temp		
				1.2	23.11	37.125		142	1	16	21		

WESTON MANAGERS DESIGNERS/CONSULTANTS

FIELD DATA SHEET

Method 0030 - Volatile Organics

Page ____ of ____

Client	USAF/EQM	Run No.	2	Meter Box ID	Vost 4	TENAX Tube Sample Numbers	
W.O.#	3214-008-040	Test Method	M0030	Meter Box Y	0.9947	Set One	150113
Project ID	AF	Date	9.12.00	Probe ID/Length	3	Set Two	
Mode/Source ID	I	Baro. Press (in Hg)	29.06	Probe Material	Boro	Set Three	
Samp. Loc.	LMF119	Ambient Temp (°F)	88			Set Four	
Source	F22 Engine	Operator	NJS			Set Five	
		Sample Time	40			Set Six	
Comments:						Stack Blank	

Leak Checks (liters/min @ in Hg Vac)

	Set One	Set Two	Set Three	Set Four	Set Five	Set Six
Initial	.1@2					
Final	.0@2					

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	ROTOMETER SETTING	ORIFICE PRESSURE Delta H (in H_2O)	DRY GAS METER READING (liters)	DGM INLET TEMP (°C)	DGM OUTLET TEMP (°C)	PROBE TEMP (°C)	SAMPLE TRAIN VAC (in Hg)	FIRST COND. EXIT TEMP (°C)	SECOND COND. EXIT TEMP (°C)		COMMENTS
	0	1151			1989.525								
	5		35	1.2	1992.3	N/A	43	143	1	19	22		
	10		38	1.2	1995.2		43	135	1	17	21		
	15		40	1.2	1998.1		43	137	1	16	20		
	20		41	1.2	2001.25		44	146	1	18	21		
	25		43	1.2	2004.55		45	149	1	17	20		
	30		44	1.2	2007.85		45	152	1	17	20		
	35		45	1.3	2011.80		46	147	1	18	21		
	40	1231	46	1.3	2014.720		46	150	1	19	20		
				Avg Delta H	Total Volume	Avg Tm		Max Temp	Max Vac	Max Temp	Max Temp		
				1.225	25.195	44.375		150	1	19	22		

WESTON MANAGERS ENGINEERS/CONSULTANTS

FIELD DATA SHEET

Method 0030 - Volatile Organics

Page ____ of ____

Client	USAF/EQM	Run No.	3	Meter Box ID	Vost 4	TENAX Tube Sample Numbers	
W.O.#	3214-008-040	Test Method	M0030	Meter Box Y	0.9947	Set One	15016
Project ID	AF	Date	9.12.00	Probe ID/Length	3	Set Two	
Mode/Source ID	1	Baro. Press (in Hg)	29.06	Probe Material	Boro	Set Three	
Samp. Loc.	LMF119	Ambient Temp (°F)	90			Set Four	
Source	F22 Engine	Operator	WBL			Set Five	
		Sample Time	40			Set Six	

Comments:

Leak Checks (liters/min @ in Hg Vac)

	Set One	Set Two	Set Three	Set Four	Set Five	Set Six
Initial	0.0 @ 2"					
Final	0.0 @ 2"					

Stack Blank 15008

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	ROTOMETER SETTING	ORIFICE PRESSURE Delta H (in H_2O)	DRY GAS METER READING (liters)	DGM INLET TEMP (°C)	DGM OUTLET TEMP (°C)	PROBE TEMP (°C)	SAMPLE TRAIN VAC (in Hg)	FIRST COND. EXIT TEMP (°C)	SECOND COND. EXIT TEMP (°C)		COMMENTS
	0	1249			2017.615								
	5		37	1.2	2020.65	N/A	45	148	1	18	22		
	10		41	1.2	2023.7		46	148	1	17	22		
	15		40	1.2	2026.6		47	147	1	19	21		
	20		40	1.2	2029.5		46	142	1	17	20		
	25		39	1.2	2032.4		47	146	1	17	20		
	30		39	1.2	2035.2		46	150	1	19	20		
	35		39	1.2	2038.1		46	153	1	19	20		
	40	1329	39	1.2	2040.770		46	153	1	18	20		
				Avg Delta H	Total Volume	Avg Tm		Max Temp	Max Vac	Max Temp	Max Temp		
				1.20	23.155	46.175		153	1	19	22		

WESTON MANAGERS DESIGNERS/CONSULTANTS

FIELD DATA SHEET

Method 0030 - Volatile Organics

Page ____ of ____

Client	USAF/EQM	Run No.	1	Meter Box ID	Vost 4	TENAX Tube Sample Numbers	
W.O.#	3214-008-040	Test Method	M0030	Meter Box Y	0.9947	Set One	15011
Project ID	AF	Date	5-12-00	Probe ID/Length	3	Set Two	
Mode/Source ID	A	Baro. Press (in Hg)	29.06	Probe Material	Boro	Set Three	
Samp. Loc.	LMF119	Ambient Temp (°F)	82			Set Four	
Source	F22 Engine	Operator	NA			Set Five	
		Sample Time	40			Set Six	
Comments:						Stack Blank	

Leak Checks (liters/min @ in Hg Vac)

	Set One	Set Two	Set Three	Set Four	Set Five	Set Six
Initial	0.0@2					
Final	0.0@2					

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	ROTOMETER SETTING	ORIFICE PRESSURE Delta H (in H_2O)	DRY GAS METER READING (liters)	DGM INLET TEMP (°C)	DGM OUTLET TEMP (°C)	PROBE TEMP (°C)	SAMPLE TRAIN VAC (in Hg)	FIRST COND. EXIT TEMP (°C)	SECOND COND. EXIT TEMP (°C)		COMMENTS
	0	1614			2042.685								
	5		29	1.2	2045.2	NA	47	144	≈1	20	20		
	10		41	1.2	2048.1		48	157	1	19	20		
	15		39	1.2	2050.85		49	152	1	19	20		
	20		39	1.2	2054.8		48	141	1	19	20		
	25		39	1.2	2056.7		47	141	1	15	20		
	30		40	1.2	2058.5		47	135	1	19	19		
	35		37	1.2	2062.3		47	135	1	18	19		
	40	1654	38	1.2	2064.85		46	133	1	18	19		
				Avg Delta H	Total Volume	Avg Tm		Max Temp	Max Vac	Max Temp	Max Temp		
				1.2	22.165	47.375		157	1	20	20		

WESTON MANAGERS ENGINEERS/CONSULTANTS

FIELD DATA SHEET

Method 0030 - Volatile Organics

Page ____ of ____

Client	USAF/EQM	Run No.	2	Meter Box ID	Vost 4	TENAX Tube Sample Numbers	
W.O.#	3214-008-040	Test Method	M0030	Meter Box Y	0.9947	Set One	15005
Project ID	AF	Date	9.12.00	Probe ID/Length	3	Set Two	
Mode/Source ID	A	Baro. Press (in Hg)	29.06	Probe Material	Boro	Set Three	
Samp. Loc.	LMF119	Ambient Temp (°F)	92			Set Four	
Source	F22 Engine	Operator	[illegible]			Set Five	
		Sample Time	40			Set Six	

Comments:

Leak Checks (liters/min @ in Hg Vac)

	Set One	Set Two	Set Three	Set Four	Set Five	Set Six
Initial	0.0@2					
Final	0.0@2					

Stack Blank 15006

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	ROTOMETER SETTING	ORIFICE PRESSURE Delta H (in H_2O)	DRY GAS METER READING (liters)	DGM INLET TEMP (°C)	DGM OUTLET TEMP (°C)	PROBE TEMP (°C)	SAMPLE TRAIN VAC (in Hg)	FIRST COND. EXIT TEMP (°C)	SECOND COND. EXIT TEMP (°C)		COMMENTS
	0	1711			2067.93								
	5		~~A-2~~ 26	1.2	2069.8	NA	45	146	1	19	20		
	10		30	1.2	2072.1		45	142	1	19	20		
	15		32	1.2	2074.4		45	140	1	18	20		
	20		33	1.2	2076.8		44	139	1	18	19		
	25		34	1.2	2079.1		44	139	1	18	19		
	30		35	1.2	2081.7		44	138	1	18	19		
	35		35	1.2	2084.2		44	139	1	17	19		
	40	1751	35	1.2	2086.49		44	139	1	17	19		
				Avg Delta H	Total Volume	Avg Tm	Max Temp	Max Vac	Max Temp	Max Temp			
				1.2	18.56	44.375 ~~44.4~~	146	1	19	20			

WESTON MANAGERS DESIGNERS/CONSULTANTS

FIELD DATA SHEET

Method 0030 - Volatile Organics

Page ____ of ____

Client	USAF/EQM	Run No.	3	Meter Box ID	Vost 4	TENAX Tube Sample Numbers	
W.O.#	3214-008-040	Test Method	M0030	Meter Box Y	0.9947	Set One	15015
Project ID	AF	Date	5.12.00	Probe ID/Length	3	Set Two	
Mode/Source ID	A	Baro. Press (in Hg)	29.06	Probe Material	Boro	Set Three	
Samp. Loc.	LMF119	Ambient Temp (°F)	90			Set Four	
Source	F22 Engine	Operator	MA			Set Five	
		Sample Time	40			Set Six	
Comments:						Stack Blank	

Leak Checks (liters/min @ in Hg Vac)

	Set One	Set Two	Set Three	Set Four	Set Five	Set Six
Initial	0.0@2					
Final	0.0@2					

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	ROTOMETER SETTING	ORIFICE PRESSURE Delta H (in H_2O)	DRY GAS METER READING (liters)	DGM INLET TEMP (°C)	DGM OUTLET TEMP (°C)	PROBE TEMP (°C)	SAMPLE TRAIN VAC (in Hg)	FIRST COND. EXIT TEMP (°C)	SECOND COND. EXIT TEMP (°C)		COMMENTS
	0	1804			2091.705								
	5		24	1.2	2094.1	~4	42	131	1	18	20		
	10		34	1.2	2096.6		42	134	1	16	19		
	15		36	1.2	2099.2		42	135	1	16	19		
	20		37	1.2	2101.9		42	137	1	15	18		
	25		37	1.2	2104.7		42	136	1	15	18		
	30		38	1.2	2107.4		42	138	1	15	19		
	35		38	1.2	2110.3		42	135	1	17	19		
	40	1846	39	1.2	2112.880		42	137	1	16	18		
				Avg Delta H	Total Volume	Avg Tm	Max Temp	Max Vac	Max Temp	Max Temp			
				1.2	21.175	42.0	137	1	18	20			

WESTON MANAGERS ENGINEERS CONSULTANTS

FIELD DATA SHEET

Method 0030 - Volatile Organics

Page ____ of ____

Client	USAF/EQM	Run No.	1	Meter Box ID	Vost 4	TENAX Tube Sample Numbers	
W.O.#	3214-008-040	Test Method	M0030	Meter Box Y	0.9947	Set One	15017
Project ID	AF	Date	9-13-00	Probe ID/Length	3	Set Two	
Mode/Source ID	N	Baro. Press (in Hg)	28.97	Probe Material	Boro	Set Three	
Samp. Loc.	LMF119	Ambient Temp (°F)	81			Set Four	
Source	F22 Engine	Operator	NDA			Set Five	
		Sample Time	40			Set Six	
Comments:						Stack Blank	

Leak Checks (liters/min @ in Hg Vac)

	Set One	Set Two	Set Three	Set Four	Set Five	Set Six
Initial	0.003					
Final	0.002					

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	ROTOMETER SETTING	ORIFICE PRESSURE Delta H (in H_2O)	DRY GAS METER READING (liters)	DGM INLET TEMP (°C)	DGM OUTLET TEMP (°C)	PROBE TEMP (°C)	SAMPLE TRAIN VAC (in Hg)	FIRST COND. EXIT TEMP (°C)	SECOND COND. EXIT TEMP (°C)		COMMENTS
	0	1115			2115.395								
	5		32	1.2	2117.85	NA	40	134	1	20	20		
	10		39	1.2	2121.1		39	135	1	18	20		
	15		42	1.2	2124.4		38	135	1	19	20		
	20		43	1.2	2127.5		38	134	1	19	19		
	25		40	1.2	2130.05		38	134	1	19	19		
	30		41	1.2	2133.7		38	136	1	19	19		
	35		41	1.2	2136.9		39	138	1	17	19		
	40	1159	40	1.2	2139.900		39	138	1	18	19		
				Avg Delta H	Total Volume	Avg Tm		Max Temp	Max Vac	Max Temp	Max Temp		
				1.20	24.505	38.625		138	1	20	20		

WESTON MANAGERS DESIGNERS/CONSULTANTS

FIELD DATA SHEET

Method 0030 - Volatile Organics

Page ____ of ____

Client	USAF/EQM	Run No.	2	Meter Box ID	Vost 4	TENAX Tube Sample Numbers	
W.O.#	3214-008-040	Test Method	M0030	Meter Box Y	0.9947	Set One	15019
Project ID	AF	Date	F.13.00	Probe ID/Length	3	Set Two	
Mode/Source ID	N	Baro. Press (in Hg)	28.97	Probe Material	Boro	Set Three	
Samp. Loc.	LMF119	Ambient Temp (°F)	86			Set Four	
Source	F22 Engine	Operator	JA			Set Five	
		Sample Time	40			Set Six	
Comments:						Stack Blank	15012

Leak Checks (liters/min @ in Hg Vac)

	Set One	Set Two	Set Three	Set Four	Set Five	Set Six
Initial	0.0 @ 2					
Final	0.0 @ 2					

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	ROTOMETER SETTING	ORIFICE PRESSURE Delta H (in H_2O)	DRY GAS METER READING (liters)	DGM INLET TEMP (°C)	DGM OUTLET TEMP (°C)	PROBE TEMP (°C)	SAMPLE TRAIN VAC (in Hg)	FIRST COND. EXIT TEMP (°C)	SECOND COND. EXIT TEMP (°C)		COMMENTS
	0	1216			2143.700								
	5		35	1.2	2146.2		40	139	1	20	20		
	10		37	1.2	2149.5		40	142	1	19	20		
	15		38	1.2	2152.1		41	136	1	19	20		
	20		37	1.2	2154.7		42	140	1	18	20		
	25		36	1.2	2157.3		42	142	1	19	20		
	30		36	1.2	2160.00		42	138	1	18	19		
	35		36	1.2	2162.5		41	138	1	19	20		
	40	1256	37	1.2	2165.470		42	138	1	19	20		
				Avg Delta H	Total Volume	Avg Tm	Max Temp	Max Vac	Max Temp	Max Temp			
				1.20 ✓	21.77 ✓	41.25 ✓	142	1	20	20			

WESTON MANAGERS ONE/CONSULTANTS

FIELD DATA SHEET

Method 0030 - Volatile Organics

Client	USAF/EQM	Run No.	1	Meter Box ID	Vost 4	TENAX Tube Sample Numbers	
W.O.#	3214-008-040	Test Method	M0030	Meter Box Y	0.9947	Set One	1504
Project ID	AF	Date	9.14.00	Probe ID/Length	3	Set Two	
Mode/Source ID	M	Baro. Press (in Hg)	28.94	Probe Material	Boro	Set Three	
Samp. Loc.	LMF119	Ambient Temp (°F)	80			Set Four	
Source	F22 Engine	Operator	MA			Set Five	
		Sample Time	40			Set Six	
Comments:						Stack Blank	

Leak Checks (liters/min @ in Hg Vac)

	Set One	Set Two	Set Three	Set Four	Set Five	Set Six
Initial	0.002					
Final	0.002					

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	ROTOMETER SETTING	ORIFICE PRESSURE Delta H (in H_2O)	DRY GAS METER READING (liters)	DGM INLET TEMP (°C)	DGM OUTLET TEMP (°C)	PROBE TEMP (°C)	SAMPLE TRAIN VAC (in Hg)	FIRST COND. EXIT TEMP (°C)	SECOND COND. EXIT TEMP (°C)		COMMENTS
	0	1035			2168.065								
	5		~~Not~~ 38	1.2	2171.3		38	147	1	17	20		
	10		40	1.2	2174.5		37	146	1	18	19		
	15		40	1.2	2177.2		36	136	1	16	18		
	20		40	1.2	2180.2		35	133	1	14	18		
	25		41	1.2	2183.3		35	134	1	16	19		
	30		41	1.2	2185.9		35	132	1	15	19		
	35		37	1.2	2188.7		35	136	1	16	19		
	40	~~1111~~ 1119	38	1.2	2191.172		35	143	1	16	19		IDLE/mil.
		1122											
				Avg Delta H	Total Volume	Avg Tm	Max Temp	Max Vac	Max Temp	Max Temp			
				1.20	23.107	35.75 ~~35.8~~	147	1	18	20			

WESTON MANAGERS DESIGNERS/CONSULTANTS

FIELD DATA SHEET

Method 0030 - Volatile Organics

Page ____ of ____

Client	USAF/EQM	Run No.	2	Meter Box ID	Vost 4	TENAX Tube Sample Numbers	
W.O.#	3214-008-040	Test Method	M0030	Meter Box Y	0.9947	Set One	15003
Project ID	AF	Date	9.14.00	Probe ID/Length	3	Set Two	
Mode/Source ID	M	Baro. Press (in Hg)	28.54	Probe Material	Boro	Set Three	
Samp. Loc.	LMF119	Ambient Temp (°F)	88			Set Four	
Source	F22 Engine	Operator	NA			Set Five	
		Sample Time	~~10~~ 35			Set Six	
Comments:						Stack Blank	

Leak Checks (liters/min @ in Hg Vac)

	Set One	Set Two	Set Three	Set Four	Set Five	Set Six
Initial	0.0@3					
Final						

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	ROTOMETER SETTING	ORIFICE PRESSURE Delta H (in H_2O)	DRY GAS METER READING (liters)	DGM INLET TEMP (°C)	DGM OUTLET TEMP (°C)	PROBE TEMP (°C)	SAMPLE TRAIN VAC (in Hg)	FIRST COND. EXIT TEMP (°C)	SECOND COND. EXIT TEMP (°C)		COMMENTS
	0	1407			2193.778								
	5		40	1.2	2196.5		39	147	1	20	20		
	10		40	1.2	2199.6		38	135	1	20	20		
	15		42	1.2	2202.7		38	132	1	20	20		
	20		40	1.2	2205.8		38	136	1	19	20		
	25		42	1.2	2208.5		38	136	1	19	19		
	30		39	1.2	2211.5		38	142	1	19	19		
	35	1442	40	1.2	2214.500		38	143	1	19	20		
	40												
				Avg Delta H	Total Volume	Avg Tm		Max Temp	Max Vac	Max Temp	Max Temp		
				1.2	20.772	77.14		147	1	20	20		

WESTON MANAGERS ENGINEERS/CONSULTANTS

JM

fitte 641

ISOKINETIC FIELD DATA SHEET

EPA Method 5/202 - Particulate

*EQ ! Page 1 of 1

Client	USAF/EQM
W.O.#	20054.006.001.2000
Project ID	AF
Mode/Source ID	I
Samp. Loc. ID	LMF119
Run No.ID	1
Test Method ID	M202
Date ID	12SEP2000
Source/Location	Idle F119-PW-100
Sample Date	12-Sep-00
Baro. Press (in Hg)	29.06
Operator	NAM

Stack Conditions

	Assumed	Actual
% Moisture	3	
Impinger Vol (ml)		
Silica gel (g)		
CO2, % by Vol	0.5	
O2, % by Vol	20.5	
Temperature (°F)	149	
Meter Temp (°F)	90	
Static Press (in H_2O)	-0.02	
Ambient Temp (°F)	87	

Meter Box ID	# WC17	
Meter Box Y	0.9895	
Meter Box Del H	1.7925	
Probe ID / Length	P74	4
Probe Material	Boro	
Pitot / Thermocouple ID		
Pitot Coefficient	0.84	
Nozzle ID		
Avg Nozzle Dia (in)	0.743	
Area of Stack (ft^2)	4	
Sample Time	60	
Total Traverse Pts	1	

K Factor 311.9685

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.005		0.001
Leak Check @ (in Hg)	12-15 NH		5
Pitot good	(yes) / no	yes / no	(yes) / no
Orsat good	yes / no	yes / no	yes / no

Temp Check	Pre-Test Set	Post-Test Set
Meter Box Temp		
Reference Temp		
Pass/Fail (+/- 2°)	Pass / Fail	Pass / Fail
Temp Change Response	yes / no	yes / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPINGER EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)	COMMENTS
	0	1039			628.702								
1	5	1044	0.01	2.93	633.5	130	91	91	245	250	68	5	
	10	1049	0.01	2.87	638.4	138	91	91	229	248	61	5	
	15	1054	0.01	2.87	643.4	140	92	92	236	249	59	5	
	20	1059	0.01	2.86	648.4	142	92	92	238	248	64	5	
	25	[illegible]	0.01	2.87	653.3	142	93	93	237	248	68	5	
	30	1109	0.01	2.87	658.3	142	93	93	239	249	68	5	
	35	1114	0.01	2.86	663.3	143	93	93	239	248	68	5	
	40	1119	0.01	2.87	668.3	143	94	94	244	248	68	5	
	45	1124	0.01	2.86	673.2	144	94	94	247	250	66	5	
	50	1129	0.01	2.86	678.2	145	94	94	244	247	66	5	
	55	1134	0.01	2.86	683.2	145	95	95	246	248	67	5	
↓	60	1139	0.01	2.87	688.219	144	95	95	244	248	68	5	

Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
~~0.0100~~ 0.10000	2.87083	59.517	141.50	93.08	229/247	250	68	5	

Avg Sqrt Del H
1.69434

Comments: * K-factor does not have meter temp or stack temp included. These are input at each point.

WESTON MANAGERS DESIGNERS/CONSULTANTS

Filter 64

ISOKINETIC FIELD DATA SHEET

EPA Method 5/202 - Particulate

EQ! Page 1 of 1

Client	USAF/EQM
W.O.#	20054.006.001.2000
Project ID	AF
Mode/Source ID	I
Samp. Loc. ID	LMF119
Run No.ID	2
Test Method ID.	M202
Date ID	12SEP2000
Source/Location	Idle F119-PW-100
Sample Date	12-Sep-00
Baro. Press (in Hg)	29.06
Operator	NM

Stack Conditions

	Assumed	Actual
% Moisture	3	
Impinger Vol (ml)		
Silica gel (g)		
CO2, % by Vol	0.5	
O2, % by Vol	20.5	
Temperature (°F)	149	
Meter Temp (°F)	90	
Static Press (in H_2O)	-0.02	
Ambient Temp (°F)		

Meter Box ID	2 WC 19
Meter Box Y	0.9894
Meter Box Del H	1.7680
Probe ID / Length	P184 / 4
Probe Material	Boro
Pitot / Thermocouple ID	
Pitot Coefficient	0.84
Nozzle ID	
Avg Nozzle Dia (in)	0.741
Area of Stack (ft^2)	4
Sample Time	60
Total Traverse Pts	1

K Factor 304.4048

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.005		0.002
Leak Check @ (in Hg)	12.5 in		6
Pitot good	(yes) / no	yes / no	(yes) / no
Orsat good	yes / no	yes / no	yes / no

Temp Check	Pre-Test Set	Post-Test Set
Meter Box Temp		
Reference Temp		
Pass/Fail (+/- 2°)	Pass / Fail	Pass / Fail
Temp Change Response	yes / no	yes / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPING EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)		COMMENTS
	0	1145			492.528									
	5	1150	0.01	2.83	497.520	144	88	88	259	253	*	5		* Bad thermocouple
	10	1155	0.01	2.83	502.7	145	88	88	269	255	*	6		↓
	15	1200	0.01	2.83	507.2	145	88	88	266	255	*	5.5		
	20	1205	0.01	2.76	512.1	145	89	89	273	256	*	5.5		
	25	1210	0.01	2.76	517.0	145	89	89	261	255	55	5.5		
	30	1215	0.02	5.52	523.8	146	90	90	255	256	56	9		
	35	1220	0.01	2.77	528.7	146	91	91	238	257	60	5.5		
	40	1225	0.01	2.77	533.6	146	92	92	243	255	61	5.5		
	45	1230	0.01	2.77	538.5	147	92	92	250	254	61	5.5		
	50	1235	0.01	2.77	543.4	146	92	92	245	252	62	5.5		
	55	1240	0.01	2.78	548.7	145	93	93	241	253	62	5.5		
	60	1245	0.01	2.78	553.345	145	92	92	244	250	61	5.5		

Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
~~0.01083~~ ~~0.10343~~ ~~0.01083~~ 0.10345	3.01417	60.817	145.42	90.33	238/273	257/250	62	9	

Avg Sqrt Del H: 1.72591

Comments:

WESTON MANAGERS DESIGNERS/CONSULTANTS

filter 639

ISOKINETIC FIELD DATA SHEET

EPA Method 5/202 - Particulate

Page 1 of 1

Client	USAF/EQM
W.O.#	20054.006.001.2000
Project ID	AF
Mode/Source ID	1
Samp. Loc. ID	LMF119
Run No.ID	3
Test Method ID	M202
Date ID	12SEP2000
Source/Location	Idle F119-PW-100
Sample Date	12-Sep-00
Baro. Press (in Hg)	29.06
Operator	NM

Stack Conditions

	Assumed	Actual
% Moisture	3	
Impinger Vol (ml)		
Silica gel (g)		
CO2, % by Vol	0.5	
O2, % by Vol	20.5	
Temperature (°F)	146	
Meter Temp (°F)	90	
Static Press (in H_2O)	-0.02	
Ambient Temp (°F)	90	

Meter Box ID	WL17	
Meter Box Y	0.9895	
Meter Box Del H	1.7925	
Probe ID / Length	P74	4
Probe Material	Boro	
Pitot / Thermocouple ID		
Pitot Coefficient	0.84	
Nozzle ID		
Avg Nozzle Dia (in)	0.743	
Area of Stack (ft^2)	4	
Sample Time	60	
Total Traverse Pts	1	

K Factor 311.9685

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.001		0.003
Leak Check @ (in Hg)	15		4
Pitot good	(yes) / no	yes / no	(yes) / no
Orsat good	N/A yes / no	yes / no	yes / no

Temp Check	Pre-Test Set	Post-Test Set
Meter Box Temp		
Reference Temp		
Pass/Fail (+/- 2°)	Pass / Fail	Pass / Fail
Temp Change Response	yes / no	yes / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPINGER EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)	COMMENTS
	0	1252			688.634								
	5	1257	0.01	2.83	694.52	128	90	90	208	250	*	3	+ Sun on
	10	1302	0.01	2.83	699.0	148	91	91	229	249	*	3	impinger,
	15	1307	0.01	2.83	703.9	148	92	92	239	250	*	3.5	Not covered
	20	1312	0.01	2.83	708.8	148	92	92	243	251	+68	3.5	run 3
	25	1317	0.01	2.85	713.8	146	93	93	243	248	+71	3.5	* Thermocouple
	30	1322	0.01	2.85	718.7	146	94	94	242	248	+69	3.5	not responding
	35	1327	0.01	2.86	723.6	146	95	95	247	248	+69	3.5	
	40	1332	0.01	2.86	728.6	147	96	96	245	246	+69	3.5	
	45	1337	0.01	2.86	733.6	147	96	96	244	248	+69	3.5	
	50	1342	0.01	2.86	738.6	148	97	97	245	248	+68	3.5	
	55	1347	0.01	2.86	743.6	149	98	98	244	248	+67	3.5	
	60	1352	0.01	2.86	748.557	149	99	99	245	248	+67	3.5	

Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
~~0.01000~~ 0.10000	2.84833	59.923	145.83	94.42	208/247	248/251	71 (+)	3.5	

Avg Sqrt Del H: 1.68770

Comments:

WESTON MANAGERS DESIGNERS/CONSULTANTS

SAMPLE RECOVERY FIELD DATA

EPA Method 5/202 - Particulate

Client	USAF/EQM	W.O. #	20054.006.001.2000
Location/Plant	Lockheed Martin GA	Source & Location	Idle F119-PW-100

Run No. 1 — Sample Date 12-Sep-00 — Recovery Date 9/12/00

Sample I.D. AF - I - LMF119 - 1 - M202 - 12SEP2000 — Analyst PAE — Filter Number 641

	Impinger 1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	Di H20	Di H20	~~Empty~~ DI H2O						Silica Gel	
Final	84	113	101						314.7	
Initial	100	100	100						300	
Gain	-16	13	1					-2	14.7	12.7

Impinger Color Clear — 74 DI Rinse, 23 DCM Rinse — Labeled? yes

Silica Gel Condition 1/2 spent — Sealed? yes

Run No. 2 — Sample Date 12-Sep-00 — Recovery Date 9/12/00

Sample I.D. AF - I - LMF119 - 2 - M202 - 12SEP2000 — Analyst PAE — Filter Number 640

	Impinger 1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	Di H20	Di H20	~~Empty~~ DI H2O						Silica Gel	
Final	94	103	101						313	
Initial	100	100	100						300	
Gain	-6	3	1		-			-2	13	11.0

Impinger Color Clear — 53 ml DI Rinse, 21 DCM Rinse — Labeled? yes

Silica Gel Condition 1/4 spent — Sealed? yes

Run No. 3 — Sample Date 12-Sep-00 — Recovery Date 9/12/00

Sample I.D. AF - I - LMF119 - 3 - M202 - 12SEP2000 — Analyst — Filter Number 639

	Impinger 1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	Di H20	Di H20	~~Empty~~ DI H2O						Silica Gel	
Final	94	100	102						316	
Initial	100	100	100						300	
Gain	-6	-	~~102~~					-4	16	12.0

Impinger Color clear — Labeled?

Silica Gel Condition — Sealed?

Check COC for Sample IDs of Media Blanks

WESTON MANAGERS DESIGNERS/CONSULTANTS

Blank Filter # 642

Filter 638

ISOKINETIC FIELD DATA SHEET

EPA Method 5/202 - Particulate

EQ! Page 1 of 1

Field	Value
Client	USAF/EQM
W O.#	20054.006.001.2000
Project ID	AF
Mode/Source ID	A
Samp. Loc. ID	LMF119
Run No.ID	1
Test Method ID	M202
Date ID	12SEP2000
Source/Location	Approch F119-PW-100
Sample Date	12-Sep-00
Baro. Press (in Hg)	28.94
Operator	NM

Stack Conditions

	Assumed	Actual
% Moisture	3	
Impinger Vol (ml)		
Silica gel (g)		
CO2, % by Vol	0.5	
O2, % by Vol	20.5	
Temperature (°F)		
Meter Temp (°F)	96	
Static Press (in H_2O)	-0.05	
Ambient Temp (°F)	90	

Field	Value
Meter Box ID	2 WC17
Meter Box Y	0.9895
Meter Box Del H	1.7925
Probe ID / Length	P184 / 4
Probe Material	Boro
Pitot / Thermocouple ID	
Pitot Coefficient	0.84
Nozzle ID	
Avg Nozzle Dia (in)	0.496
Area of Stack (ft^2)	4
Sample Time	60
Total Traverse Pts	1

K Factor 61.9511

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.005		0.002
Leak Check @ (in Hg)	15		6
Pitot good	(yes) / no	yes / no	(yes) / no
Orsat good	N/A yes / no	yes / no	yes / no

Temp Check	Pre-Test Set	Post-Test Set
Meter Box Temp		
Reference Temp		
Pass/Fail (+/- 2°)	Pass / Fail	Pass / Fail
Temp Change Response	yes / no	yes / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPINGER EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)	COMMENTS
	0	1607			748.932								
	5	1612	0.09	5.17	755.5	149	102	102	235	246	68	5.5	
	10	1617	0.09	5.14	762.2	151	103	103	233	247	68	5.5	
	15	1622	0.10	6.09	769.8	151	104	104	241	247	67	6.0	
	20	1627	0.09	~~4.5~~ ~~5.0~~ 5.16	776.0	150	105	105	236	247	64	5.5	
	25	1632	0.08	4.59	782.3	150	105	105	239	246	64	5.0	
	30	1637	0.09	5.16	789.0	150	105	105	239	248	64	5.5	
	35	1642	0.09	5.16	795.7	150	105	105	236	247	66	5.5	
	40	1647	0.09	5.16	802.4	150	105	105	237	246	67	5.5	
	45	1652	0.08	4.59	808.7	150	105	105	236	246	68	5.0	
	50	1657	0.09	5.16	815.81	150	104	104	237	246	68	5.5	
	55	1702	0.09	5.16	821.9	150	104	104	235	246	68	5.5	
	60	1707	0.09	5.16	828.611	150	104	104	235	245	68	5.5	

Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
~~0.0~~ 0.29849	5.14167	79.679	150.08	104.25	233/239	245/248	68	6	

Avg Sqrt Del H
2.26621

Comments:

WESTON MANAGERS DESIGNERS/CONSULTANTS

filt 637

ISOKINETIC FIELD DATA SHEET

EPA Method 5/202 - Particulate

EQ! Page 1 of 1

Client	USAF/EQM
W.O.#	20054.006.001.2000
Project ID	AF
Mode/Source ID	A
Samp. Loc. ID	LMF119
Run No ID	2
Test Method ID	M202
Date ID	12SEP2000
Source/Location	Approch F119-PW-100
Sample Date	12-Sep-00
Baro. Press (in Hg)	28.94
Operator	NM

Stack Conditions

	Assumed	Actual
% Moisture	3	
Impinger Vol (ml)		
Silica gel (g)		
CO2, % by Vol	0.5	
O2, % by Vol	20.5	
Temperature (°F)	150	
Meter Temp (°F)	96	
Static Press (in H_2O)	-0.05	
Ambient Temp (°F)		

Meter Box ID	2WC19	
Meter Box Y	0.9894	
Meter Box Del H	1.7680	
Probe ID / Length	P74	4
Probe Material	Boro	
Pitot / Thermocouple ID		
Pitot Coefficient	0.84	
Nozzle ID		
Avg Nozzle Dia (in)	0.496	
Area of Stack (ft^2)	4	
Sample Time	60	
Total Traverse Pts	1	

K Factor 61.1044

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.008		0.005
Leak Check @ (in Hg)	15		12
Pitot good	(yes) / no	yes / no	(yes) / no
Orsat good	yes / no	yes / no	yes / no

Temp Check	Pre-Test Set	Post-Test Set
Meter Box Temp		
Reference Temp		
Pass/Fail (+/- 2°)	Pass / Fail	Pass / Fail
Temp Change Response	yes / no	yes / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPING EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)	COMMENTS
	0	1712			553.585								
	5	1717	0.10	5.2	558.07	148	93	93	222	254	67	7	
	10	1722	0.09	~~5.2~~ 4.99 NM	573.0	150	94	94	229	256	53	7	
	15	1727	0.09	5.00	579.6	150	95	95	244	254	55	7.5	
	20	1732	0.08	4.46	585.8	150	96	96	247	256	57	7.0	
	25	1737	0.08	4.46	592.1	150	96	96	252	253	57	7.0	
	30	1742	0.09	5.02	598.4	150	97	97	253	253	57	7.5	
	35	1747	0.10	5.59	606.8	150	98	98	253	248	59	8.5	
	40	1752	0.09	5.04	611.43	150	99	99	252	257	60	8.5	
	45	1757	0.08	4.46	618.3	149	99	99	251	254	61	8	
	50	1802	0.09	5.02	625.4	149	100	100	249	253	62	8	
	55	1807	0.09	5.02		149	100	100	250	252	62	8	
	60	1812	0.08	4.46	632.185	147	100	100	251	252	64	8	

Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
0.29699	4.89333	78.600	149.33	97.25	222/253	248/256	64	8.5	

Avg Sqrt Del H: 2.21072

Comments:

WESTON MANAGERS DESIGNERS/CONSULTANTS

Filter 656

ISOKINETIC FIELD DATA SHEET

EPA Method 5/202 - Particulate

EQ! Page 1 of 1

Client	USAF/EQM			
W.O.#	20054.006.001.2000	**Stack Conditions**	Assumed	Actual
Project ID	AF	% Moisture	3	
Mode/Source ID	A	Impinger Vol (ml)		
Samp. Loc. ID	LMF119	Silica gel (g)		
Run No.ID	3	CO2, % by Vol	0.5	
Test Method ID	M202	O2, % by Vol	20.5	
Date ID	12SEP2000	Temperature (°F)		
Source/Location	Approch F119-PW-100	Meter Temp (°F)	96	
Sample Date	12-Sep-00	Static Press (in H_2O)	-0.05	
Baro. Press (in Hg)	28.74			
Operator	NM	Ambient Temp (°F)	90	

Meter Box ID	2WC17
Meter Box Y	0.9895
Meter Box Del H	1.7925
Probe ID / Length	P184 / 4
Probe Material	Boro
Pitot / Thermocouple ID	
Pitot Coefficient	0.84
Nozzle ID	
Avg Nozzle Dia (in)	0.496
Area of Stack (ft^2)	4
Sample Time	60
Total Traverse Pts	1

K Factor 61.9511

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.010		0.006
Leak Check @ (in Hg)	15		6
Pitot good	(yes) / no	yes / no	(yes) / no
Orsat good	yes / no	yes / no	yes / no

Temp Check	Pre-Test Set	Post-Test Set
Meter Box Temp		
Reference Temp		
Pass/Fail (+/- 2°)	Pass / Fail	Pass / Fail
Temp Change Response	yes / no	yes / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPINGER EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)		COMMENTS
	0	1819			828.865									
	5	1824	0.09	5.1	835.3	148	96	90	248	248	67	5		
	10	1829	0.09	5.12	841.9	148	98	98	243	258	58	5.5		
	15	1834	0.09	5.12	848.5	148	98	98	248	250	60	5.0		
	20	1839	0.08	4.56	858.4	148	99	99	252	246	60	5.0		
	25	1844	0.09	5.14	862.3	148	100	100	255	247	61	5.5		
	30	1849	0.09	5.14	868.1	148	101	101	254	246	72	5.5		
	35	1854	0.08	4.57	874.2	148	101	101	249	246	62	5.0		
	40	1859	0.08	4.59	880.6	147	102	102	243	[illegible]	59	5.0		
	45	1904	0.09	5.17	887.3	146	102	102	254	248	58	5.5		
	50	1909	0.09	5.17	893.8	146	102	102	251	248	58	5.5		
	55	1914	0.09	5.17	900.6	146	102	102	255	248	58	5.5		
	60	1919	0.09	5.16	907.187	146	101	101	256	248	58	5.5		

Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
0.29571	5.00083	78.322	147.25	100.17	243/256	246/258	72	5.5	

Avg Sqrt Del H
2.23555

Comments:

WESTON MANAGERS DESIGNERS/CONSULTANTS

SAMPLE RECOVERY FIELD DATA

EPA Method 5/202 - Particulate

Client	USAF/EQM	W.O. #	20054.006.001.2000
Location/Plant	Lockheed Martin GA	Source & Location	Approch F119-PW-100

Run No. 1 — Sample Date 12-Sep-00 — Recovery Date 9/12/00

Sample I.D. AF - A - LMF119 - 1 - M202 - 12SEP2000 — Analyst PAC — Filter Number 638

	Impinger									
	1	2	3 (DRY)	4	5	6	7	Imp.Total	8	Total
Contents	Di H20	Di H20	~~Empty~~	Di H_2O					Silica Gel	
Final	93 +13 DRC	113	93 / 113						318.7	
Initial	100	100	100						300	
Gain	-7	13	13					19	18.7	37.7

Impinger Color: Clear — 6E di Rinse — Labeled? Yes

Silica Gel Condition: 1/4 spent — 30 Dcm Rinse — Sealed? Yes

Run No. 2 — Sample Date 12-Sep-00 — Recovery Date 9/12/00

Sample I.D. AF - A - LMF119 - 2 - M202 - 12SEP2000 — Analyst PAC — Filter Number 637

	Impinger									
	1	2	3 (DRY)	4	5	6	7	Imp.Total	8	Total
Contents	Di H20	Di H20	~~Empty~~	D. H_2O					Silica Gel	
Final	93	104	111						321.4	
Initial	100	100	100						300	
Gain	-7	4	11	-				8	21.4	29.4

Impinger Color: clear — 50ml di Rinse — Labeled? Yes

Silica Gel Condition: 3/4 spent — 27ml Dcm Rinse — Sealed? Yes

Run No. 3 — Sample Date 12-Sep-00 — Recovery Date 9/12

Sample I.D. AF - A - LMF119 - 3 - M202 - 12SEP2000 — Analyst PAC — Filter Number 636

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	Di H20	Di H20	~~Empty~~ Di H_2O						Silica Gel	
Final	95	112	104						320.1	
Initial	100	100	100						300	
Gain	-5	12	4					11	20.1	31.1

Impinger Color: clear — Labeled? ✓

Silica Gel Condition: 3/4 used — Sealed? ✓

Check COC for Sample IDs of Media Blanks

WESTON MANAGERS DESIGNERS/CONSULTANTS

ISOKINETIC FIELD DATA SHEET

EPA Method 5/202 - Particulate

WESTON Page 1 of 1

Client	USAF/EQM
W.O.#	20054.006.001.2000
Project ID	AF
Mode/Source ID	N
Samp. Loc. ID	LMF119
Run No.ID	1
Test Method ID	M202
Date ID	12SEP2000
Source/Location	Intermediate F119-PW-100
Sample Date	13-Sep-00
Baro. Press (in Hg)	28.97
Operator	NM

Stack Conditions

	Assumed	Actual
% Moisture	2	
Impinger Vol (ml)		
Silica gel (g)		
CO2, % by Vol	0.5	
O2, % by Vol	20.5	
Temperature (°F)	200	
Meter Temp (°F)	90	
Static Press (in H_2O)	-0.25	
Ambient Temp (°F)	80	

Meter Box ID	WC 17
Meter Box Y	0.9895
Meter Box Del H	1.7925
Probe ID / Length	4
Probe Material	Boro
Pitot / Thermocouple ID	
Pitot Coefficient	0.84
Nozzle ID	
Avg Nozzle Dia (in)	0.350
Area of Stack (ft^2)	4
Sample Time	60
Total Traverse Pts	1

K Factor ~~15.7921~~ NM 131449

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.005		0.003
Leak Check @ (in Hg)	18		8
Pitot good	(yes) / no	yes / no	(yes) / no
Orsat good	yes / no	yes / no	yes / no

Temp Check	Pre-Test Set	Post-Test Set
Meter Box Temp		
Reference Temp		
Pass/Fail (+/- 2°)	Pass / Fail	Pass / Fail
Temp Change Response	yes / no	yes / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPINGER EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)		COMMENTS
	0	1110			907.411									
	5	1115	0.44	5.78	914.1	192	90	90	240	249	67	6.5		
	10	1120	0.41	5.39	920.9	193	92	92	236	246	59	6.0		
	15	1125	0.43	5.65	927.8	193	93	93	246	246	59	6.5		
	20	1130	0.44	5.78	934.8	193	94	94	251	247	60	6.5		
	25	1135	0.47	6.18	941.9	193	44	94	252	246	60	7.0		
	30	1140	0.44	5.78	948.9	193	94	94	252	244	61	7.0		
	35	1145	0.43	5.65	955.8	194	94	94	254	247	62	7.0		
	40	1150	0.44	5.78	962.8	194	95	95	257	244	62	7.0		
	45	1155	0.43	5.65	969.7	193	96	96	256	245	63	7.0		
	50	1200	0.40	5.26	976.4	193	95	95	255	245	63	7.0		
	55	1205	0.41	5.39	983.2	193	96	96	254	248	64	6.5		
	60	1210	0.42	5.52	990.080	193	96	96	254	244	65	7.0		

Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
0.655604	5.65083	82.669	193.08	94.08	236/257	244/249	67	7.0	

Avg Sqrt Del H

Comments:

WESTON MANAGERS DESIGNERS/CONSULTANTS

ISOKINETIC FIELD DATA SHEET

EPA Method 5/202 - Particulate

WESTON Page 1 of 1

Client	USAF/EQM
W.O.#	20054.006.001.2000
Project ID	AF
Mode/Source ID	N
Samp. Loc ID	LMF119
Run No.ID	2
Test Method ID	M202
Date ID	12SEP2000
Source/Location	Intermediate F119-PW-100
Sample Date	13-Sep-00
Baro. Press (in Hg)	28.97
Operator	NM

Stack Conditions	Assumed	Actual
% Moisture	2	
Impinger Vol (ml)		
Silica gel (g)		
CO2, % by Vol	0.5	
O2, % by Vol	20.5	
Temperature (°F)	200	
Meter Temp (°F)	90	
Static Press (in H_2O)	-0.25	
Ambient Temp (°F)		

Meter Box ID	WC 19
Meter Box Y	0.9894
Meter Box Del H	1.7680
Probe ID / Length	4
Probe Material	Boro
Pitot / Thermocouple ID	
Pitot Coefficient	0.84
Nozzle ID	
Avg Nozzle Dia (in)	0.350
Area of Stack (ft^2)	4
Sample Time	60
Total Traverse Pts	1

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.009		0.15 *
Leak Check @ (in Hg)	16		12
Pitot good	yes / no	yes / no	yes / no
Orsat good	yes / no	yes / no	yes / no
Temp Check	Pre-Test Set		Post-Test Set
Meter Box Temp			
Reference Temp			
Pass/Fail (+/- 2°)	Pass / Fail		Pass / Fail
Temp Change Response	yes / no		yes / no

K Factor 12.8182

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPING EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)		COMMENTS
	0	1213			633.305									
	5	1218	0.42	5.38	639.8	197	87	87	194	241	66	10		
	10	1223	0.43	5.51	646.4	199	88	88	252	251	74	11		
	15	1228	0.42	5.38	653.0	199	88	88	~~199~~ 245	248	71	11		
	20	1233	0.43	5.51	659.7	198	90	90	253	249	58	11		
	25	1238	0.43	5.51	666.6	200	90	90	251	253	57	12		
	30	1243	0.42	5.38	673.5	200	91	91	245	250	56	12		
	35	1248	0.44	5.64	680.5	198	91	91	247	247	57	12		
	40	1253	0.43	5.51	687.3	199	91	91	245	249	57	12		
	45	1258	0.44	5.64	694.2	199	92	92	246	254	57	12		
	50	103	0.44	5.64	701.2	200	92	92	246	248	58	12.5		
	55	1:08	0.43	5.51	708.1	200	92	92	247	247	59	12		
	60	1:13	0.45	5.76	715.074	200	92	92	247	256	59	12.5		
														* FILTER HEATER LOOSE
			Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm		Min/Max	Min/Max	Max Temp	Max Vac	Max Temp	
			0.656978	5.53083	81.769	199.08	90.30		94/253	241/254	74	12.5		
				Avg Sqrt Del H	Comments:									

WESTON MANAGERS / CONSULTANTS

SAMPLE RECOVERY FIELD DATA

EPA Method 5/202 - Particulate

Client: USAF/EQM — W.O. #: 20054.006.001.2000

Location/Plant: Lockheed Martin GA — Source & Location: Intermediate F119-PW-100

Run No. 1 — Sample Date 13-Sep-00 — Recovery Date 9/13/00

Sample I.D. AF - N - LMF119 - 1 - M202 - 12SEP2000 — Analyst — Filter Number 632

	Impinger									
	1	2	~~3~~ DRIED	4	5	6	7	Imp.Total	8	Total
Contents	Di H20	Di H20	~~Empty~~						Silica Gel	
Final	99	118	100						321.9	
Initial	100	100	100						300	
Gain	-1	18	0					17	21.9	38.9

Impinger Color: CLEAR — Labeled? Y

Silica Gel Condition: 3/4 SPENT — Sealed? Y

Run No. 2 — Sample Date 13-Sep-00 — Recovery Date 9.13.00

Sample I.D. AF - N - LMF119 - 2 - M202 - 12SEP2000 — Analyst — Filter Number 631

	Impinger									
	1	2	3 Di H2O	4	5	6	7	Imp.Total	8	Total
Contents	Di H20	Di H20	~~Empty~~						Silica Gel	
Final	94	116	108						324.2	
Initial	100	100	100						300	
Gain	-6	16	8					18	24.2	42.2

Impinger Color: clear — Labeled? Y

Silica Gel Condition: 3/4 used — Sealed? Y

Run No. 3 — Sample Date 13-Sep-00 — Recovery Date

Sample I.D. AF - N - LMF119 - 3 - M202 - 12SEP2000 — Analyst — Filter Number 630

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	Di H20	Di H20	Empty						Silica Gel	
Final										
Initial	100	100							300	
Gain										

Impinger Color — Labeled?

Silica Gel Condition — Sealed?

Check COC for Sample IDs of Media Blanks

WESTON

ISOKINETIC FIELD DATA SHEET

EPA Method 5/202 - Particulate

westen Page 1 of 1

Client	USAF/EQM
W.O.#	20054.006.001.2000
Project ID	AF
Mode/Source ID	M
Samp. Loc. ID	LMF119
Run No.ID	1
Test Method ID	M202
Date ID	12SEP2000
Source/Location	Military F119-PW-100
Sample Date	14 ~~12~~ Sep-00
Baro. Press (in Hg)	28.94
Operator	NW

Stack Conditions

	Assumed	Actual
% Moisture	2	
Impinger Vol (ml)		
Silica gel (g)		
CO2, % by Vol	0.5	
O2, % by Vol	20.5	
Temperature (°F)	250	
Meter Temp (°F)	90	
Static Press (in H_2O)	-0.47	
Ambient Temp (°F)	75	

Meter Box ID	WC17
Meter Box Y	0.9895
Meter Box Del H	1.7925
Probe ID / Length	P74 / 4
Probe Material	Boro
Pitot / Thermocouple ID	
Pitot Coefficient	0.84
Nozzle ID	
Avg Nozzle Dia (in)	0.302
Area of Stack (ft^2)	4
Sample Time	60
Total Traverse Pts	1

K Factor 6.6927

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.005		.004
Leak Check @ (in Hg)	15		14
Pitot good	(yes) / no	yes / no	(yes) / no
Orsat good	yes / no	yes / no	yes / no

Temp Check	Pre-Test Set	Post-Test Set
Meter Box Temp		
Reference Temp		
Pass/Fail (+/- 2°)	Pass / Fail	Pass / Fail
Temp Change Response	yes / no	yes / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPINGER EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)		COMMENTS
	0	1034			990.552									
	5	1039	0.83	5.55	997.2	239	93	93	242	244	62	12		
	10	1044	0.78	5.22	1003.8	246	95	95	239	245	50	11.5		
	15	1049	0.78	5.12	1010.5	246	96	96	235	243	53	11.5		
	20	1054	0.75	5.02	1017.0	245	97	97	238	245	55	11.0		
	25	1059	0.77	5.15	1023.6	247	97	97	236	244	56	11.5		
	30	1104	0.78	5.22	1030.2	246	97	97	243	246	57	12.0		STOP 1110
	35	1109	0.78	5.22	1036.8	247	96	96	244	246	58	12.0		1037.991
	40	1120	0.80	5.35	1043.4	247	94	94	250	247	58	12.0		
	45	1125	0.78	5.22	1050.0	247	95	95	244	246	56	12.5		START 1116
	50	1130	0.80	5.35	1056.7	249	96	96	243	246	59	13.0		
	55	1135	0.85	5.69	1063.6	249	95	95	245	247	60	13.5		
	60	1140	0.78	5.22	1070.239	250	95	95	247	246	61	13.0		

Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
0.888702	5.28583	79.687	246.50	95.50	235/250	243/247	62	13.5	

Avg Sqrt Del H:

Comments:

WESTON MANAGERS DESIGNERS/CONSULTANTS

ISOKINETIC FIELD DATA SHEET

EPA Method 5/202 - Particulate

westfield Page 1 of 1

Client	USAF/EQM
W.O.#	20054.006.001.2000
Project ID	AF
Mode/Source ID	M
Samp. Loc. ID	LMF119
Run No.ID	2
Test Method ID	M202
Date ID	12SEP2000
Source/Location	Military F119-PW-100
Sample Date	14 ~~13~~ Sep-00
Baro. Press (in Hg)	28.94
Operator	Jim

Stack Conditions

	Assumed	Actual
% Moisture	2	
Impinger Vol (ml)		
Silica gel (g)		
CO2, % by Vol	0.5	
O2, % by Vol	20.5	
Temperature (°F)	250	
Meter Temp (°F)	~~90~~ 96	
Static Press (in H_2O)	-0.47	
Ambient Temp (°F)		

Meter Box ID	WC 19	
Meter Box Y	0.9894	
Meter Box Del H	1.7680	
Probe ID / Length	P181	4
Probe Material	Boro	
Pitot / Thermocouple ID		
Pitot Coefficient	0.84	
Nozzle ID		
Avg Nozzle Dia (in)	0.300	
Area of Stack (ft^2)	4	
Sample Time	60	
Total Traverse Pts	1	

K Factor ~~6.4281~~ 6.4982

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.008		0.012
Leak Check @ (in Hg)	15		10
Pitot good	(yes) / no	yes / no	(yes) / no
Orsat good	yes / no	yes / no	yes / no
Temp Check	Pre-Test Set		Post-Test Set
Meter Box Temp			
Reference Temp			
Pass/Fail (+/- 2°)	Pass / Fail		Pass / Fail
Temp Change Response	yes / no		yes / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPING EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)	COMMENTS
	0	1405			715.808								
	5	1410	0.82	5.32	722.4	258	94	94	250	252	62	8	
	10	1415	0.80	5.20	729.0	260	95	95	246	248	48	8.5	
	15	1420	0.82	5.32	735.8	260	96	96	246	249	55	8.5	
	20	1425	0.82	5.32	742.5	258	97	97	243	250	59	9.0	
	25	1430	0.78	5.07	749.1	258	98	98	247	248	61	8.5	
	30	1435	0.82	5.32	755.8	258	98	98	250	250	62	9.0	
	35	1440	0.80	5.20	762.5	259	98	98	250	255	65	9.0	
	40	1451	0.78	5.07	768.8	246	98	98	249	249	67	9.0	
	45	1456	0.82	5.32	775.7	258	97	97	245	249	59	9.5	
	50	1501	0.82	5.32	782.4	260	98	98	250	249	63	9.5	
	55	1506	0.82	5.32	789.1	259	98	98	248	251	65	9.5	
	60	1511	0.80	5.20	795.872	260	99	99	247	252	68	9.5	

Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
0.899034	5.24833	80.064	257.83	97.17	243/250	248/255	68	9.5	

Avg Sqrt Del H

Comments:

WESTON® MANAGERS DESIGNERS/CONSULTANTS

SAMPLE RECOVERY FIELD DATA

EPA Method 5/202 - Particulate

Client	USAF/EQM	W.O. #	20054.006.001.2000
Location/Plant	Lockheed Martin GA	Source & Location	Military F119-PW-100

Run No. 1 — Sample Date 13-Sep-00 — Recovery Date 9/14/00

Sample I.D. AF - M - LMF119 - 1 - M202 - 12SEP2000 — Analyst _____ — Filter Number 634

	Impinger									
	1	2	3 (DI H2O)	4	5	6	7	Imp.Total	8	Total
Contents	Di H2O	Di H2O	~~Empty~~						Silica Gel	
Final	108	110	102					320	320.5	
Initial	100	100	100					300	300	
Gain	8	10	2					20	20.5	

Impinger Color _____ — Labeled? _____

Silica Gel Condition _____ — Sealed? _____

Run No. 2 — Sample Date 13-Sep-00 — Recovery Date 9/14/00

Sample I.D. AF - M - LMF119 - 2 - M202 - 12SEP2000 — Analyst PAE — Filter Number 633

	Impinger									
	1	2	3 (DI H2O)	4	5	6	7	Imp.Total	8	Total
Contents	Di H2O	Di H2O	~~Empty~~						Silica Gel	
Final	99	107	104						323	
Initial	100	100	100						300	
Gain	-1	7	4	-				10	23	-

Impinger Color Clear — Labeled? yes

Silica Gel Condition 1/2 spent — Sealed? yes

Run No. 3 — Sample Date 13-Sep-00 — Recovery Date _____

Sample I.D. AF - M - LMF119 - 3 - M202 - 12SEP2000 — Analyst _____ — Filter Number 635

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	Di H2O	Di H2O	Empty						Silica Gel	
Final										
Initial	100	100							300	
Gain										

Impinger Color _____ — Labeled? _____

Silica Gel Condition _____ — Sealed? _____

Check COC for Sample IDs of Media Blanks

WESTON MANAGERS DESIGNERS/CONSULTANTS

ISOKINETIC FIELD DATA SHEET

*EPA Method 0011 - Formaldehyde

Page 1 of 1

Client	USAF/EQM
W.O.#	20054.006.001.2000
Project ID	AF
Mode/Source ID	I
Samp. Loc. ID	[illegible]19
Run No.ID	1
Test Method ID	M0011
Date ID	12SEP2000
Source/Location	Idle F119-PW-100
Sample Date	12-Sep-00
Baro. Press (in Hg)	29.06
Operator	RDC

Stack Conditions	Assumed	Actual
% Moisture	3	
Impinger Vol (ml)		
Silica gel (g)		
CO2, % by Vol	0.5	
O2, % by Vol	20.5	
Temperature (°F)	149	
Meter Temp (°F)	~~40~~ 82	
Static Press (in H_2O)	-0.02	
Ambient Temp (°F)	87	

Meter Box ID	8
Meter Box Y	1.016
Meter Box Del H	1.591
Probe ID / Length	PST / 4
Probe Material	Boro
Pitot / Thermocouple ID	
Pitot Coefficient	0.84
Nozzle ID	
Avg Nozzle Dia (in)	0.570
Area of Stack (ft^2)	4
Sample Time	180
Total Traverse Pts	1

K Factor 85.271

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.007		0.005
Leak Check @ (in Hg)	12		5
Pitot good	yes / no	yes / no	yes / no
Orsat good	N/A yes / no	yes / no	yes / no

Temp Check	Pre-Test Set	Post-Test Set
Meter Box Temp		
Reference Temp		
Pass/Fail (+/- 2°)	Pass / Fail	Pass / Fail
Temp Change Response	yes / no	yes / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPINGER EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)		COMMENTS
	0	10:39			~~319~~ 2319.563									
	10	10:49	0.01	0.85271	325.113	126	92	90	234	250	61	3		
	20	10:59	0.01	0.85271	330.100	138	95	91	216	248	55	3		
	30	11:09	0.01	0.85271	336.9	140	96	92	242	251	59	3		K changed at 11:04
	40	11:19	0.01	0.88467	342.8	141	97	93	247	250	62	3		K= 88.4667
	50	11:24	0.01	0.88467	348.7	143	97	94	252	250	63	3		
	60	11:39	0.01	0.88467	354.7	143	98	94	254	251	65	3		
	70	11:49	0.01	0.88467	360.6	142	98	95	245	250	66	3		
	80	11:59	0.01	0.88467	366.6	143	99	95	252	250	64	3		
	90	12:09	0.01	0.885	372.6	143	99	95	243	250	58	3		Delta H values
	100	12:19	0.01	0.885	378.6	145	100	95	248	250	59	3		different due to
	110	12:29	0.01	0.883	384.6	145	101	96	246	250	60	3		slight changes
	120	12:39	0.01	0.884	390.5	146	102	97	257	249	60	3		in K Factor
	130	12:49	0.01	0.885	396.5	143	101	97	254	250	61	3		
	140	12:54	0.01	0.888	402.6	145	102	98	255	250	64	3		
	150	1:09	0.01	0.887	408.5	146	102	98	247	250	58	3		
	160	1:19	0.01	0.885	414.5	146	103	99	249	250	58	3		
	170	1:29	0.01	0.887 ~~0.890~~	420.5	145	104	100	238	249	58	3		
	180	1:39	0.01	0.890	426.562	145	106	101	248	250	57	3		

Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
0.1000	~~0.87850~~ 0.88000267	106.999	142.50	97.56	216/257	248/251	64	3	

Avg Sqrt Del H: 0.93726

Comments:

EPA Method 0011 from EPA SW-846

WESTON MANAGERS DESIGNERS/CONSULTANTS

SAMPLE RECOVERY FIELD DATA

*EPA Method 0011 - Formaldehyde

Client: USAF/EQM | W.O. #: 20054.006.001.2000

Location/Plant: Lockheed Martin GA | Source & Location: Idle F119-PW-100

Run No. 1 | Sample Date 12-Sep-00 | Recovery Date

Sample I.D. AF - I - LMF119 - 1 - M0011 - 12SEP2000 | Analyst | Filter Number

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	DNPH	DNPH	DNPH						Silica Gel	
Final	142	50	122						319.2	
Initial	100	100	100						300	
Gain	42	-50	22					14	19.2	33.2

Impinger Color: DARK YELLOW | Labeled?

Silica Gel Condition: 1/2 SPENT | Sealed?

Run No. 2 | Sample Date 12-Sep-00 | Recovery Date

Sample I.D. AF - I - LMF119 - 2 - M0011 - 12SEP2000 | Analyst | Filter Number

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	DNPH	DNPH	DNPH						Silica Gel	
Final										
Initial	100	100	100						300	
Gain			-						-	

Impinger Color | Labeled?

Silica Gel Condition | Sealed?

Run No. 3 | Sample Date 12-Sep-00 | Recovery Date

Sample I.D. AF - I - LMF119 - 3 - M0011 - 12SEP2000 | Analyst | Filter Number

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	DNPH	DNPH	DNPH						Silica Gel	
Final										
Initial	100	100	100						300	
Gain										

Impinger Color | Labeled?

Silica Gel Condition | Sealed?

Check COC for Sample IDs of Media Blanks

WESTON

ISOKINETIC FIELD DATA SHEET

*EPA Method 0011 - Formaldehyde

		Stack Conditions	Assumed	Actual
Client	USAF/EQM	% Moisture	3	
W.O.#	20054.006.001.2000	Impinger Vol (ml)		
Project ID	AF	Silica gel (g)		
Mode/Source ID	A	CO2, % by Vol	0.5	
Samp. Loc. ID	LMF119	O2, % by Vol	20.5	
Run No.ID	1	Temperature (°F)	146	
Test Method ID	M0011	Meter Temp (°F)	95	
Date ID	12SEP2000	Static Press (in H_2O)	-0.05	
Source/Location	Approach F119-PW-100			
Sample Date	12-Sep-00			
Baro. Press (in Hg)	28.94			
Operator	RJC	Ambient Temp (°F)	90	

Meter Box ID	8		
Meter Box Y	1.016		
Meter Box Del H	1.591	**Leak Checks**	Initial / Mid-Point / Final
Probe ID / Length	4	Sample Train (ft^3)	0.004 / / 0.002
Probe Material	Boro	Leak Check @ (in Hg)	15 / / 6
Pitot / Thermocouple ID		Pitot good	(yes) / no / yes / no / yes / (no)
Pitot Coefficient	0.84	Orsat good	yes / no / yes / no / yes / no
Nozzle ID		**Temp Check**	Pre-Test Set / Post-Test Set
Avg Nozzle Dia (in)	0.457	Meter Box Temp	
Area of Stack (ft^2)	4	Reference Temp	
Sample Time	180	Pass/Fail (+/- 2°)	Pass / Fail / Pass / Fail
Total Traverse Pts	1	Temp Change Response	yes / no / yes / no

K Factor ~~36.255~~ 36.255

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPINGER EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)		COMMENTS
	0	16:07			426.741									
	10	16:17	0.09	3.26	437.6	151	114	110	220	~~58~~	58	4		PROBE NOT
	20	16:27	~~1.00~~ 0.1	3.63	448.9	150	117	110	230	250	56	4		OPERATIONAL USED
	30	16:37	0.08	2.90	459.9	150	117	110	240	251	55	4		MS ΔP.
	40	16:47	0.09	3.26	470.8	150	116	110	265	252	57	4		
	50	16:57	0.08	2.90	481.7	150	116	110	250	248	59	3.8		
	60	17:07	0.09	3.26	492.5	150	114	110	240	247	60	3.9		
	70	17:17	0.09	3.26	503.5	150	114	109	240	251	59	3.9		
	80	17:27	0.09	3.26	514.5	150	114	109	230	248	61	3.9		
	90	17:37	0.09	3.26	525.6	149	114	109	253	251	62	3.9		
	100	17:47	0.08	2.90	536.5	149	114	109	255	248	63	3.9		
	110	17:57	0.10	3.63	547.3	150	114	108	255	248	65	3.9		
	120	18:07	0.08	2.90	558.0	149	114	108	233	246	58	3.9		
	130	18:17	0.09	3.26	568.8	148	113	107	255	247	58	3.9		
	140	18:27	0.09	3.26	579.6	148	112	106	248	248	58	3.8		
	150	18:37	0.08	2.90	590.8	148	112	107	247	249	59	3.9		
	160	18:47	0.09	3.26	601.3	148	112	106	240	247	60	3.9		
	170	18:57	0.09	3.26	612.3	147	112	106	232	247	60	3.9		
	180	19:07	0.08	2.90	623.314	147	111	105	233	247	60	3.9		
			Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts		Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp	
			0.29608	3.18111	196.573	149.11		111.08	220/265	247/251	61	3.9		
				Avg Sqrt Del H 1.78242										

WESTON MANAGERS DESIGNERS/CONSULTANTS

Comments:

EPA Method 0011 from EPA SW-846

SAMPLE RECOVERY FIELD DATA

*EPA Method 0011 - Formaldehyde

Client: USAF/EQM | W.O. #: 20054.006.001.2000

Location/Plant: Lockheed Martin GA | Source & Location: Approach F119-PW-100

Run No. 1 | Sample Date 12-Sep-00 | Recovery Date 12Sep00

Sample I.D. AF - A - LMF119 - 1 - M0011 - 12SEP2000 | Analyst EMS | Filter Number —

RINSE: 90 ml | 50ml | 75ml

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	DNPH	DNPH	DNPH						Silica Gel	
Final	107	118	92						336.6	
Initial	100	100	100						300	
Gain	7	18	-8					17	36.6	53.6

Impinger Color: yellow | Labeled? ✓

Silica Gel Condition: 1/2 blue | Sealed? ✓

Run No. 2 | Sample Date 12-Sep-00 | Recovery Date —

Sample I.D. AF - A - LMF119 - 2 - M0011 - 12SEP2000 | Analyst — | Filter Number —

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	DNPH	DNPH	DNPH						Silica Gel	
Final	105									
Initial	100	100	100						300	
Gain		-								

Impinger Color: — | Labeled? —

Silica Gel Condition: — | Sealed? —

Run No. 3 | Sample Date 12-Sep-00 | Recovery Date —

Sample I.D. AF - A - LMF119 - 3 - M0011 - 12SEP2000 | Analyst — | Filter Number —

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	DNPH	DNPH	DNPH						Silica Gel	
Final										
Initial	100	100	100						300	
Gain										

Impinger Color: — | Labeled? —

Silica Gel Condition: — | Sealed? —

Check COC for Sample IDs of Media Blanks

WESTON MANAGERS DESIGNERS/CONSULTANTS

ISOKINETIC FIELD DATA SHEET

*EPA Method 0011 - Formaldehyde

Client	USAF/EQM
W.O.#	20054.006.001.2000
Project ID	AF
Mode/Source ID	N
Samp. Loc. ID	LMF119
Run No.ID	1
Test Method ID	M0011
Date ID	12SEP2000
Source/Location	Intermediate F119-PW-100
Sample Date	13-Sep-00
Baro. Press (in Hg)	28.97
Operator	RJC

Stack Conditions

	Assumed	Actual
% Moisture	2	
Impinger Vol (ml)		
Silica gel (g)		
CO2, % by Vol	0.5	
O2, % by Vol	20.5	
Temperature (°F)	200	
Meter Temp (°F)	90	
Static Press (in H_2O)	-0.25	
Ambient Temp (°F)		

Meter Box ID	8
Meter Box Y	1.016
Meter Box Del H	1.591
Probe ID / Length	4
Probe Material	Boro
Pitot / Thermocouple ID	
Pitot Coefficient	0.84
Nozzle ID	
Avg Nozzle Dia (in)	0.303
Area of Stack (ft^2)	4
Sample Time	180
Total Traverse Pts	1

K Factor 6.4791

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.012		0.004
Leak Check @ (in Hg)	16		11
Pitot good	(yes) / no	yes / no	NA yes / no
Orsat good	yes / no	yes / no	yes / no

Temp Check	Pre-Test Set	Post-Test Set
Meter Box Temp		
Reference Temp		
Pass/Fail (+/- 2°)	Pass / Fail	Pass / Fail
Temp Change Response	yes / no	yes / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPINGER EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)		COMMENTS
	0	11:10			623.588									
	10	11:20	0.64	4.15	636.4	190	103	103	232	248	62	4.1		
	20	11:30	0.43	2.79	646.9	193	107	103	258	248	59	4.1		
	30	11:40	0.47	3.05	657.5	193	107	103	253	247	61	3.2		
	40	11:50	0.43	2.79	667.9	194	107	103	252	248	63	3.2		
	50	12:00	0.43	2.79	678.3	194	106	102	255	248	66	3.4		
	60	12:10	0.41	2.66	688.3	194	107	103	253	247	59	3.4		
	70	12:20	0.40	2.59	698.3	194	107	103	253	246	57	3.2		
	80	12:30	0.42	2.72	708.6	195	107	103	255	246	58	3.2		
	90	12:40	0.43	2.79	718.9	196	107	103	255	248	60	3.2		
	100	12:50	0.44	2.85	729.2	195	107	104	253	246	60	3.2		
	110	13:00	0.44	2.85	739.5	196	108	104	256	248	62	3.2		
	120	13:10	0.44	2.85	750.0	196	108	104	257	248	63	3.2		
	130	13:20	0.45	2.92		198	109	105	256	248	67	3.2		← Stop time 13:1[illegible]
	140	~~13:30~~ RJC												Volume = 753.3
	150	~~13:40~~ RJC												stopped clock at
	160	~~13:50~~ RJC												123.1
	170	~~14:00~~ RJC												
	180	~~14:10~~ RJC												

Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
0.66875	2.90769	126.412	194.46	105.11	232/258	246/248	66	4.1	

Avg Sqrt Del H

Comments:

EPA Method 0011 from EPA SW-846

WESTON MANAGERS DESIGNERS/CONSULTANTS

SAMPLE RECOVERY FIELD DATA

*EPA Method 0011 - Formaldehyde

Client: USAF/EQM | W.O. #: 20054.006.001.2000

Location/Plant: Lockheed Martin GA | Source & Location: Intermediate F119-PW-100

Run No. 1 | Sample Date 13-Sep-00 | Recovery Date 13 Sept 00

Sample I.D. AF - N - LMF119 - 1 - M0011 - 12SEP2000 | Analyst EMS | Filter Number

Rinse: 90 | 140 | 150

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	DNPH	DNPH	DNPH						Silica Gel	
Final	106	110	102						325.6	
Initial	100	100	100						300	
Gain	16	10	2					28	25.6	53.6

Impinger Color: 1/2 blue | Labeled? ✓

Silica Gel Condition: yellow | Sealed? ✓

Run No. 2 | Sample Date 12-Sep-00 | Recovery Date

Sample I.D. AF - N - LMF119 - 2 - M0011 - 12SEP2000 | Analyst | Filter Number

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	DNPH	DNPH	DNPH						Silica Gel	
Final										
Initial	100	100	100						300	
Gain	-						-			

Impinger Color | Labeled?

Silica Gel Condition | Sealed?

Run No. 3 | Sample Date 12-Sep-00 | Recovery Date

Sample I.D. AF - N - LMF119 - 3 - M0011 - 12SEP2000 | Analyst | Filter Number

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	DNPH	DNPH	DNPH						Silica Gel	
Final										
Initial	100	100	100						300	
Gain										

Impinger Color | Labeled?

Silica Gel Condition | Sealed?

Check COC for Sample IDs of Media Blanks

WESTON MANAGERS DESIGNERS/CONSULTANTS

ISOKINETIC FIELD DATA SHEET

*EPA Method 0011 - Formaldehyde

			Stack Conditions	
Client	USAF/EQM		Assumed	Actual
W.O.#	20054.006.001.2000	% Moisture	2	
Project ID	AF	Impinger Vol (ml)		
Mode/Source ID	M	Silica gel (g)		
Samp. Loc. ID	LMF119	CO2, % by Vol	0.5	
Run No.ID	1	O2, % by Vol	20.5	
Test Method ID	M0011	Temperature (°F)	250	
Date ID	12SEP2000	Meter Temp (°F)	90	
Source/Location	Military F119-PW-100	Static Press (in H_2O)	-0.47	
Sample Date	RC 14 ~~13~~ Sep-00			
Baro. Press (in Hg)	28.94			
Operator	RQ, C.	Ambient Temp (°F)		

Meter Box ID	8
Meter Box Y	1.016
Meter Box Del H	1.591
Probe ID / Length	4
Probe Material	Boro
Pitot / Thermocouple ID	
Pitot Coefficient	0.84
Nozzle ID	
Avg Nozzle Dia (in)	0.271
Area of Stack (ft^2)	4
Sample Time	180
Total Traverse Pts	1

K Factor 3.8518

Leak Checks	Initial	Mid-Point	Final
Sample Train (ft^3)	0.002		
Leak Check @ (in Hg)	15		
Pitot good	(yes) / no	yes / no	NA yes / no
Orsat good	yes / no	yes / no	yes / no
Temp Check	Pre-Test Set		Post-Test Set
Meter Box Temp			
Reference Temp			
Pass/Fail (+/- 2°)	Pass / Fail		Pass / Fail
Temp Change Response	yes / no		yes / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM INLET TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPINGER EXIT TEMP (°F)	SAMPLE TRAIN VAC (in Hg)	COMMENTS
	0	1034			753.558								
	10	1044	0.83	3.20	764.0	228	96	94	244	244	69	4.5	
	20	1054	0.78	3.00	774.8	246	101	95	252	243	53	4.5	
	30	11:04	0.77	2.97	785.4	245	101	95	255	242	54	4.5	- Stop Volume = 791.713
	40	RC ~~11:14~~ 11:20	0.78	3.00	795.9	246	101	95	254	244	56	4.5	- Stopped clock at 35
	50	11:30	0.78	3.00	806.6	245	100	96	243	244	55	4.5	RC ~~35~~ ~~5~~
	60	11:40	0.85	3.27	817.7	250	102	96	250	244	60	4.7	- Time = 11:10A.. Stop
	70	RC ~~14:05~~ 14:05	0.79	3.04	828.4	252	103	96	251	245	62	4.7	
	80	~~14:15~~ RC ~~0.82~~	~~0.82~~	~~3.16~~ 3.16	839.3	RC ~~255~~ 256	~~104~~ 106	~~104~~ RC 102	~~255~~ RC 254	~~246~~ 246	~~57~~ 57	4.7	- Stop vol. = 814.78
	90	14:25	0.81	3.12	850.2	255	109	103	253	244	62	4.7	- Stop clock = 61.9
	100	RC ~~14:35~~ 14:30	0.80	3.08	860.9	255	110	103	253	246	66	4.7	- Stop time at 11:4..
	110	15:00	0.82	3.16	871.9	255	107	103	259	244	64	4.5	
	120	15:10	0.80	3.08	882.9	255	111	105	251	245	65	4.5	- Stop vol. = 855.26
	130	15:20	0.78	3.00	886.316	256	111	105	252	247	67	4.5	- Stop clock = 97.4
	140												- Stop Time = ~~14~~ RC
	150												
	160												- Stopped run at 15:12
	170												- Final Volume is 886.316
	180												
			Avg Sqrt Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm		Min/Max	Min/Max	Max Temp	Max Vac	Max Temp
			0.844765	3.08307	135.758	249.37	101.77		243/259	242/247	69	4.7	

Avg Sqrt Del H

Comments:

EPA Method 0011 from EPA SW-846

WESTON MANAGERS DESIGNERS/CONSULTANTS

SAMPLE RECOVERY FIELD DATA

*EPA Method 0011 - Formaldehyde

Client	USAF/EQM	W.O. #	20054.006.001.2000
Location/Plant	Lockheed Martin GA	Source & Location	Military F119-PW-100

Run No. 1 — Sample Date ~~12~~ 14-Sep-00 — Recovery Date 9-14-00

Sample I.D. AF - M - LMF119 - 1 - M0011 - 12SEP2000 — Analyst [illegible] — Filter Number —

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	DNPH	DNPH	DNPH						Silica Gel	
Final	122	116	98						9MK 327.4 325	
Initial	100	100	100						300	
Gain	22	16	-2					36	27.4	63.4

Impinger Color — Labeled?

Silica Gel Condition — Sealed?

Run No. 2 — Sample Date 12-Sep-00 — Recovery Date

Sample I.D. AF - M - LMF119 - 2 - M0011 - 12SEP2000 — Analyst — Filter Number

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	DNPH	DNPH	DNPH						Silica Gel	
Final										
Initial	100	100	100						300	
Gain			-						-	

Impinger Color — Labeled?

Silica Gel Condition — Sealed?

Run No. 3 — Sample Date 12-Sep-00 — Recovery Date

Sample I.D. AF - M - LMF119 - 3 - M0011 - 12SEP2000 — Analyst — Filter Number

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	DNPH	DNPH	DNPH						Silica Gel	
Final										
Initial	100	100	100						300	
Gain										

Impinger Color — Labeled?

Silica Gel Condition — Sealed?

Check COC for Sample IDs of Media Blanks

WESTON MANAGERS OF ENGINEERS CONSULTANTS

APPENDIX B

PARTICULATE ANALYTICAL RESULTS

THIS PAGE INTENTIONALLY LEFT BLANK

PHILIP
ANALYTICAL SERVICES

ANALYTICAL DATA QUALITY PACKAGE

PREPARED BY PHILIP ANALYTICAL

PROJECT 196995

FOR
Roy F. Weston, Inc.

SAMPLED: September 12, 2000

CLIENT CONTACT: Pete Virag

00001

4418 Pottsville Pike, Reading, PA 19605 (610) 921-8833 (610) 921-9667 fax

Philip Analytical Services Data Deliverables Package

TABLE OF CONTENTS

Title Page/Sample Key

Field ID	Lab Sample ID
AF-A-LMF119-1-M202-12SEP2000-FHA, FILT #638, BHC, BHS	1420084
AF-A-LMF119-2-M202-12SEP2000-FHA, FILT #637, BHC, BHS	1420085
AF-A-LMF119-3-M202-12SEP2000-FHA, FILT #636, BHC, BHS	1420086
COMP: AF-A-LMF119-1-3-M202-12SEP2000-FILT #636, 637, 638	1420087
AF-I-LMF119-1-M202-12SEP2000-FHA, FILT #641, BHC, BHS	1420088
AF-I-LMF119-2-M202-12SEP2000-FHA, FILT #640, BHC, BHS	1420089
AF-I-LMF119-3-M202-12SEP2000-FHA, FILT #639, BHC, BHS	1420090
AF-I-LMF119-SB-M202-12SEP2000-ACE, FILT #642, DCM, DIH2O	1420091
COMP: AF-I-LMF119-1-3-M202-12SEP2000-FILT #639, 640, 641	1420092
AF-M-LMF119-1-M202-12SEP2000-FHA, FILT #634, BHC, BHS	1420093
AF-M-LMF119-2-M202-12SEP2000-FHA, FILT #633, BHC, BHS	1420094
AF-M-LMF119-3-M202-12SEP2000-FILT #635	1420095
COMP: AF-M-LMF119-1-3-M202-12SEP2000-FILT #633, 634, 635	1420096
AF-N-LMF119-1-M202-12SEP2000-FHA, FILT #632, BHC, BHS	1420097
AF-N-LMF119-2-M202-12SEP2000-FHA, FILT #631, BHC, BHS	1420098
AF-N-LMF119-3-M202-12SEP2000-FILT #630	1420099
COMP: AF-N-LMF119-1-3-M202-12SEP2000-FILT #630, 631, 632	1420100
Filter W646	1421165
Filter W647	1421166
Filter W648	1421167

00005

Chain-of-Custody

Lab Tracking Number
196995

Chain-of-Custody Record/Lab Work Request

WESTON

Client	USAF/EQM, Lockheed Martin GA		
Work Order Number	20054.006.001.2000	**Phone Number**	610-701-7327
Contact Person	Pete Virag	**Turn Around Time**	Standard

				Analyses Requested/Other Info				
Lab ID	**Field Sample ID**	**Sample Collection Date**	**Analysis**	**Filter #**				**Sample Check-off**
	AF - A - LMF119 - 1 - M202 - 12SEP2000 - FHA	9/12/00	M202					
	AF - A - LMF119 - 1 - M202 - 12SEP2000 - FILT	9/12/00	M202	635				
	AF - A - LMF119 - 1 - M202 - 12SEP2000 - BHC	9/12/00	M202					
	AF - A - LMF119 - 1 - M202 - 12SEP2000 - BHS	9/12/00	M202					
	AF - A - LMF119 - 2 - M202 - 12SEP2000 - FHA	9/12/00	M202					
	AF - A - LMF119 - 2 - M202 - 12SEP2000 - FILT	9/12/00	M202	637				
	AF - A - LMF119 - 2 - M202 - 12SEP2000 - BHC	9/12/00	M202					
	AF - A - LMF119 - 2 - M202 - 12SEP2000 - BHS	9/12/00	M202					
	AF - A - LMF119 - 3 - M202 - 12SEP2000 - FHA	9/12/00	M202					
	AF - A - LMF119 - 3 - M202 - 12SEP2000 - FILT	9/12/00	M202	636				
	AF - A - LMF119 - 3 - M202 - 12SEP2000 - BHC	9/12/00	M202					
	AF - A - LMF119 - 3 - M202 - 12SEP2000 - BHS	9/12/00	M202					

Notes: M5 - Gravimetric Analysis per EPA Method 5 for front half and EPA Method 202 for Back Half

weigh all fractions to 0.01 mg using a five place balance,
weigh filters individually followed by placing Runs 1-3 filters together on the balance
to obtain a composite weight of the 3 FILTERS.

Relinquished By	Received By	Date	Time	Lab Use Only	
		19 Sept 00	1100	Shipper PAS	Air Bill #
		9-19-00	1435	Opened By	Date/Time
				Temp °C 28	Condition intact
				Custody Seals: Yes No None (N/A)	

Laboratory Comments:

Lab Tracking Number
196995

Chain-of-Custody Record/Lab Work Request

WESTON

Client	USAF/EQM, Lockheed Martin GA		
Work Order Number	20054.006.001.2000	**Phone Number**	610-701-7327
Contact Person	Pete Virag	**Turn Around Time**	Standard

Lab ID	Field Sample ID	Sample Collection Date	Analyses Requested/Other Info: Analysis	Filter #			Sample Check-off
	AF - I - LMF119 - 1 - M202 - 12SEP2000 - FHA	9/12/00	M202				
	AF - I - LMF119 - 1 - M202 - 12SEP2000 - FILT	9/12/00	M202	641			
	AF - I - LMF119 - 1 - M202 - 12SEP2000 - BHC	9/12/00	M202				
	AF - I - LMF119 - 1 - M202 - 12SEP2000 - BHS	9/12/00	M202				
	AF - I - LMF119 - 2 - M202 - 12SEP2000 - FHA	9/12/00	M202				
	AF - I - LMF119 - 2 - M202 - 12SEP2000 - FILT	9/12/00	M202	640			
	AF - I - LMF119 - 2 - M202 - 12SEP2000 - BHC	9/12/00	M202				
	AF - I - LMF119 - 2 - M202 - 12SEP2000 - BHS	9/12/00	M202				
	AF - I - LMF119 - 3 - M202 - 12SEP2000 - FHA	9/12/00	M202				
	AF - I - LMF119 - 3 - M202 - 12SEP2000 - FILT	9/12/00	M202	639			
	AF - I - LMF119 - 3 - M202 - 12SEP2000 - BHC	9/12/00	M202				
	AF - I - LMF119 - 3 - M202 - 12SEP2000 - BHS	9/12/00	M202				
	AF - I - LMF119 - SB - M202 - 12SEP2000 - ACE	9/12/00	M202				
	AF - I - LMF119 - SB - M202 - 12SEP2000 - FILT	9/12/00	M202	642			
	AF - I - LMF119 - SB - M202 - 12SEP2000 - DCM	9/12/00	M202				
	AF - I - LMF119 - SB - M202 - 12SEP2000 - DIH20	9/12/00	M202				

Notes: M5 - Gravimetric Analysis per EPA Method 5 for front half and EPA Method 202 for Back Half

Weigh all fractions to 0.01 mg using a five place balance. Weigh filters individually followed by placing Run 1-3 AZtex together on the balance to obtain a composite weight of the 3 filters.

Relinquished By	Received By	Date	Time	Lab Use Only	
		19 Sep 2000	1100	Shipper FAS	Air Bill #
		9-19-00	1435	Opened By (nel)	Date/Time
				Temp °C 28	Condition Intact
				Custody Seals: Yes No None (N/A)	

Laboratory Comments:

Lab Tracking Number
196995

Chain-of-Custody Record/Lab Work Request

WESTON

Client	USAF/EQM, Lockheed Martin GA		
Work Order Number	20054.006.001.2000	**Phone Number**	610-701-7327
Contact Person	Pete Virag	**Turn Around Time**	Standard

			Analyses Requested/Other Info				
Lab ID	**Field Sample ID**	**Sample Collection Date**	**Analysis**	**Filter #**			**Sample Check-off**
	AF - M - LMF119 - 1 - M202 - 12SEP2000 - FHA	9/13/00	M202				
	AF - M - LMF119 - 1 - M202 - 12SEP2000 - FILT	9/13/00	M202	634			
	AF - M - LMF119 - 1 - M202 - 12SEP2000 - BHC	9/13/00	M202				
	AF - M - LMF119 - 1 - M202 - 12SEP2000 - BHS	9/13/00	M202				
	AF - M - LMF119 - 2 - M202 - 12SEP2000 - FHA	9/13/00	M202				
	AF - M - LMF119 - 2 - M202 - 12SEP2000 - FILT	9/13/00	M202	633			
	AF - M - LMF119 - 2 - M202 - 12SEP2000 - BHC	9/13/00	M202				
	AF - M - LMF119 - 2 - M202 - 12SEP2000 - BHS	9/13/00	M202				
	~~AF - M - LMF119 - 3 - M202 - 12SEP2000 - FHA~~	9/13/00	M202				
	AF - M - LMF119 - 3 - M202 - 12SEP2000 - FILT	9/13/00	M202	635			
	~~AF - M - LMF119 - 3 - M202 - 12SEP2000 - BHC~~	9/13/00	M202				
	~~AF - M - LMF119 - 3 - M202 - 12SEP2000 - BHS~~	9/13/00	M202				

Notes: M5 - Gravimetric Analysis per EPA Method 5 for front half and EPA Method 202 for Back Half

Weigh all fractions to 0.01 mg using a five place balance, weigh all filters individually followed by placing Runs 1-3 filters together on the balance to obtaining a composite weight of the 3 filters.

Relinquished By	Received By	Date	Time	Lab Use Only	
		19 Sep 2000	1100	Shipper FAS courier	Air Bill #
		9/19/00	1435	Opened By	Date/Time
				Temp °C 28	Condition intact
				Custody Seals: Yes No None N/A	

Laboratory Comments:

Lab Tracking Number
196995

Chain-of-Custody Record/Lab Work Request

WESTON

Client	USAF/EQM, Lockheed Martin GA		
Work Order Number	20054.006.001.2000	Phone Number	610-701-7327
Contact Person	Pete Virag	Turn Around Time	Standard

Lab ID	Field Sample ID	Sample Collection Date	Analyses Requested/Other Info: Analysis	Filter #			Sample Check-off
	AF - N - LMF119 - 1 - M202 - 12SEP2000 - FHA	9/13/00	M202				
	AF - N - LMF119 - 1 - M202 - 12SEP2000 - FILT	9/13/00	M202	632			
	AF - N - LMF119 - 1 - M202 - 12SEP2000 - BHC	9/13/00	M202				
	AF - N - LMF119 - 1 - M202 - 12SEP2000 - BHS	9/13/00	M202				
	AF - N - LMF119 - 2 - M202 - 12SEP2000 - FHA	9/13/00	M202				
	AF - N - LMF119 - 2 - M202 - 12SEP2000 - FILT	9/13/00	M202	631			
	AF - N - LMF119 - 2 - M202 - 12SEP2000 - BHC	9/13/00	M202				
	AF - N - LMF119 - 2 - M202 - 12SEP2000 - BHS	9/13/00	M202				
	~~AF - N - LMF119 - 3 - M202 - 12SEP2000 - FHA~~	~~9/13/00~~	~~M202~~ 0				
	AF - N - LMF119 - 3 - M202 - 12SEP2000 - FILT	9/13/00	M202	630			
	~~AF - N - LMF119 - 3 - M202 - 12SEP2000 - BHC~~	~~9/13/00~~	~~M202~~ 0				
	~~AF - N - LMF119 - 3 - M202 - 12SEP2000 - BHS~~	~~9/13/00~~	~~M202~~ 0				

Notes: M5 - Gravimetric Analysis per EPA Method 5 for front half and EPA Method 202 for Back Half

weigh all fractions to 0.01 mg using a five place balance.
weigh all filters individually followed by placing runs 1-3 filters together on the balance to obtain a composite weight of the 3 filters.

Relinquished By	Received By	Date	Time	Lab Use Only	
		9/14/00	1100	Shipper FED	Air Bill #
		9/19/00	1435	Opened By	Date/Time
				Temp °C 28	Condition intact
				Custody Seals: Yes No None (N/A)	

Laboratory Comments:

WESTON Analytics Use Only
196195

Custody Transfer Record/Lab Work Request

Page ____ of ____

Client VSAF / EQM
Est. Final Proj. Sampling Date
Work Order # 20054.006.001.2000
Project Contact/Phone # Jack Mills
AD Project Manager
QC ____ Del ____ TAT ____
Date Rec'd ____ Date Due ____
Account #

Refrigerator #
#/Type Container — Liquid / Solid
Volume — Liquid / Solid
Preservatives

ANALYSES REQUESTED → ORGANIC: VOA, BNA, Pest/PCB, Herb; INORG: Metal, CN

MATRIX CODES:
S - Soil
SE - Sediment
SO - Solid
SL - Sludge
W - Water
O - Oil
A - Air
DS - Drum Solids
DL - Drum Liquids
L - EP/TCLP Leachate
WI - Wipe
X - Other
F - Fish

Lab ID	Client ID/Description	Matrix QC Chosen (✓) MS	MSD	Matrix	Date Collected	Time Collected	WESTON Analytics Use Only
	FILTER W646						
	FILTER W647						
	FILTER W648						

FIELD PERSONNEL: COMPLETE ONLY SHADED AREAS

Special Instructions:
POST WEIGHT ON UNUSED FILTERS
ATTENTION VAUGHN ONEILL

DATE/REVISIONS:
1. ____
2. ____
3. ____
4. ____
5. ____
6. ____

WESTON Analytics Use Only

Samples were:
1) Shipped ___ or Hand Delivered ✓
Airbill # ____
2) Ambient or Chilled
3) Received in Good Condition (Y) or N
4) Labels Indicate Properly Preserved (NA) Y or N
5) Received Within Holding Times (Y) or N

COC Tape was:
1) Present on Outer Package Y or (N)
2) Unbroken on Outer Package Y or (N)
3) Present on Sample Y or (N)
4) Unbroken on Sample Y or (N)
COC Record Present Upon Sample Rec't (Y) or N

Discrepancies Between Samples Labels and COC Record? Y or (N)
NOTES:

Relinquished by	Received by	Date	Time
Jack Mills	[illegible]	9/28/00	1405

Relinquished by	Received by	Date	Time
→	[illegible]	9/28/00	1600

RFW 21-21-001/A-7/91 ____ L372 ____ L373 ____ L375 ____ L377 ____ L378 Ref# ____ Cooler# ____ 381-596a

Internal Chain-of-Custody Records

PHILIP ANALYTICAL SERVICES
INTERNAL CHAIN OF CUSTODY

USE MILITARY TIME

DATE OF SAMPLE TRANSFER TO STORAGE: nej 9/20/00 TIME: 1200 BY: (nej)

LAB SAMPLE ID	DATE/TIME REMOVED	ANALYSIS PERFORMED	DATE/TIME RETURNED	BY	USED ALL?
1420084-100	0900 HRS 9/20/00	Metal 202		JH, TD	(Y) / N
1241165-67		Metal 5		VO	(Y) / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N
					Y / N

COMMENTS:

196995 Roy F. Weston, Inc.

1420084-1420100

DUE: 26-SEP-00

Methodology Summary

METHODOLOGY SUMMARY

Philip Analytical Services
Reading, Pennsylvania

ENVIRONMENTAL ORGANICS:

AQUEOUS, WASTEWATER METHODOLOGY, (REF 1, 3)

	METHOD	PERFORMED
PURGEABLE ORGANICS BY GC/MS	624	( )
BASE-NEUTRAL/ACIDS BY GC/MS	625	( )
ORGANOCHLORINE PESTICIDES/PCBS BY GC	608	( )
PURGEABLE ORGANICS BY GC	601/602	( )
MISC		( )

SOIL & SEDIMENT, GROUNDWATER METHODOLOGY, (REF 2)

PURGEABLE ORGANICS BY GC/MS	8240/8260	( )
BASE-NEUTRAL/ACIDS BY GC/MS	8270	( )
PURGEABLE ORGANICS BY GC	8010/8020	( )
ORGANOCHLORINE PESTICIDES/PCBS BY GC	8080/8081/8082	( )
HERBICIDES	8151	( )
EXPLOSIVES	8330/8332	( )
DRO/GRO/GLYCOLS BY GC	8015, Modified	( )
MISC		( )

ENVIRONMENTAL METALS:

SAMPLE PREPARATION, AQUEOUS, (REF 1)	METHOD	PERFORMED
ICAP PREP & ANALYSIS	200.7	( )
FLAME ATOMIC ABSORPTION	200.0	( )
FURNACE ATOMIC ABSORPTION	200.0	( )
MERCURY SAMPLE PREP & ANALYSIS	245.1	( )

SAMPLE PREPARATION, SOIL & SEDIMENT, GROUNDWATER, (REF 2)

ICAP SAMPLE PREP & ANALYSIS	6010	( )
FLAME ATOMIC ABSORPTION	3050	( )
FURNACE ATOMIC ABSORPTION	3050	( )
MERCURY SAMPLE PREP & ANALYSIS	7471	( )

FLAME AA (AQUEOUS/NON-AQUEOUS), (REF 1, 2)

ALUMINUM	202.1/7020	( )
ANITMONY	204.1/7040	( )
BARIUM	208.1/7080	( )
BERYLLIUM	210.1/7090	( )
CADMIUM	213.1/7130	( )
CALCIUM	215.1/7140	( )
CHROMIUM	218.1/7190	( )
COBALT	219.1/7200	( )
COPPER	220.1/7210	( )
IRON	236.1/7381	( )
LEAD	239.1/7420	( )
MAGNESIUM	242.1/7450	( )
MANGANESE	243.1/7460	( )
MOLYBDENUM	246.1/7480	( )
NICKEL	249.1/7520	( )
POTASSIUM	258.1/7610	( )
SILVER	272.1/7760	( )
SODIUM	273.1/7760	( )
TIN	284.1/7870	( )
TITANIUM	283.1	( )
VANADIUM	283.1/7910	( )
ZINC	289.1/7950	( )

FURNACE AA (AQUEOUS/NON-AQUEOUS), (REF 1, 2)

ANTIMONY	200.9/7041	( )
ARSENIC	200.9/7060	( )
BERYLLIUM	200.9	( )
CHROMIUM	200.9/7060	( )
LEAD	200.9/7421	( )
THALLIUM	200.9/7841	( )
NICKEL	200.9/7520	( )
SELENIUM	200.9/7741	( )

ENVIRONMENTAL INORGANICS/PHYSICAL TESTING PARAMETERS

PARAMETER, (REF 1, 2, 3, 4, 5, 10)	METHOD	PERFORMED
ALKALINITY	310.1	( )
AMMONIA	350.1	( )
BIOCHEMICAL OXYGEN DEMAND	405.1	( )
BROMIDE	320.1	( )
CHEMICAL OXYGEN DEMAND-LIQUID	410.1/508A	( )
CHEMICAL OXYGEN DEMAND-SOLID	5220	( )
CHLORIDE (LIQUID/SOLID)	325.2/9252/300.0	( )
COLOR (LIQUID/SOLID)	110.1/110.2	( )
CORROSIVITY	SW846/CHAP 7	( )
CYANIDE, TOTAL (LIQUID/SOLID)	335.3/9012/4500 CD/CE	( )
EXTRACTION PROCEDURE TOXICITY	1310	( )
FECAL COLIFORM	9222D	( )
HARDNESS	130.1	( )
HEATING VALUE	353.2/9200/D2015	( )
HEXAVALENT CHROMIUM	218.4	( )
MOISTURE	D2216	( )
NITRATE,NITROGEN (LIQUID/SOLID)	353.2/9200	( )
NITRITE, NITROGEN (LIQUID/SOLID)	353.2/9200	( )
ODOR (LIQUID/SOLID)	140.1/SM207	( )
OIL AND GREASE	413.1	( )
ORGANIC CARBON, DISSOLVED	415.1	( )
ORGANIC CARBON, TOTAL	415.1	( )
PETROLEUM HYDROCARBONS	418.1,(REF 1,4)	( )
pH	150.1/9045	( )
PHENOLS, TOTAL (LIQUID/SOLID)	420.2/9066	( )
PHOSPHORUS, TOTAL	365.1	( )
REACTIVE CYANIDE	SW846/CHAP 7	( )
REACTIVE SULFIDE	SW846/CHAP 7	( )
REACTIVITY	SW846/CHAP 7	( )
SPECIFIC CONDUCTANCE	120.1	( )
SULFATE (LIQUID/SOLID)	375.4/9251/300.0	( )
SULFIDE	376.1/9030	( )
SULFUR	D4239	( )
SURFACTANTS (LIQUID/SOLID)	425.1/SM512A	( )
TCLP SET-UP	EPA 1311	( )
TOTAL COLIFORM (COLILERT METHOD)	SM9223B	( )
TOTAL DISSOLVED SOLIDS (LIQUID/SOLID)	160.1	( )
TOTAL ORGANIC HALOGENS	9020	( )
TOTAL SOLIDS	209F	( )
TOTAL SUSPENDED SOLIDS	160.2	( )
TOTAL VOLATILE SOLIDS	2540G	( )
WATER BY KARL FISCHER	4017	( )
TOTAL KJELDAHL NITROGEN	351.3	( )
PHYSICAL TESTING-ASH	D3174	( )
PHYSICAL TESTING-SULFUR	D4239	( )
PHYSICAL TESTING-CHNO ANALYSIS	D5291	( )
FECAL COLIFORM, MF	9222D	( )
MISC PARTICULATE	EPA 5 & EPA 202	(✓)

INDUSTRIAL HYGIENE PARAMETERS

AIR, (REF 6, 7, 8, 9)	METHOD	PERFORMED
VOLATILE ORGANICS BY GC/MS	EPA 18M	( )
PESTICIDES/PCBS BY GC	TO4	( )
METALS	NIOSH 7300	( )
METALS	OSHA ID 121	( )
METALS	OSHA ID 125G	( )
METALS	40CFR, PT50, APPXG	( )
MISC		( )
MISC		( )
MISC		( )

METHOD REFERENCES

ALL METHODS ARE MOST CURRECT VERSION AVAILABLE:

(1) METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE-600/4-79-002
(2) SW846 TEST METHODS FOR EVALUATING SOLID WASTE
(3) 40 CFR PART 136, VOL. 49, NO. 209 TEST PARAMETERS FOR THE ANALYSIS OF POLLUTANTS
(4) AS MODIFIED BY NJDEP-BISE
(5) STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER
(6) EPA-450/4-87-022
(7) 40 CFR PART 50, APPENDIX G
(8) OSHA MANUAL OF ANALYTICAL METHODS
(9) NIOSH MANUAL OF ANALYTICAL METHODS, (NMAM)
(10) AMERICAN SOCIETY FOR TESTING AND MATERIALS, (ASTM) STANDARDS

Laboratory Chronicle

Field ID	Lab Sample ID	Analytical Method	Date Sampled	Date Rec'd	Date of Prep	Date Of Analysis
AF-A-LMF119-1-M202-12SEP2000-FHA, FILT #638, BHC, BHS	1420084	EPA 5	9/12/00	9/19/00		9/25/00
AF-A-LMF119-2-M202-12SEP2000-FHA, FILT #637, BHC, BHS	1420085	EPA 5	9/12/00	9/19/00		9/25/00
AF-A-LMF119-3-M202-12SEP2000-FHA, FILT #636, BHC, BHS	1420086	EPA 5	9/12/00	9/19/00		9/25/00
COMP: AF-A-LMF119-1-3-M202-12SEP2000-FILT #636, 637, 638	1420087	EPA 5	9/12/00	9/19/00		9/25/00
AF-I-LMF119-1-M202-12SEP2000-FHA, FILT #641, BHC, BHS	1420088	EPA 5	9/12/00	9/19/00		9/25/00
AF-I-LMF119-2-M202-12SEP2000-FHA, FILT #640, BHC, BHS	1420089	EPA 5	9/12/00	9/19/00		9/25/00
AF-I-LMF119-3-M202-12SEP2000-FHA, FILT #639, BHC, BHS	1420090	EPA 5	9/12/00	9/19/00		9/25/00
AF-I-LMF119-SB-M202-12SEP2000-ACE, FILT #642, DCM, DIH2O	1420091	EPA 5	9/12/00	9/19/00		9/25/00
COMP: AF-I-LMF119-1-3-M202-12SEP2000-FILT #639, 640, 641	1420092	EPA 5	9/12/00	9/19/00		9/25/00
AF-M-LMF119-1-M202-12SEP2000-FHA, FILT #634, BHC, BHS	1420093	EPA 5	9/13/00	9/19/00		9/25/00
AF-M-LMF119-2-M202-12SEP2000-FHA, FILT #633, BHC, BHS	1420094	EPA 5	9/13/00	9/19/00		9/25/00
AF-M-LMF119-3-M202-12SEP2000-FILT #635	1420095	EPA 5	9/13/00	9/19/00		9/25/00
COMP: AF-M-LMF119-1-3-M202-12SEP2000-FILT #633, 634, 635	1420096	EPA 5	9/13/00	9/19/00		9/20/00
AF-N-LMF119-1-M202-12SEP2000-FHA, FILT #632, BHC, BHS	1420097	EPA 5	9/13/00	9/19/00		9/25/00
AF-N-LMF119-2-M202-12SEP2000-FHA, FILT #631, BHC, BHS	1420098	EPA 5	9/13/00	9/19/00		9/25/00
AF-N-LMF119-3-M202-12SEP2000-FILT #630	1420099	EPA 5	9/13/00	9/19/00		9/25/00
COMP: AF-N-LMF119-1-3-M202-12SEP2000-FILT #630, 631, 632	1420100	EPA 5	9/13/00	9/19/00		9/25/00
Filter W646	1421165	EPA 5		9/28/00		9/25/00
Filter W647	1421166	EPA 5		9/28/00		9/25/00
Filter W648	1421167	EPA 5		9/28/00		9/25/00
AF-A-LMF119-1-M202-12SEP2000-FHA, FILT #638, BHC, BHS	1420084	EPA 5	9/12/00	9/19/00		9/25/00
AF-A-LMF119-2-M202-12SEP2000-FHA, FILT #637, BHC, BHS	1420085	EPA 5	9/12/00	9/19/00		9/25/00
AF-A-LMF119-3-M202-12SEP2000-FHA, FILT #636, BHC, BHS	1420086	EPA 5	9/12/00	9/19/00		9/25/00
AF-I-LMF119-1-M202-12SEP2000-FHA, FILT #641, BHC, BHS	1420088	EPA 5	9/12/00	9/19/00		9/25/00
AF-I-LMF119-2-M202-12SEP2000-FHA, FILT #640, BHC, BHS	1420089	EPA 5	9/12/00	9/19/00		9/25/00
AF-I-LMF119-3-M202-12SEP2000-FHA, FILT #639, BHC, BHS	1420090	EPA 5	9/12/00	9/19/00		9/25/00
AF-I-LMF119-SB-M202-12SEP2000-ACE, FILT #642, DCM, DIH2O	1420091	EPA 5	9/12/00	9/19/00		9/25/00
AF-M-LMF119-1-M202-12SEP2000-FHA, FILT #634, BHC, BHS	1420093	EPA 5	9/13/00	9/19/00		9/25/00
AF-M-LMF119-2-M202-12SEP2000-FHA, FILT #633, BHC, BHS	1420094	EPA 5	9/13/00	9/19/00		9/25/00
AF-N-LMF119-1-M202-12SEP2000-FHA, FILT #632, BHC, BHS	1420097	EPA 5	9/13/00	9/19/00		9/20/00
AF-N-LMF119-2-M202-12SEP2000-FHA, FILT #631, BHC, BHS	1420098	EPA 5	9/13/00	9/19/00		9/20/00
AF-A-LMF119-1-M202-12SEP2000-FHA, FILT #638, BHC, BHS	1420084	EPA 202	9/12/00	9/19/00		9/25/00
AF-A-LMF119-2-M202-12SEP2000-FHA, FILT #637, BHC, BHS	1420085	EPA 202	9/12/00	9/19/00		9/25/00
AF-A-LMF119-3-M202-12SEP2000-FHA, FILT #636, BHC, BHS	1420086	EPA 202	9/12/00	9/19/00		9/25/00
AF-I-LMF119-1-M202-12SEP2000-FHA, FILT #641, BHC, BHS	1420088	EPA 202	9/12/00	9/19/00		9/25/00

AF-I-LMF119-2-M202-12SEP2000-FHA, FILT #640, BHC, BHS	1420089	EPA 202	9/12/00	9/19/00		9/25/00
AF-I-LMF119-3-M202-12SEP2000-FHA, FILT #639, BHC, BHS	1420090	EPA 202	9/12/00	9/19/00		9/25/00
AF-I-LMF119-SB-M202-12SEP2000-ACE, FILT #642, DCM, DIH2O	1420091	EPA 202	9/12/00	9/19/00		9/25/00
AF-M-LMF119-1-M202-12SEP2000-FHA, FILT #634, BHC, BHS	1420093	EPA 202	9/13/00	9/19/00		9/25/00
AF-M-LMF119-2-M202-12SEP2000-FHA, FILT #633, BHC, BHS	1420094	EPA 202	9/13/00	9/19/00		9/25/00
AF-N-LMF119-1-M202-12SEP2000-FHA, FILT #632, BHC, BHS	1420097	EPA 202	9/13/00	9/19/00		9/20/00
AF-N-LMF119-2-M202-12SEP2000-FHA, FILT #631, BHC, BHS	1420098	EPA 202	9/13/00	9/19/00		9/20/00
AF-A-LMF119-1-M202-12SEP2000-FHA, FILT #638, BHC, BHS	1420084	EPA 202	9/12/00	9/19/00		9/25/00
AF-A-LMF119-2-M202-12SEP2000-FHA, FILT #637, BHC, BHS	1420085	EPA 202	9/12/00	9/19/00		9/25/00
AF-A-LMF119-3-M202-12SEP2000-FHA, FILT #636, BHC, BHS	1420086	EPA 202	9/12/00	9/19/00		9/25/00
AF-I-LMF119-1-M202-12SEP2000-FHA, FILT #641, BHC, BHS	1420088	EPA 202	9/12/00	9/19/00		9/25/00
AF-I-LMF119-2-M202-12SEP2000-FHA, FILT #640, BHC, BHS	1420089	EPA 202	9/12/00	9/19/00		9/25/00
AF-I-LMF119-3-M202-12SEP2000-FHA, FILT #639, BHC, BHS	1420090	EPA 202	9/12/00	9/19/00		9/25/00
AF-I-LMF119-SB-M202-12SEP2000-ACE, FILT #642, DCM, DIH2O	1420091	EPA 202	9/12/00	9/19/00		9/25/00
AF-M-LMF119-1-M202-12SEP2000-FHA, FILT #634, BHC, BHS	1420093	EPA 202	9/13/00	9/19/00		9/25/00
AF-M-LMF119-2-M202-12SEP2000-FHA, FILT #633, BHC, BHS	1420094	EPA 202	9/13/00	9/19/00		9/25/00
AF-N-LMF119-1-M202-12SEP2000-FHA, FILT #632, BHC, BHS	1420097	EPA 202	9/13/00	9/19/00		9/20/00
AF-N-LMF119-2-M202-12SEP2000-FHA, FILT #631, BHC, BHS	1420098	EPA 202	9/13/00	9/19/00		9/20/00

00022

Analyte
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Particulate Weight - Filter
Wt - Acetone Probe
Wt - Acetone Probe
Wt - Acetone Probe
Wt - Acetone Probe
Wt - Acetone Probe
Wt - Acetone Probe
Wt - Acetone Probe
Wt - Acetone Probe
Wt - Acetone Probe
Wt - Acetone Probe
Wt - Acetone Probe
Particulate Wt. Organic Fraction
Particulate Wt. Organic Fraction
Particulate Wt. Organic Fraction
Particulate Wt. Organic Fraction

Particulate Wt. Organic Fraction
Particulate Wt. Organic Fraction
Particulate Wt. Organic Fraction
Particulate Wt. Organic Fraction
Particulate Wt. Organic Fraction
Particulate Wt. Organic Fraction
Particulate Wt. Organic Fraction
Particulate Wt. Inorganic Fraction
Particulate Wt. Inorganic Fraction
Particulate Wt. Inorganic Fraction
Particulate Wt. Inorganic Fraction
Particulate Wt. Inorganic Fraction
Particulate Wt. Inorganic Fraction
Particulate Wt. Inorganic Fraction
Particulate Wt. Inorganic Fraction
Particulate Wt. Inorganic Fraction
Particulate Wt. Inorganic Fraction
Particulate Wt. Inorganic Fraction

Case Narrative/ Non-Conformance Summary Report

Case Narrative/Non-Conformance Summary

Client Name: **Roy F. Weston, Inc.**
Project Name: Lockheed Martin, GA/Method 202, WO#20054.006.001.2000
PAS Project #: 196995
Today's Date: October 10, 2000

This sample delivery group consisted of 20 samples collected on September 12-13, 2000. Samples were received intact on September 19, 2000 at the Philip Analytical Services Laboratory. Samples were logged into the Laboratory Information Management System (LIMS).

The samples were prepared and analyzed for Particulate by EPA 5 and EPA 202.

The following is a summary in narrative form of the quality control results associated with the samples.

Inorganics:
Particulate-

- No problems encountered with the analysis of these samples.

Helen MacMinn, Quality Assurance Coordinator

Analytical Sample Results for All Parameters/Final Report

PHILIP ANALYTICAL SERVICES

INDUSTRIAL HYGIENE ENVIRONMENTAL TESTING

• EPA/NVLAP 101262-0 • NY DOH 10903 • NJ DEP 77678
• AIHA ACCREDITATION NO. 100439 • PA DER 06-353

ANALYTICAL REPORT

Client: Roy F. Weston, Inc.

Report to: Pete Virag
Roy F. Weston, Inc.
1400 Weston Way
Building 5-1
West Chester PA 19380-1499

Project: 196995
Received: 19-SEP-00
Reported: 18-OCT-00

Copy to: Jack Mills, Roy F. Weston, Inc.

Project Description: Method 202: USAF/EQM, Lockheed Martin GA
WO # 20054.006.001.2000

	RESULT	UNITS	METHOD	DATE	ANALYST
AF-A-LMF119-1-M202-12SEP2000-FHA, FILT #638, BHC, BHS					
Lab Sample: 1420084					
sampled: 12-SEP-00					
Particulate Weight - Filter	< 0.1	mg	EPA 5	20-SEP-00	VJO
Wt - Acetone Probe	1.8	mg	EPA 5	20-SEP-00	VJO
Particulate Wt. Organic Fraction	0.5	mg	EPA 202	20-SEP-00	VJO
Particulate Wt. Inorganic Fraction	1.4	mg	EPA 202	20-SEP-00	VJO
AF-A-LMF119-2-M202-12SEP2000-FHA, FILT #637, BHC, BHS					
Lab Sample: 1420085					
sampled: 12-SEP-00					
Particulate Weight - Filter	< 0.1	mg	EPA 5	20-SEP-00	VJO
Wt - Acetone Probe	1.4	mg	EPA 5	20-SEP-00	VJO
Particulate Wt. Organic Fraction	1.6	mg	EPA 202	20-SEP-00	VJO
Particulate Wt. Inorganic Fraction	3.9	mg	EPA 202	20-SEP-00	VJO
AF-A-LMF119-3-M202-12SEP2000-FHA, FILT #636, BHC, BHS					
Lab Sample: 1420086					
sampled: 12-SEP-00					
Particulate Weight - Filter	< 0.1	mg	EPA 5	20-SEP-00	VJO
Wt - Acetone Probe	1.1	mg	EPA 5	20-SEP-00	VJO
Particulate Wt. Organic Fraction	0.9	mg	EPA 202	20-SEP-00	VJO
Particulate Wt. Inorganic Fraction	1.3	mg	EPA 202	20-SEP-00	VJO

PHILIP
ANALYTICAL SERVICES

INDUSTRIAL HYGIENE ENVIRONMENTAL TESTING

• EPA/NVLAP 101262-0 • NY DOH 10903 • NJ DEP 77678
• AIHA ACCREDITATION NO. 100439 • PA DER 06-353

Client: Roy F. Weston, Inc.
Project: 196995

	RESULT	UNITS	METHOD	DATE	ANALYST
COMP: AF-A-LMF119-1-3-M202-12SEP2000-FILT #636, 637, 638					
Lab Sample: 1420087					
sampled: 12-SEP-00					
Particulate Weight - Filter	< 0.1	mg	EPA 5	20-SEP-00	VJO
AF-I-LMF119-1-M202-12SEP2000-FHA, FILT #641, BHC, BHS					
Lab Sample: 1420088					
sampled: 12-SEP-00					
Particulate Weight - Filter	< 0.1	mg	EPA 5	20-SEP-00	VJO
Wt - Acetone Probe	1.9	mg	EPA 5	20-SEP-00	VJO
Particulate Wt. Organic Fraction	0.8	mg	EPA 202	20-SEP-00	VJO
Particulate Wt. Inorganic Fraction	3.1		EPA 202	20-SEP-00	VJO
AF-I-LMF119-2-M202-12SEP2000-FHA, FILT #640, BHC, BHS					
Lab Sample: 1420089					
sampled: 12-SEP-00					
Particulate Weight - Filter	< 0.1	mg	EPA 5	20-SEP-00	VJO
Wt - Acetone Probe	2.2	mg	EPA 5	20-SEP-00	VJO
Particulate Wt. Organic Fraction	0.7	mg	EPA 202	20-SEP-00	VJO
Particulate Wt. Inorganic Fraction	1.9	mg	EPA 202	20-SEP-00	VJO
AF-I-LMF119-3-M202-12SEP2000-FHA, FILT #639, BHC, BHS					
Lab Sample: 1420090					
sampled: 12-SEP-00					
Particulate Weight - Filter	< 0.1	mg	EPA 5	20-SEP-00	VJO
Wt - Acetone Probe	2.2	mg	EPA 5	20-SEP-00	VJO
Particulate Wt. Organic Fraction	0.6	mg	EPA 202	20-SEP-00	VJO
Particulate Wt. Inorganic Fraction	1.7	mg	EPA 202	20-SEP-00	VJO
AF-I-LMF119-SB-M202-12SEP2000-ACE, FILT #642, DCM, DIH2O					
Lab Sample: 1420091					
sampled: 12-SEP-00					
Particulate Weight - Filter	< 0.1	mg	EPA 5	20-SEP-00	VJO
Wt - Acetone Probe	0.3	mg	EPA 5	20-SEP-00	VJO
Particulate Wt. Organic Fraction	< 0.1	mg	EPA 202	20-SEP-00	VJO
Particulate Wt. Inorganic Fraction	0.7	mg	EPA 202	20-SEP-00	VJO

PHILIP ANALYTICAL SERVICES

INDUSTRIAL HYGIENE ENVIRONMENTAL TESTING

• EPA/NVLAP 101262-0 • NY DOH 10903 • NJ DEP 77678
• AIHA ACCREDITATION NO. 100439 • PA DER 06-353

Client: Roy F. Weston, Inc.
Project: 196995

	RESULT	UNITS	METHOD	DATE	ANALYST
COMP: AF-I-LMF119-1-3-M202-12SEP2000-FILT #639, 640, 641					
Lab Sample: 1420092					
sampled: 12-SEP-00					
Particulate Weight - Filter	< 0.1	mg	EPA 5	20-SEP-00	VJO
AF-M-LMF119-1-M202-12SEP2000-FHA, FILT #634, BHC, BHS					
Lab Sample: 1420093					
sampled: 13-SEP-00					
Particulate Weight - Filter	< 0.1	mg	EPA 5	20-SEP-00	VJO
Wt - Acetone Probe	2.5	mg	EPA 5	20-SEP-00	VJO
Particulate Wt. Organic Fraction	0.7	mg	EPA 202	20-SEP-00	VJO
Particulate Wt. Inorganic Fraction	1.7	mg	EPA 202	20-SEP-00	VJO
AF-M-LMF119-2-M202-12SEP2000-FHA, FILT #633, BHC, BHS					
Lab Sample: 1420094					
sampled: 13-SEP-00					
Particulate Weight - Filter	< 0.1	mg	EPA 5	20-SEP-00	VJO
Wt - Acetone Probe	1.7	mg	EPA 5	20-SEP-00	VJO
Particulate Wt. Organic Fraction	1.1	mg	EPA 202	20-SEP-00	VJO
Particulate Wt. Inorganic Fraction	5.3	mg	EPA 202	20-SEP-00	VJO
AF-M-LMF119-3-M202-12SEP2000-FILT #635					
Lab Sample: 1420095					
sampled: 13-SEP-00					
Particulate Weight - Filter	< 0.1	mg	EPA 5	20-SEP-00	VJO
COMP: AF-M-LMF119-1-3-M202-12SEP2000-FILT #633, 634, 635					
Lab Sample: 1420096					
sampled: 13-SEP-00					
Particulate Weight - Filter	< 0.01	mg	EPA 5	20-SEP-00	VJO
AF-N-LMF119-1-M202-12SEP2000-FHA, FILT #632, BHC, BHS					
Lab Sample: 1420097					
sampled: 13-SEP-00					
Particulate Weight - Filter	< 0.1	mg	EPA 5	20-SEP-00	VJO
Wt - Acetone Probe	1.4	mg	EPA 5	20-SEP-00	VJO
Particulate Wt. Organic Fraction	1.4	mg	EPA 202	20-SEP-00	VJO
Particulate Wt. Inorganic Fraction	3.3	mg	EPA 202	20-SEP-00	VJO

PHILIP
ANALYTICAL SERVICES

INDUSTRIAL HYGIENE ENVIRONMENTAL TESTING

• EPA/NVLAP 101262-0 • NY DOH 10903 • NJ DEP 77678
• AIHA ACCREDITATION NO. 100439 • PA DER 06-353

Client: Roy F. Weston, Inc.
Project: 196995

	RESULT	UNITS	METHOD	DATE	ANALYST
AF-N-LMF119-2-M202-12SEP2000-FHA, FILT #631, BHC, BHS					
Lab Sample: 1420098					
sampled: 13-SEP-00					
Particulate Weight - Filter	< 0.1	mg	EPA 5	20-SEP-00	VJO
Wt - Acetone Probe	1.9	mg	EPA 5	20-SEP-00	VJO
Particulate Wt. Organic Fraction	1.2	mg	EPA 202	20-SEP-00	VJO
Particulate Wt. Inorganic Fraction	2.3	mg	EPA 202	20-SEP-00	VJO
AF-N-LMF119-3-M202-12SEP2000-FILT #630					
Lab Sample: 1420099					
sampled: 13-SEP-00					
Particulate Weight - Filter	< 0.01	mg	EPA 5	20-SEP-00	VJO
COMP: AF-N-LMF119-1-3-M202-12SEP2000-FILT #630, 631, 632					
Lab Sample: 1420100					
sampled: 13-SEP-00					
Particulate Weight - Filter	< 0.01	mg	EPA 5	20-SEP-00	VJO
Filter W646					
Lab Sample: 1421165					
Particulate Weight - Filter	- 0.19	mg	EPA 5	20-SEP-00	VJO
Filter W647					
Lab Sample: 1421166					
Particulate Weight - Filter	- 0.11	mg	EPA 5	20-SEP-00	VJO
Filter W648					
Lab Sample: 1421167					
Particulate Weight - Filter	- 0.18	mg	EPA 5	20-SEP-00	VJO

< Indicates less than the limit of quantitation.

Inorganics Raw Data (Lachat, IC, non-automated)

Particulate Analysis

Lab No.: 1420084 196995 Roy F. Weston, Inc.

Client: WUNK Due: 26-SEP-0lved
AF-A-LMF119-1-M202-12SEP2000-FHA, FILT #638, BHC, BHS
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35

9/20/00 (1500 HRS)
9/25/00

Description Inorganic Fraction

A. Sample Volume 390 mls

_____ wash _____ mls Blank Correction

Total: 390 ml x 2X10-6 g/ml - .0008 g

B. Tare Weights

Continer: 115.1603 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/23/00	(1)	115.1625	_____	(4)	_____
9/25/00	(2)	115.1626	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

Final Gross Weight: 115.1625 g
Tare Weight: 115.1603 g
Residue Weight: .0022 g
Blank Weight: .0008 g
.0014 g

D. Net Weights:

Remarks: _____

Analyst JB / VO

Particulate Analysis

Pro. No.: _____

Lab No.: 1420084 196995 Roy F. Weston, Inc. ved 9/20/00

Client: MUNK Due: 26-SEP-0(9/25/00
AF-A-LMF119-1-M202-12SEP2000-FHA, FILT #638, BHC, BHS
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35

Description Organic Fraction

A. Sample Volume 30 mls

_____ wash 150 mls Blank Correction

Total: 180 ml x _____ g/ml - _____ g

B. Tare Weights

Container: 107.1515 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/25/00	(1)	107.1523	_____	(4)	_____
9/25/00	(2)	107.1520	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

Final Gross Weight: 107.1520 g
Tare Weight: 107.1515 g
Residue Weight: .0005 g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JB / VB

Particulate Analysis

Pm No:

Lab No.: 1420084 196995 Roy F. Weston, Inc. 9/20/00

Client: WUNK Due: 26-SEP-0 9/25/00
AF-A-LMF119-1-M202-12SEP2000-FHA, FILT #638, BHC, BHS
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35

Description Probe Acetone

A. Sample Volume 75 mls

25 mls wash Blank Correction

Total: 100 ml x 3X10-4 g/ml - .0003 g

B. Tare Weights

Container: 95.4735 g

Filter: g

Thimble: g

Total: g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	95.4756		(4)	
9/23/00	(2)	95.4760		(5)	
	(3)			(6)	

Final Gross Weight: 95.4756 g
Tare Weight: 95.4735 g
Residue Weight: .0021 g
Blank Weight: .0003 g
.0018

D. Net Weights:

Remarks:

Analyst JB/VD

Particulate Analysis

Lab No.: 1420084 196995 Roy F. Weston, Inc.

Client: WUNK Due: 26-SEP-00
AF-A-LMF119-1-M202-12SEP2000-FHA, FILT #638, BHC, BHS
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35

9/20/00
9/27/00

Description Filter - 638

A. Sample Volume _____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Container: _____ g

Filter: 0.19912 g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	0.19438		(4)	
9/25/00	(2)	0.19340		(5)	
	(3)			(6)	

-.00474

Final Gross Weight: _____ g
Tare Weight: _____ g
Residue Weight: _____ g
Blank Weight: _____ g

D. Net Weights:
Remarks: _____

Analyst JH/VO

Particulate Analysis

Lab No. 1420085 196995 Roy F. Weston, Inc.

Client: WUNK Due: 26-SEP-0ceived 9/20/00
AF-A-LMF119-2-M202-12SEP2000-FHA, FILT #637, BHC, BHS
Sampled: 12-SEP-00
Received: 19-SEP-00 14:35 t: 9/25/00

Description Inorganic Fraction

A. Sample Volume 375 mls

_____ wash _____ mls Blank Correction

Total: 375 ml x 2×10^{-6} g/ml - .0008 g

B. Tare Weights

Continer: 108.5920 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/25/00	(1)	108.5967	_____	(4)	_____
9/25/00	(2)	108.5967	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

Final Gross Weight: 108.5967 g
Tare Weight: 108.5920 g
Residue Weight: .0047 g
Blank Weight: .0008 g
.0039

D. Net Weights:

Remarks: _____

Analyst JB / VO

Particulate Analysis

Lab Nc 1420085 196995 Roy F. Weston, Inc. :

Client: WUNK Due: 26-SEP-0 ceived 9/20/00
AF-A-LMF119-2-M202-12SEP2000-FHA, FILT #637, BHC, BHS
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35 ut: 9/25/00

Description Organic Fraction

A. Sample Volume

30 mls

wash 150 mls Blank Correction

Total: 180 ml x g/ml - g

B. Tare Weights

Continer: 118.3761 g

Filter: g

Thimble: g

Total: g

Container No.

C. Gross Weights

Date			Date		
9/23/00	(1)	118.3782		(4)	
9/23/00	(2)	118.3777		(5)	
	(3)			(6)	

Final Gross Weight: 118.3777 g
Tare Weight: 118.3761 g
Residue Weight: .0016 g
Blank Weight: g

D. Net Weights:

Remarks:

Analyst JD / VD

Particulate Analysis

Lab No.: 1420085 196995 Roy F. Weston, Inc.

Pm. No.: _____

Client: WUNK

Due: 26-SEP-0(

AF-A-LMF119-2-M202-12SEP2000-FHA, FILT #637, BHC, BHS

Sampled: 12-SEP-00 :

Received: 19-SEP-00 14:35

ived 9/20/00

9/25/00

Description Probe Acetone

A. Sample Volume 70 mls

_____ wash 25 mls Blank Correction

Total: ~~25~~ 100 ml x 3 X 10⁻⁴ g/ml - .0003 g

B. Tare Weights

Continer: 104.7725 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	104.7742	_____	(4)	_____
9/23/00	(2)	104.7748	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

Final Gross Weight: 104.7742 g

Tare Weight: 104.7725 g

Residue Weight: .0017 g

Blank Weight: .0003 g

.0014 g

D. Net Weights:

Remarks: _____

Analyst JB / VS

00039

Particulate Analysis

Lab No.: 1420085 196995 Roy F. Weston, Inc.

Client: WUNK
AF-A-LMF119-2-M202-12SEP2000-FHA, FILT #637, BHC, BHS
Sampled: 12-SEP-00
Received: 19-SEP-00 14:35

Due: 26-SEP-0

eived 9/20/00
9/25/00

Description Filter - 637

A. Sample Volume

_____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Continer: _____ g

Filter: 0.20282 g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	0.19897	_____	(4)	_____
9/25/00	(2)	0.19878	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

- 0.00385

Final Gross Weight: _____ g
Tare Weight: _____ g
Residue Weight: _____ g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JH / VB

00040

Particulate Analysis

Lab No.: _____

1420086 196995 Roy F. Weston, Inc.

Clier WUNK Due: 26-SEP-0 Received 9/20/00

AF-A-LMF119-3-M202-12SEP2000-FHA, FILT #636, BHC, BHS

Sampled: 12-SEP-00 :

Received: 19-SEP-00 14:35 Out: 9/25/00

Description _____

Inorganic Fraction

A. Sample Volume 458 mls

_____ wash _____ mls Blank Correction

Total: 450 ml x 2x10⁻⁶ g/ml - .0009 g

B. Tare Weights

Continer: 97.8864 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/23/00	(1)	97.8886		(4)	
9/25/00	(2)	97.8887		(5)	
	(3)			(6)	

Final Gross Weight: 97.8886 g

Tare Weight: 97.8864 g

Residue Weight: .0022 g

Blank Weight: .0009 g

.0013

D. Net Weights:

Remarks: _____

Analyst JB / VI

Particulate Analysis

Lab: 1420086 196995 Roy F. Weston, Inc.

Pro. No.: _____

Client: WUNK
AF-A-LMF119-3-M202-12SEP2000-FHA, FILT #636, BHC, BHS
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35

Due: 26-SEP-00

Received: 9/20/00

Out: 9/25/00

Description: Organic Fraction

A. Sample Volume

50 mls

_____ wash 150 mls Blank Correction

Total: 200 ml x _____ g/ml - _____ g

B. Tare Weights

Continer: 101.2279 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9-23-00	(1)	101.2293		(4)	
9-23-00	(2)	101.2288		(5)	
	(3)			(6)	

Final Gross Weight: 101.2288 g
Tare Weight: 101.2279 g
Residue Weight: .0009 g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst: JB / VO

00042

Particulate Analysis

Lab 1420086 196995 Roy F. Weston, Inc. No.: _____

Clie WUNK Due: 26-SEP-0 Received 9/20/00
AF-A-LMF119-3-M202-12SEP2000-FHA, FILT #636, BHC, BHS
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35 Out: 9/25/00

Description Probe Acetone

A. Sample Volume 130 mls

_____ wash 25 mls Blank Correction

Total: 155 ml x 3 x 10⁻⁴ g/ml - .0005 g

B. Tare Weights

Continer: 100.4371 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	100.4387	_____	(4)	_____
9/22/00	(2)	100.4393	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

Final Gross Weight: 100.4387 g
Tare Weight: 100.4371 g
Residue Weight: .0016 g
Blank Weight: .0005 g
.0011 g

D. Net Weights:

Remarks: _____

Analyst JB / VB

00043

Particulate Analysis

Lab No 1420086 196995 Roy F. Weston, Inc.

Client: WUNK Due: 26-SEP-00 Received 9/20/00
AF-A-LMF119-3-M202-12SEP2000-FHA, FILT #636, BHC, BHS
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35 By: 9/25/00

Description Filter - 636

A. Sample Volume

_____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Continer: _____ g

Filter: 0.19956 g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	0.19877	_____	(4)	_____
9/25/00	(2)	0.19880	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

- 0.00106 g

Final Gross Weight: _____ g
Tare Weight: _____ g
Residue Weight: _____ g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JP / VO

00044

Particulate Analysis

Lab No.: 1420087 196995 Roy F. Weston, Inc.

Client: WUNK
COMP: AF-A-LMF119-1-3-M202-12SEP2000-FILT #636, 637, 638 Due: 26-SEP-0
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35

9/20/00
9/27/00

Description: filter - 636, 637, 638

A. Sample Volume

_____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Continer:	0.19986	g
Filter:	0.20282	g
Thimble:	0.19912	g
Total:	0.60180	g

Container No.

C. Gross Weights

Date			Date		
~~9/26/00~~	(1)	~~0.58917~~	_____	(4)	_____
9/26/00	(2)	0.59219	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

~~-0.001263~~
-0.00961 g

Final Gross Weight: _____ g
Tare Weight: _____ g
Residue Weight: _____ g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JH / VO

Particulate Analysis

Lat 1420088 196995 Roy F. Weston, Inc. No.: _____

Clie WUNK Due: 26-SEP-0
AF-I-LMF119-1-M202-12SEP2000-FHA, FILT #641, BHC, BHS, Received 9/20/00
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35 Out: 9/25/00

Description _____

Inorganic Fraction

A. Sample Volume 380 mls

_____ wash _____ mls Blank Correction

Total: 380 ml x 2x10-6 g/ml - .0008 g

B. Tare Weights

Continer: ~~113.4332~~ g

Filter: 113.4342 g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9-25-00	(1)	113.4386	_____	(4)	_____
9/25/00	(2)	113.4381	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

Final Gross Weight: 113.4381 g
Tare Weight: 113.4342 g
Residue Weight: .0039 g
Blank Weight: .0008 g
.0031 g

D. Net Weights:

Remarks: _____

Analyst JB / VK

Particulate Analysis

Lab N 1420088 196995 Roy F. Weston, Inc. Pro. No.: _____

Clier WUNK Received 9/20/00
AF-I-LMF119-1-M202-12SEP2000-FHA, FILT #641, BHC, BHS Due: 26-SEP-0(Out: 9/25/00
Sampled: 12-SEP-00
Received: 19-SEP-00 14:35

Description Organic
~~Inorganic~~ Fraction

A. Sample Volume

25 mls

_____ wash 150 mls Blank Correction

Total: 175 ml x _____ g/ml - _____ g

B. Tare Weights

Continer: 101.0364 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/23/00	(1)	101.0374	_____	(4)	_____
9/23/00	(2)	101.0372	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

Final Gross Weight: 101.0372 g
Tare Weight: 101.0364 g
Residue Weight: .0008 g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JB/VO

00047

Particulate Analysis

Lab I 1420088 196995 Roy F. Weston, Inc. No.: _____

Clien WUNK Due: 26-SEP-0 Received 9/20/00
AF-I-LMF119-1-M202-12SEP2000-FHA, FILT #641, BHC, BHS
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35 Out: 9/25/00

Description Probe Acetone

A. Sample Volume

60 mls

_____ wash 25 mls Blank Correction

Total: 85 ml x 3 X 10⁻⁶ g/ml - .0003 g

B. Tare Weights

Continer: 111.8000 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	111.8022	_____	(4)	_____
9/23/00	(2)	111.8026	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

Final Gross Weight: 111.8022 g
Tare Weight: 111.8000 g
Residue Weight: .0022 g
Blank Weight: .0003 g
.0019 g

D. Net Weights:

Remarks: _____

Analyst JB / VG

00048

Particulate Analysis

Lab N 1420088 196995 Roy F. Weston, Inc. P.O.: _____

Client WUNK Due: 26-SEP-0 Received 9/20/00
AF-I-LMF119-1-M202-12SEP2000-FHA, FILT #641, BHC, BHS
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35 Out: 9/27/00

Description Filter - 641

A. Sample Volume

_____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Continer: _____ g

Filter: 0.20099 g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	0.20092	_____	(4)	_____
9/25/00	(2)	0.20015	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

- 0.00084

Final Gross Weight: _____ g
Tare Weight: _____ g
Residue Weight: _____ g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JH / VD

00049

Particulate Analysis

1420089 196995 Roy F. Weston, Inc.

Lab I: WUNK Due: 26-SEP-0

Clier: AF-I-LMF119-2-M202-12SEP2000-FHA, FILT #640, BHC, BHS
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35

Io.: _____

Received: 9/20/00

Date Out: 9/25/00

Description: Inorganic Fraction
~~Probe Acetone~~

A. Sample Volume

375 mls

_____ wash _____ mls Blank Correction

Total: 375 ml x 2X10-4 g/ml - .0008 g

B. Tare Weights

Continer: 108.2866 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9-25-00	(1)	108.2893		(4)	
9-25-00	(2)	108.2896		(5)	
	(3)			(6)	

Final Gross Weight: 108.2893 g
Tare Weight: 108.2866 g
Residue Weight: .0027 g
Blank Weight: .0008 g
.0019

D. Net Weights:

Remarks: _____

Analyst: JP / VR

00050

Particulate Analysis

Lab Nr: 1420089 196995 Roy F. Weston, Inc.

Client: WUNK
AF-I-LMF119-2-M202-12SEP2000-FHA, FILT #640, BHC, BHS
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35

Due: 26-SEP-0eceived 9/20/00

ut: 9/25/00

Description: Organic Fraction

A. Sample Volume

25 mls

wash 150 mls Blank Correction

Total: 175 ml x _____ g/ml - _____ g

B. Tare Weights

Continer: 114.4155 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/23/00	(1)	114.4166	_____	(4)	_____
9/23/00	(2)	114.4162	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

Final Gross Weight: 114.4162 g
Tare Weight: 114.4155 g
Residue Weight: .0007 g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JB / VO

00051

Particulate Analysis

Lab No: 1420089 196995 Roy F. Weston, Inc.

Client: WUNK
AF-I-LMF119-2-M202-12SEP2000-FHA, FILT #640, BHC, BHS
Sampled: 12-SEP-00
Received: 19-SEP-00 14:35

Due: 26-SEP-00

Rec No.:

Received: 9/20/00

Out: 9/25/00

Description: Probe Acetone

A. Sample Volume: 50 mls

wash: 25 mls Blank Correction

Total: 75 ml x 3 x 10⁻⁴ g/ml - .0002 g

B. Tare Weights

Continer: 102.7532 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	102.7556		(4)	
9/23/00	(2)	102.7559		(5)	
	(3)			(6)	

Final Gross Weight: 102.7556 g
Tare Weight: 102.7532 g
Residue Weight: .0024 g
Blank Weight: .0002 g

D. Net Weights: .0022 g

Remarks: _____

Analyst: JB / VA

Particulate Analysis

Lab No 1420089 196995 Roy F. Weston, Inc.

Client: WUNK
AF-I-LMF119-2-M202-12SEP2000-FHA, FILT #640, BHC, BHS
Sampled: 12-SEP-00
Received: 19-SEP-00 14:35

Due: 26-SEP-0

Received 9/20/00

Out: 9/27/00

Description Filter - 640

A. Sample Volume _____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Continer: _____ g

Filter: 0.20242 g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	0.19971		(4)	
9/25/00	(2)	0.19874		(5)	
	(3)			(6)	

- 0.00097

Final Gross Weight: _____ g
Tare Weight: _____ g
Residue Weight: _____ g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JH / VO

00053

Particulate Analysis

Lab No 1420090 196995 Roy F. Weston, Inc.

Client: WUNK Due: 26-SEP-00 Received 9/20/00
AF-I-LMF119-3-M202-12SEP2000-FHA, FILT #639, BHC, BHS
Sampled: 12-SEP-00
Received: 19-SEP-00 14:35 Out: 9/25/00

Description Inorganic Fraction

A. Sample Volume 375 mls

_____ wash _____ mls Blank Correction

Total: 375 ml x 2 x 10⁻⁶ g/ml - .0007 g

B. Tare Weights

Continer: 109.3194 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	109.3218		(4)	
9/25/00	(2)	109.3224		(5)	
	(3)			(6)	

Final Gross Weight: 109.3218 g
Tare Weight: 109.3194 g
Residue Weight: .0024 g
Blank Weight: .0007 g
.0017 g

D. Net Weights:

Remarks: _____

Analyst JB / VO

Particulate Analysis

Lab N 1420090 196995 Roy F. Weston, Inc. o.: _____

Client WUNK Due: 26-SEP-0 Received 9/20/00
AF-I-LMF119-3-M202-12SEP2000-FHA, FILT #639, BHC, BHS
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35 Out: 9/25/00

Description Organic Fraction

A. Sample Volume

50 mls

_____ wash 150 mls Blank Correction

Total: 200 ml x _____ g/ml - _____ g

B. Tare Weights

Continer: 101.4960 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/23/00	(1)	101.4969		(4)	
9/23/00	(2)	101.4966		(5)	
	(3)			(6)	

Final Gross Weight: 101.4966 g
Tare Weight: 101.4960 g
Residue Weight: .0006 g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JB | VG

Particulate Analysis

Lab No.: _____

Lab N 1420090 196995 Roy F. Weston, Inc.

Clien WUNK Due: 26-SEP-0(Received 9/20/00
AF-I-LMF119-3-M202-12SEP2000-FHA, FILT #639, BHC, BHS
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35 Out: 9/27/00

Description Probe Acetone

A. Sample Volume

130 mls

25 mls wash Blank Correction

Total: 155 ml x 3x10-6 g/ml - .0005 g

B. Tare Weights

Continer: 118.9712 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	118.9739		(4)	
9/23/00	(2)	118.9746		(5)	
	(3)			(6)	

Final Gross Weight: 118.9739 g
Tare Weight: 118.9712 g
Residue Weight: .0027 g
Blank Weight: .0005 g
.0022 g

D. Net Weights:

Remarks: _____

Analyst JB / VB

00056

Particulate Analysis

La' Pro. No.: _____

1420090 196995 Roy F. Weston, Inc.

Cl WUNK e Received 9/20/00

AF-I-LMF119-3-M202-12SEP2000-FHA, FILT #639, BHC, BHS Due: 26-SEP-0

Sampled: 12-SEP-00 :

Received: 19-SEP-00 14:35 e Out: 9/27/00

Description _____

Filter - 639

A. Sample Volume

_____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Continer: _____ g

Filter: 0.20618 g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	0.20570	_____	(4)	_____
9/25/00	(2)	0.20593	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

-0.00025

Final Gross Weight: 0. g

Tare Weight: _____ g

Residue Weight: _____ g

Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JH / VI

Particulate Analysis

Rm No.: _____

Lab No. 1420091 196995 Roy F. Weston, Inc.

Client: WUNK Due: 26-SEP-0 Received 9/20/00
AF-I-LMF119-SB-M202-12SEP2000-ACE, FILT #642, DCM, DII
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35 Ext: 9/25/00

Description Inorganic Fraction

A. Sample Volume 295 mls

_____ wash _____ mls Blank Correction

Total: 295 ml x .0007/295 g/ml - 2 x 10⁻⁶ g

B. Tare Weights

Container: 106.4605 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/23/00	(1)	106.4612	_____	(4)	_____
9/23/00	(2)	106.4613	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

Final Gross Weight: 106.4612 g
Tare Weight: 106.4605 g
Residue Weight: .0007 g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JB / VO

Particulate Analysis

Lab No: 1420091 196995 Roy F. Weston, Inc.

Pro. No.:

Client: WUNK Due: 26-SEP-0(

AF-I-LMF119-SB-M202-12SEP2000-ACE, FILT #642, DCM, DI

Sampled: 12-SEP-00 :

Received: 19-SEP-00 14:35

Date Received: 9/20/00

Date Out: 9/25/00

Description: Organic Fraction

A. Sample Volume: 40 mls

wash: 158 mls Blank Correction

Total: 196 ml x g/ml - g

B. Tare Weights

Continer: 112.7870 g

Filter: g

Thimble: g

Total: g

Container No.

C. Gross Weights

Date			Date		
9-23-00	(1)	112.7869		(4)	
	(2)			(5)	
	(3)			(6)	

Final Gross Weight: g

Tare Weight: g

Residue Weight: g

Blank Weight: — g

D. Net Weights:

Remarks:

Analyst: JB / VO

00059

Particulate Analysis

Lab No.: 1420091 196995 Roy F. Weston, Inc.

Client: WUNK
AF-I-LMF119-SB-M202-12SEP2000-ACE, FILT #642, DCM, DII
Sampled: 12-SEP-00
Received: 19-SEP-00 14:35

Due: 26-SEP-0 ceived 9/20/00

ut: 9/25/00

Description Probe Acetone

A. Sample Volume 80 mls

wash 25 mls Blank Correction

Total: 105 ml x .0003/105 g/ml - 3X10⁻⁶ g

B. Tare Weights

Contiher: 105.3148 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	~~105.3151~~	9/22/00	(4)	105.3151
~~9/22/00~~	(2)	~~105.3160~~	9/23/00	(5)	105.3152
	(3)		9/25/00	(6)	

Final Gross Weight: 105.3151 g
Tare Weight: 105.3148 g
Residue Weight: .0003 g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JB / VB

00060

Particulate Analysis

Lab No. 1420091 196995 Roy F. Weston, Inc.

Client: WUNK
AF-I-LMF119-SB-M202-12SEP2000-ACE, FILT #642, DCM, DI
Sampled: 12-SEP-00
Received: 19-SEP-00 14:35

Due: 26-SEP-0[illegible]

Received 9/20/00

[illegible]: 9/27/00

Description Filter - 642

A. Sample Volume _____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Continer:	_____ g	Container No.
Filter:	0.20361 g	
Thimble:	_____ g	
Total:	_____ g	

C. Gross Weights

Date			Date		
9/22/00	(1)	0.20208	_____	(4)	_____
9/25/00	(2)	~~0.20154~~ 0.20231	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

- 0.00130

Final Gross Weight: _____ g
Tare Weight: _____ g
Residue Weight: _____ g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JH / VR

Particulate Analysis

Lab 1420092 196995 Roy F. Weston, Inc. No.: _____

Clier WUNK Due: 26-SEP-0 Received 9/20/00
COMP: AF-I-LMF119-1-3-M202-12SEP2000-FILT #639, 640, 64
Sampled: 12-SEP-00 :
Received: 19-SEP-00 14:35 Out: 9/27/00

Description _____
Filter - #639, 640, 64

A. Sample Volume _____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Continer:	0.20618	g
Filter:	0.20242	g
Thimble:	0.20361	g
Total:	0.61221	g

Container No.

C. Gross Weights

Date			Date		
9/26/00	(1)	0.60876		(4)	
	(2)			(5)	
	(3)			(6)	

- 0.00349 g

Final Gross Weight: _____ g
Tare Weight: _____ g
Residue Weight: _____ g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JH / VD

00062

Particulate Analysis

No.: _____

Lab No: 1420093 196995 Roy F. Weston, Inc.

Client: WUNK
AF-M-LMF119-1-M202-12SEP2000-FHA, FILT #634, BHC, BHS
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35

Due: 26-SEP-00 Received 9/20/00

Out: 9/26/00

Description Inorganic Fraction

A. Sample Volume 475 mls

_____ wash _____ mls Blank Correction

Total: 475 ml x 2x10-6 g/ml - .0010 g

B. Tare Weights

Container: 106.5257 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/23/00	(1)	106.5284	_____	(4)	_____
9/25/00	(2)	106.5291	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

Final Gross Weight: 106.5284 g
Tare Weight: 106.5257 g
Residue Weight: .0027 g
Blank Weight: .0010 g
.0017 g

D. Net Weights:

Remarks: _____

Analyst TB / VO

Particulate Analysis

Lab No.: _____

Lab No: 1420093 196995 Roy F. Weston, Inc.

Client: WUNK Due: 26-SEP-00 Received 9/20/00
AF-M-LMF119-1-M202-12SEP2000-FHA, FILT #634, BHC, BHS
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35 Out: 9/26/00

Description Organic Fraction

A. Sample Volume 50 mls

_____ wash 150 mls Blank Correction

Total: 200 ml x _____ g/ml - _____ g

B. Tare Weights

Continer: 104.4621 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/23/00	(1)	104.4631	_____	(4)	_____
9/23/00	(2)	104.4628	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

Final Gross Weight: 104.4628 g
Tare Weight: 104.4621 g
Residue Weight: .0007 g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JB / VO

Particulate Analysis

Lab No.: 1420093 196995 Roy F. Weston, Inc.

Client: WUNK
AF-M-LMF119-1-M202-12SEP2000-FHA, FILT #634, BHC, BHS
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35

Due: 26-SEP-00 Solved 9/21/00 (1500 hrs)
9/26/00

Description probe acetone

A. Sample Volume 100 mls

wash 25 mls Blank Correction

Total: 125 ml x 3 X 10⁻⁴ g/ml - .0004 g

B. Tare Weights

Continer: 102.0758 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	102.0787		(4)	
9/23/00	(2)	102.0791		(5)	
	(3)			(6)	

Final Gross Weight: 102.0787 g
Tare Weight: 102.0758 g
Residue Weight: .0029 g
Blank Weight: .0004 g
.0025 g

D. Net Weights:

Remarks: _____

Analyst TMD 1/10

00065

Particulate Analysis

Lab No.: 1420093 196995 Roy F. Weston, Inc.

No.: ____

Client: WUNK Due: 26-SEP-00
AF-M-LMF119-1-M202-12SEP2000-FHA, FILT #634, BHC, BHS
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35

Received: 9/21/00 (1500)

Out: 9/24/00

Description: Filter -634

A. Sample Volume ____ mls

____ wash ____ mls Blank Correction

Total: ____ ml x ____ g/ml - ____ g

B. Tare Weights

Continer: ____ g

Filter: 0.20526 g

Thimble: ____ g

Total: ____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	0.20441		(4)	
9/25/00	(2)	0.20444		(5)	
	(3)			(6)	

-0.00082

Final Gross Weight: ____ g
Tare Weight: ____ g
Residue Weight: ____ g
Blank Weight: ____ g

D. Net Weights:
Remarks:

Analyst TMO / VO

Particulate Analysis

Lab No.: 1420094 196995 · Roy F. Weston, Inc.

Client: WUNK
AF-M-LMF119-2-M202-12SEP2000-FHA, FILT #633, BHC, BHS
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35

Due: 26-SEP-00

Received 9/20/00

9/26/00

Description Inorganic Fraction

A. Sample Volume 395 mls

_____ wash _____ mls Blank Correction

Total: 395 ml x 2×10^{-4} g/ml - .0010 g

B. Tare Weights

Continer: 113.5717 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/25/00	(1)	113.5782		(4)	
9/25/00	(2)	113.5786		(5)	
	(3)			(6)	

Final Gross Weight: 113.5780 g
Tare Weight: 113.5717 g
Residue Weight: .0063 g
Blank Weight: .0010 g
.0053 g

D. Net Weights:

Remarks: _____

Analyst JB / VO

00067

Particulate Analysis

Lab No.: 1420094 196995 Roy F. Weston, Inc.

Client: WUNK
AF-M-LMF119-2-M202-12SEP2000-FHA, FILT #633, BHC, BHS
Sampled: 13-SEP-00
Received: 19-SEP-00 14:35

Due: 26-SEP-00 ved 9/20/00
9/26/00

Description Organic Fraction

A. Sample Volume 35 mls

wash 150 mls Blank Correction

Total: 185 ml x _____ g/ml - _____ g

B. Tare Weights

Continer: 117.1329 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/23/00	(1)	117.1345		(4)	
9/23/00	(2)	117.1340		(5)	
	(3)			(6)	

Final Gross Weight: 117.1340 g
Tare Weight: 117.1329 g
Residue Weight: .0011 g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JB / VB

00068

Particulate Analysis

Lab No.: 1420094 196995 Roy F. Weston, Inc.

Client: WUNK Due: 26-SEP-0 elved 9/21/00 (4500)
AF-M-LMF119-2-M202-12SEP2000-FHA, FILT #633, BHC, BHS
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35 : 9/26/00

Description probe acetone

A. Sample Volume 95 mls

wash 25 mls Blank Correction

Total: 120 ml x 3X10-4 g/ml - .0004 g

B. Tare Weights

Continer: 117.1814 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	117.1836		(4)	
9/22/00	(2)	117.1835		(5)	
	(3)			(6)	

Final Gross Weight: 117.1835 g
Tare Weight: 117.1814 g
Residue Weight: .0021 g
Blank Weight: .0004 g
.0017

D. Net Weights:

Remarks: _____

Analyst JMD / VG

Particulate Analysis

Pm No.: _____

Lab No.: 1420094 196995 Roy F. Weston, Inc.

Received 9/21/00 (1500)

Client: WUNK Due: 26-SEP-0(

AF-M-LMF119-2-M202-12SEP2000-FHA, FILT #633, BHC, BHS

Sampled: 13-SEP-00 :

Received: 19-SEP-00 14:35

It: 9/26/00

Description Filter -633

A. Sample Volume _____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Container: _____ g

Filter: 0.20016 g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	0.19810	_____	(4)	_____
9/25/00	(2)	0.19803	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

- 0.00206 g

Final Gross Weight: _____ g

Tare Weight: _____ g

Residue Weight: _____ g

Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst Imd 10/6

00070

Particulate Analysis

1420095 196995 Roy F. Weston, Inc.

Pro. No.: _____

WUNK
AF-M-LMF119-3-M202-12SEP2000-FILT #635
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35

Due: 26-SEP-00

Date Received 9/21/00 (1500)

Date Out: 9/27/00

Description Filter -635

A. Sample Volume _____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Continer: _____ g

Filter: 0.19854 g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	0.19706	_____	(4)	_____
9/25/00	(2)	0.19699	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

-0.00148 g

Final Gross Weight: _____ g
Tare Weight: _____ g
Residue Weight: _____ g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst TMD / VT

Particulate Analysis

Lab I: 1420096 196995 Roy F. Weston, Inc.

Pro. No.: 9/20/00

Clier: WUNK

Received 9/27/00

COMP: AF-M-LMF119-1-3-M202-12SEP2000-FILT #633, 634, 635 Due: 26-SEP-0

Sampled: 13-SEP-00 :

Received: 19-SEP-00 14:35

Out:

Description Filter - #633 - 634 - 635

A. Sample Volume

_____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Continer:	0.200016	g
Filter:	0.20526	g
Thimble:	0.19854	g
Total:	0.603946	g

Container No.

C. Gross Weights

Date			Date		
9/26/00	(1)	0.59966		(4)	
	(2)			(5)	
	(3)			(6)	

- 0.00430 g

Final Gross Weight: _____ g

Tare Weight: _____ g

Residue Weight: _____ g

Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JH / VO

00072

Particulate Analysis

Lab No.: 1420097 196995 Roy F. Weston, Inc.

Client: WUNK Due: 26-SEP-00
AF-N-LMF119-1-M202-12SEP2000-FHA, FILT #632, BHC, BHS
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35

9/20/00
9/26/00

Description Inorganic Fraction

A. Sample Volume 410 mls

wash mls Blank Correction

Total: 410 ml x 2x10-4 g/ml - .0008 g

B. Tare Weights

Container: 115.9141 g

Filter: g

Thimble: g

Total: g

Container No.

C. Gross Weights

Date			Date		
9/23/00	(1)	115.9182		(4)	
9/25/00	(2)	115.9189		(5)	
	(3)			(6)	

Final Gross Weight: 115.9182 g
Tare Weight: 115.9141 g
Residue Weight: .0041 g
Blank Weight: .0008 g
.0033 g

D. Net Weights:

Remarks:

Analyst JB/VO

Particulate Analysis

Lab No. 1420097 196995 Roy F. Weston, Inc. : _____

Client: WUNK Due: 26-SEP-0ceived 9/20/00
AF-N-LMF119-1-M202-12SEP2000-FHA, FILT #632, BHC, BHS I: 9/26/00
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35

Description Organic Fraction

A. Sample Volume 26 mls

_____ wash 150 mls Blank Correction

Total: 170 ml x _____ g/ml - _____ g

B. Tare Weights

Container: 101.5887 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/25/00	(1)	101.5906	_____	(4)	_____
9/25/00	(2)	1005901	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

Final Gross Weight: 101.5901 g
Tare Weight: 101.5887 g
Residue Weight: .0014 g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JB / VB

Particulate Analysis

Lab No.: 1420097 196995 Roy F. Weston, Inc.

Client: WUNK
AF-N-LMF119-1-M202-12SEP2000-FHA, FILT #632, BHC, BHS
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35

Due: 26-SEP-00 Solved 9/21/00 (1500) 9/26/00

Description probe acetone

A. Sample Volume 85 mls

wash 25 mls Blank Correction

Total: 110 ml x 3×10^{-4} g/ml - .0003 g

B. Tare Weights

Continer: 108.6822 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	108.6839		(4)	
9/23/00	(2)	108.6844		(5)	
	(3)			(6)	

Final Gross Weight: 108.6839 g
Tare Weight: 108.6822 g
Residue Weight: .0017 g
Blank Weight: .0003 g
.0014 g

D. Net Weights:

Remarks: _____

Analyst TMD / VK

Particulate Analysis

Lab No.: 1420097 196995 Roy F. Weston, Inc.

Client: WUNK
AF-N-LMF119-1-M202-125EP2000-FHA, FILT #632, BHC, BHS
Sampled: 13-SEP-00
Received: 19-SEP-00 14:35
Due: 26-SEP-00

9/21/00 (1500)
9/27/00

Description Filter-632

A. Sample Volume _____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Continer:	_____ g	Container No.
Filter:	0.20136 g	
Thimble:	_____ g	
Total:	_____ g	

C. Gross Weights

Date			Date		
9/22/00	(1)	0.19957	_____	(4)	_____
9/25/00	(2)	0.14973	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

-0.00163 g

Final Gross Weight: _____ g
Tare Weight: _____ g
Residue Weight: _____ g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JMD / VR

00076

Particulate Analysis

Log No.: _____

Lab No.: 1420098 196995 Roy F. Weston, Inc.

Client: WUNK Due: 26-SEP-0 Received 9/20/00
AF-N-LMF119-2-M202-12SEP2000-FHA, FILT #631, BHC, BHS
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35 9/26/00

Description Inorganic Fraction

A. Sample Volume 450 mls

_____ wash _____ mls Blank Correction

Total: 450 ml x 2×10^{-4} g/ml - .0009 g

B. Tare Weights

Container: 117.1748 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date		Date	
9/23/00	(1) 117.1780	_____	(4) _____
9/25/00	(2) 117.1787	_____	(5) _____
_____	(3) _____	_____	(6) _____

Final Gross Weight: 117.1780 g
Tare Weight: 117.1748 g
Residue Weight: .0032 g
Blank Weight: .0009 g
.0023

D. Net Weights:

Remarks: _____

Analyst JB / VO

Particulate Analysis

Pro. No.: _____

Lab No.: 1420098 196995 Roy F. Weston, Inc.

Client: WUNK Due: 26-SEP-0
AF-N-LMF119-2-M202-12SEP2000-FHA, FILT #631, BHC, BHS
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35

eceived 9/20/00

ut: 9/26/00

Description Organic Fraction

A. Sample Volume 60 mls

_____ wash 150 mls Blank Correction

Total: 210 ml x _____ g/ml - _____ g

B. Tare Weights

Continer: 104.7118 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/25/00	(1)	104.7134	_____	(4)	_____
9/25/00	(2)	104.7130	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

Final Gross Weight: 104.7130 g
Tare Weight: 104.7118 g
Residue Weight: .0012 g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JB / VB

00078

Particulate Analysis

Lab No.: 1420098 196995 Roy F. Weston, Inc.

Client: WUNK Due: 26-SEP-00
AF-N-LMF119-2-M202-12SEP2000-FHA, FILT #631, BHC, BHS
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35

9/21/00 (1500)
9/26/00

Description probe acetone

A. Sample Volume 175 mls

25 mls wash

Blank Correction

Total: 200 ml x 3 X 10⁻⁴ g/ml - .0006 g

B. Tare Weights

Container: 107.1927 g

Filter: _____ g

Thimble: _____ g

Total: _____ g

Container No.

C. Gross Weights

Date			Date		
9/22/00	(1)	107.1952		(4)	
9/23/00	(2)	107.1955		(5)	
	(3)			(6)	

Final Gross Weight: 107.1952 g
Tare Weight: 107.1927 g
Residue Weight: .0025 g
Blank Weight: .0006 g
.0019

D. Net Weights:

Remarks: _____

Analyst JMD/VS

00079

Particulate Analysis

Lab No.: 1420098 196995 Roy F. Weston, Inc.

Client: WUNK Due: 26-SEP-01
AF-N-LMF119-2-M202-12SEP2000-FHA, FILT #631, BHC, BHS
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35

9/21/00 (1500)
9/27/00

Description Filter-631

A. Sample Volume _____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Continer:	_____ g	Container No.
Filter:	0.20183 g	
Thimble:	_____ g	
Total:	_____ g	

C. Gross Weights

Date			Date		
9/22/00	(1)	0.19739	_____	(4)	_____
9/25/00	(2)	0.19697	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

-0.00448

Final Gross Weight: _____ g
Tare Weight: _____ g
Residue Weight: _____ g
Blank Weight: _____ g

D. Net Weights:
Remarks: _____

Analyst TMD/VD

00080

Particulate Analysis

Lab: 1420099 196995 Roy F. Weston, Inc.

WUNK
AF-N-LMF119-3-M202-12SEP2000-FILT #630
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35

Due: 26-SEP-0

Pro. No.: _____

Date Received 9/21/00 (1500)

Date Out: 9/27/0

Description Filter-630

A. Sample Volume _____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Continer:	_____ g	Container No.
Filter:	0.20432 g	
Thimble:	_____ g	
Total:	_____ g	

C. Gross Weights

Date			Date		
9/27/00	(1)	0.20188	_____	(4)	_____
9/25/00	(2)	0.20192	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

- 0.00240 g

Final Gross Weight: _____ g
Tare Weight: _____ g
Residue Weight: _____ g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JMD / LY

00081

Particulate Analysis

Lab N: 1420100 196995 Roy F. Weston, Inc. O.: _____

Client WUNK Due: 26-SEP-0 Received 9/20/00
COMP: AF-N-LMF119-1-3-M202-12SEP2000-FILT #630, 631, #632
Sampled: 13-SEP-00 :
Received: 19-SEP-00 14:35 Out: 9/27/00

Description Filter #632 - 631 - 630

A. Sample Volume _____ mls

_____ wash _____ mls Blank Correction

Total: _____ ml x _____ g/ml - _____ g

B. Tare Weights

Continer:	0.20136	g
Filter:	0.20183	g
Thimble:	0.20432	g
Total:	0.60751	g

Container No.

C. Gross Weights

Date			Date		
~~9/26/00~~	(1)	~~0.60043~~	_____	(4)	_____
9/26/00	(2)	0.59931	_____	(5)	_____
_____	(3)	_____	_____	(6)	_____

- 0.00820

Final Gross Weight: _____ g
Tare Weight: _____ g
Residue Weight: _____ g
Blank Weight: _____ g

D. Net Weights:

Remarks: _____

Analyst JH / VS

00082

Particulate Analysis

1421165 196995 Roy F. Weston, Inc.

WUNK
Filter W646
Sampled: - - :
Received: 28-SEP-00 16:00

Due: 10-OCT-0

Pro. No: _____

Date Received: 9/29/00 (1510)

Date Out: 10/2/00 VO

Description: FILTER # 646

A. Sample Volume: _____ mls _____ Wash(mls)

Blank Correction

Total: _____ ml x _____ g/ml _____ g

B. Tare Weights:

Container: _____ g

Filter: 0.20166 g

Thimble: _____ g

Total: _____ g

C. Gross Weights:

Date 9/29/00 (1) 0.20231 Before Drying Date 10/2/00 (3) 0.20149

10/2/00 (2) 0.20147 after Drying _____ (4) _____

0.20231
0.20164
+ .00065
Before Dry

0.20166
0.20147
- .00019
after Drying

Final Gross Weights: 0. g

Tare Weight: _____ g

Residue Weight: _____ g

Blank Weight : _____ g

Residue Weight: _____ g

D. Net Weights:

Remarks: _____

00083

Particulate Analysis

Lab No: 1421166 196995 Roy F. Weston, Inc.

WUNK
Filter W647
Sampled: - - :
Received: 28-SEP-00 16:00

Due: 29-SEP-0

Pro. No: _____

Date Received: 9/29/00 (1510)

Date Out: 10/2/00 VO

Description: Filter # 647

A. Sample Volume: _____ mls _____ Wash(mls)

Blank Correction

Total: _____ ml x _____ g/ml _____ g

B. Tare Weights:

Container: _____ g

Filter: 0.20071 g

Thimble: _____ g

Total: _____ g

C. Gross Weights:

Date 9/29/00 (1) 0.20130 Before Drying Date 10/2/00 (3) 0.20065

10/2/00 (2) 0.20060 After Dry _____ (4) _____

.20130
.20071
+ .00059 g
Before Drying

.20071
.20060
- .00011 g
after Drying

Final Gross Weights: _____ g

Tare Weight: _____ g

Residue Weight: _____ g

Blank Weight : _____ g

Residue Weight: _____ g

D. Net Weights:

Remarks: _____

00084

Particulate Analysis

1421167 196995 Roy F. Weston, Inc.

Pro. No: _____

WUNK
Filter W648
Sampled: - - :
Received: 28-SEP-00 16:00

Due: 29-SEP-0

Bottle 50A of 00

Date Received: 9/29/00 (1510)

Date Out: 10/2/00 VO

Description: Filter # 648

A. Sample Volume: _____ mls _____ Wash(mls)

Blank Correction

Total: _____ ml x _____ g/ml _____ g

B. Tare Weights:

Container: _____ g

Filter: 0.20092 g

Thimble: _____ g

Total: _____ g

C. Gross Weights:

Date 9/29/00 (1) 0.20150 Before Dryy Date 10/2/00 (3) 0.20074

10/2/00 (2) 0.20078 After Dry _____ (4) _____

.20150 .20092
.20092 .20074
+.00058 -.00018
Before Dryy after Dryy

Final Gross Weights: _____ g

Tare Weight: _____ g

Residue Weight: _____ g

Blank Weight : _____ g

Residue Weight: _____ g

D. Net Weights:

Remarks: _____

_____