

**UNITED STATES AIR FORCE
ARMSTRONG LABORATORY**

**Compliance Sampling of the Type "1"
Classified Waste Incinerator
Hickam AFB, Hawaii**

Kyle W. Blasch, Captain, USAF, BSC

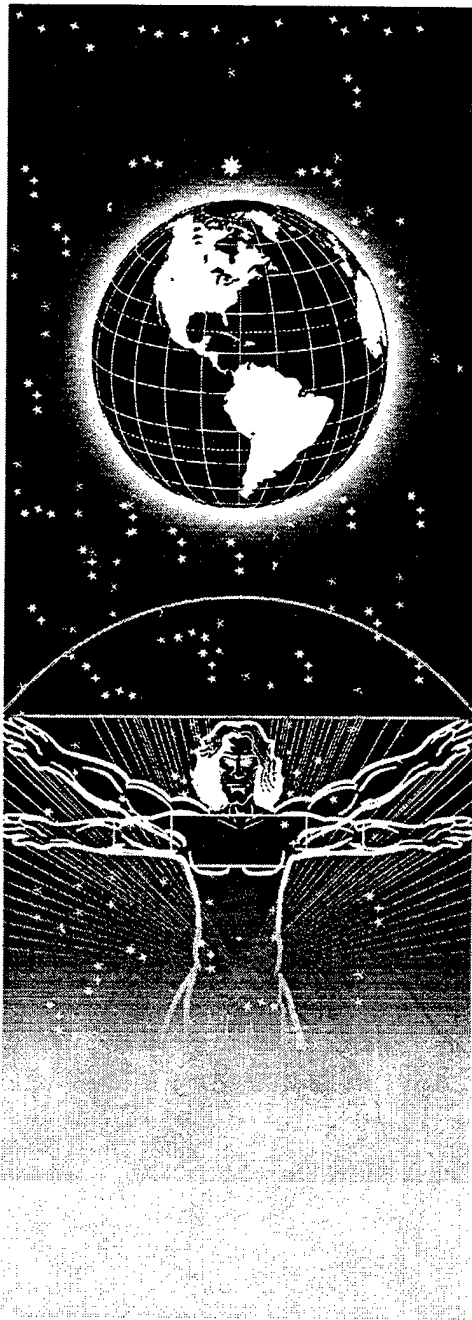
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September 1997

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Occupational and Environmental Health
Directorate
Bioenvironmental Engineering Division
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13. ABSTRACT (Maximum 200 words) Compliance emissions testing for total particulate matter was conducted on a Type "1" incinerator located at Building 83366, Hickam Air Force Base, Hawaii. The incinerator is currently used to destroy classified waste consisting of paper documents and cardboard containers. Sampling was performed from 1 August 1996 through 15 August 1996 using Environmental Protection Agency Methods 1-5 contained in 40 CFR 60 Appendix A. Results indicate that the Type "1" incinerator is in full compliance with all applicable particulate matter emission standards.				
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**COMPLIANCE SAMPLING OF THE
TYPE "1" CLASSIFIED WASTE INCINERATOR
HICKAM AFB, HAWAII**

INTRODUCTION

On 1-15 Aug 96, compliance emissions testing was conducted on a type "1" (Bldg. 83366) classified waste incinerator at Hickam AFB, Hawaii (Figure 1). A type "1" incinerator is defined as a solid waste incinerator which burns type "1" waste: a mixture of combustible waste such as paper, cardboard cartons, wood scrap, and foliage. The Hickam AFB incinerator burns primarily classified paper and cardboard waste.

The current particulate matter emissions requirement by the State of Hawaii for type "1" incinerators is 4.0 lb PM per ton of waste burned. This emission limit is less than the emission factor contained in AP-42 of 4.7 lb PM/ton for multiple chamber incinerators. The Environmental Flight (15 CES/CEV) at Hickam AFB requested the assistance of Armstrong Laboratory's Air Quality Function (AL/OEBQ) in quantifying the pollutant emissions from the incinerator to determine compliance status (see Appendices A&B). The emissions sampling results were used to determine whether the incinerator meets the 4.0lb/ton limit. Pollutants monitored during the survey included total particulate matter (PM), oxygen (O₂), and carbon monoxide (CO). Environmental Protection Agency (EPA) Method 5 contained in 40 CFR 60 Appendix A was used to sample for total particulate matter.

Site and Incinerator Description

The Hickam AFB type "1" incinerator is an Advanced Combustion Model No. CA 750, Serial No. 5933. This incinerator consists of both a primary (lower) and secondary (upper) chamber. Loading of the waste is accomplished by one entry port on the front of the incinerator (Figure 2 and 3). The incinerator uses multiple diesel-fired burners for each chamber. The incinerator is currently utilized to burn type "0" waste and has a design (rated) capacity of 750 lb/hr.



Figure 1. Type "1" Incinerator (left) and Silver Reclamation Incinerator (right) at Hickam AFB, Hawaii.

The type "1" incinerator is scheduled to burn two charges per week. Each charge weighs 250 lb on average. The batch is allowed to burn until all refuse is reduced to ashes. Most of the batch is burned within the first hour and the remaining portion of the waste smolders until it no longer burns. Typically the smoldering lasts approximately 24 hours.

The type "1" incinerator is equipped with a screen at the top of the stack to control large particulates (see Figure 1 and 3). It is not equipped with further control devices.

Applicable Standards and Guidelines

According to the State of Hawaii regulations, Title II Chapter 60.12, the TPM emission standard is 4.0 lb/ton (2 g/kg) from a type "1" incinerator. In order to determine compliance with this standard the incinerator needed to be sampled or an appropriate emission factor determined. The EPA's emission factor document, AP-42, was consulted for emission factors. Unfortunately, the EPA AP-42¹ TPM emission factor for the type "1" incinerator is 4.7

lb/ton. This exceeds the allowable limit for the State of Hawaii 4.0 lb/ton limit. As a result emissions testing was conducted to determine the total particulate matter emission rate.



Figure 2. Front end loading of Type "1" incinerator.

METHODS AND MATERIALS

Particulate sampling and analysis were conducted in accordance with Environmental Protection Agency (EPA) Methods 1 through 5. These methods are found in Appendix A to Title 40, Code of Federal Regulations, Part 60³. As indicated previously, each burn can last up to 24 - 36 hours in length, however most of the waste is consumed in the first hour. Sample runs were started at the beginning of each burn and assumed to collect most of the particulate matter mass released.

The incinerator exhaust stack is circular with an inside diameter of 36 inches (see Figure 4). The Type "1" incinerator stack is 226 inches tall. Each stack has 2 sampling port holes. The sampling ports are on the same horizontal plane, 90 degrees apart. The sampling ports for the Type "1" incinerator are located 54 inches upstream from the stack exit and 172 inches downstream from the last stack disturbance (Figure 4). EPA Method 1 requires the sampling port holes to be located a minimum of 0.5

duct diameters upstream and 2.0 duct diameters downstream of the nearest flow disturbances. The ports are 1.5 duct diameters upstream (the stack exit) and 4.8 duct diameters downstream (incinerator exit).

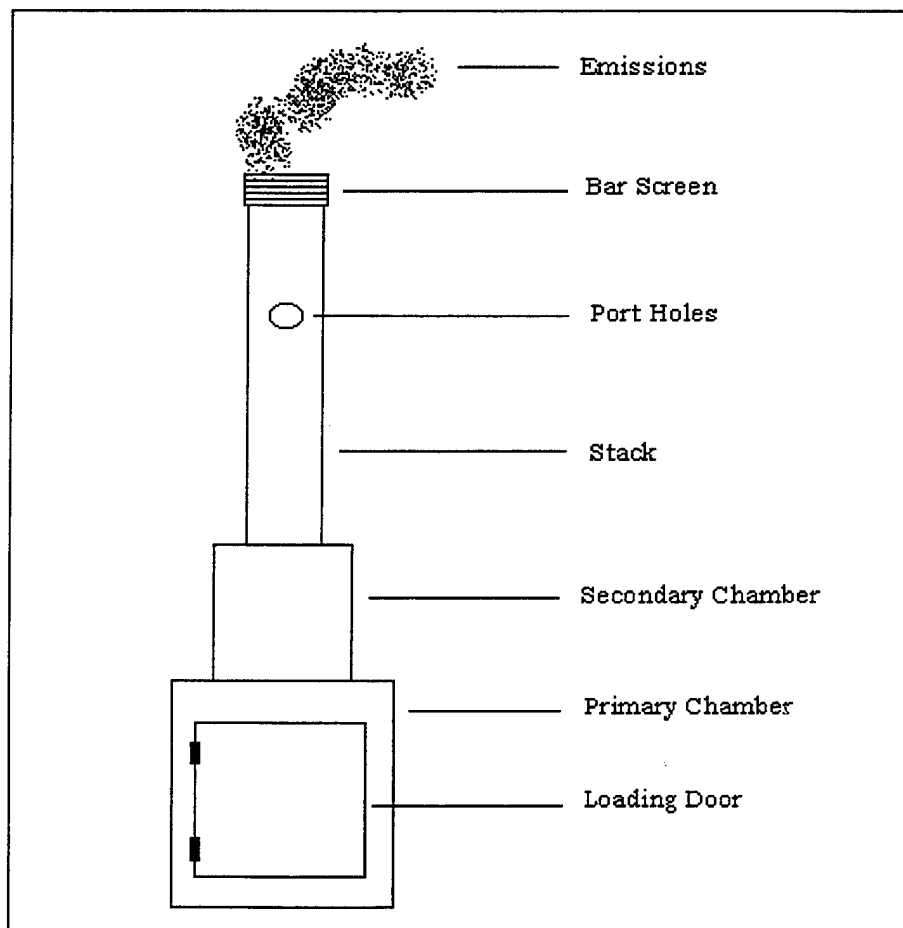
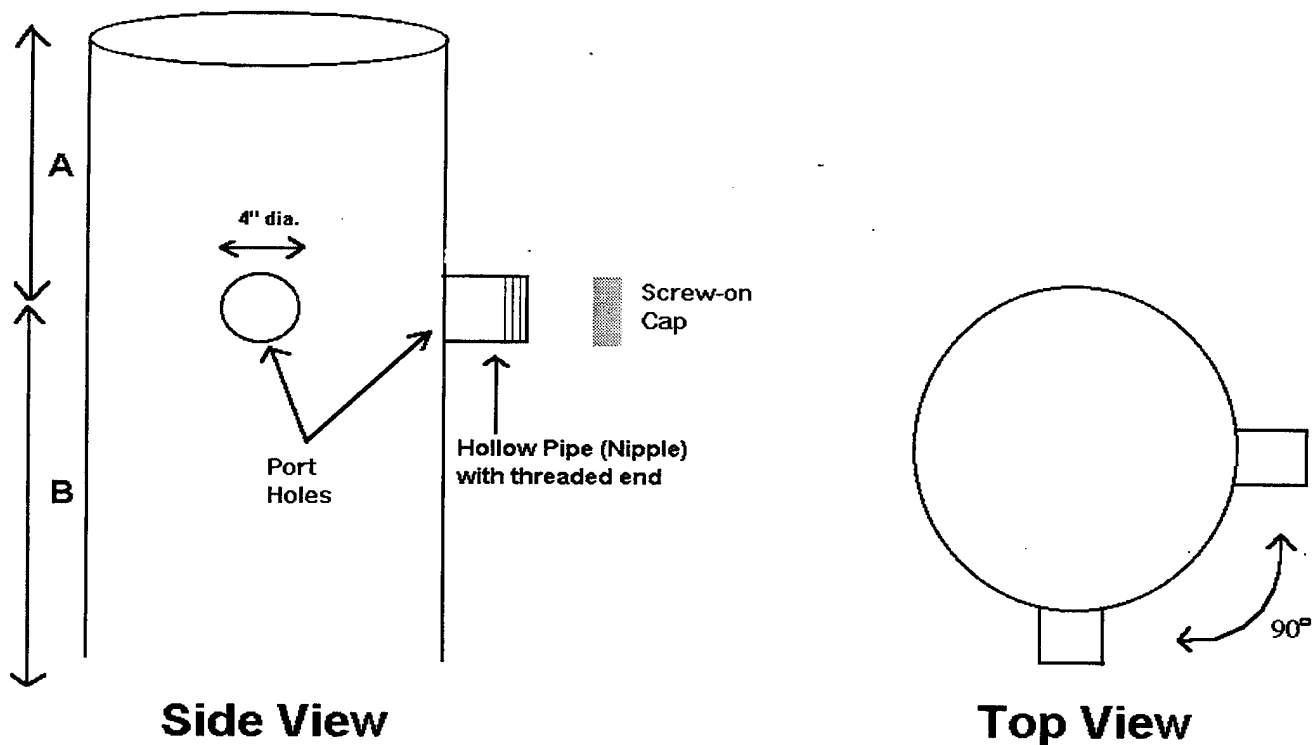


Figure 3. Schematic of Type "1" incinerator. (Not to Scale)



Notes

1. **A** = Distance from center of port holes to the nearest flow disturbance downstream. If possible, this distance should be ≥ 2 stack diameters. At a minimum, this distance must be ≥ 0.5 stack diameters. (For the Type "1" Incinerator $A = 54"$.)
2. **B** = Distance from center of port holes to the nearest flow disturbance upstream. If possible, this distance should be ≥ 8 stack diameters. At a minimum, this distance must be ≥ 2 stack diameters. (For the Type "1" Incinerator $B = 172"$.)

Figure 4. Locations of Exhaust Stack Sampling Ports

The EPA's Hewlett-Packard 41 (HP 41) "METH 1" calculator program was used to determine locations and numbers of traverse points⁴. A total of 24 traverse points (12 for each port hole) were used to collect a representative sample from the Type "1" incinerator.

Prior to the first sampling run, the average degree of cyclonic flow was determined by using a Type-S pitot tube and measuring the stack gas rotational angle at each point along the center traverse. Flow conditions are considered acceptable when the arithmetic mean average of the rotational angles is 20 degrees or less. Rotational angle measurements showed the Type "1" incinerator's air flow to be within acceptable limits. A preliminary velocity pressure traverse, using the same Type-S pitot tube, was also accomplished at this time.

A grab sample for Orsat analysis (measures O_2 and CO_2 for stack gas molecular weight determination) was taken during each sampling run (see Figures 5 & 6)

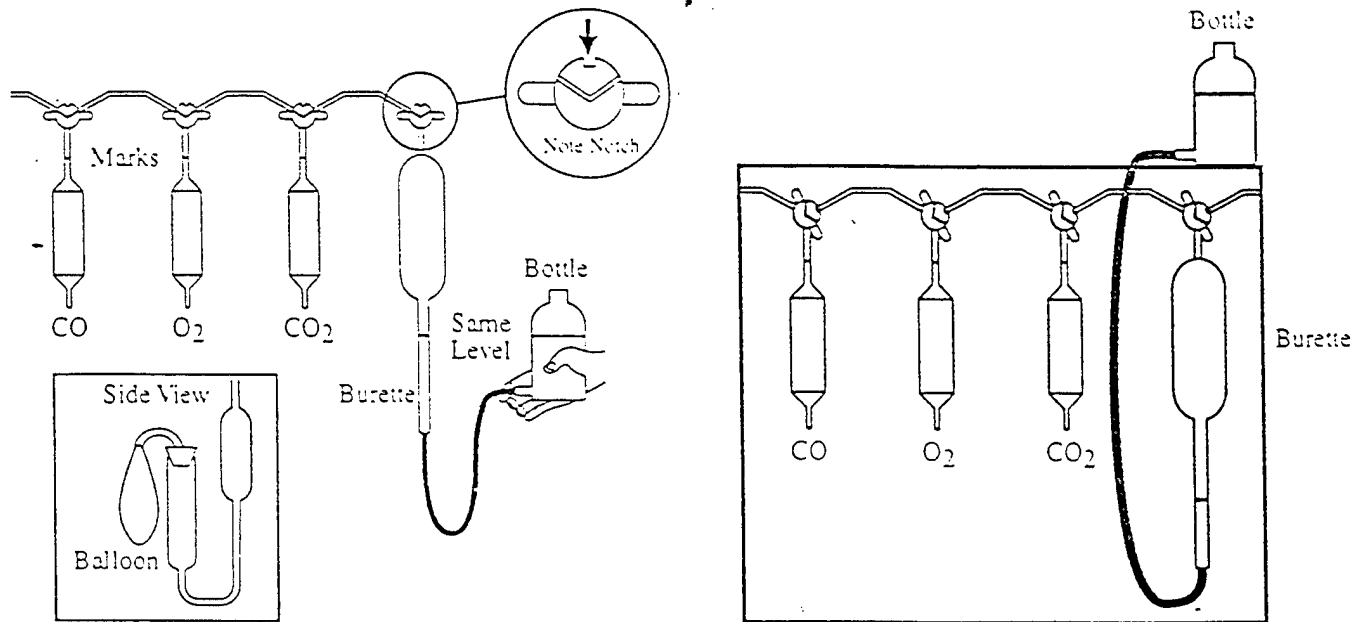


Figure 5. Schematic of Orsat Analyzer

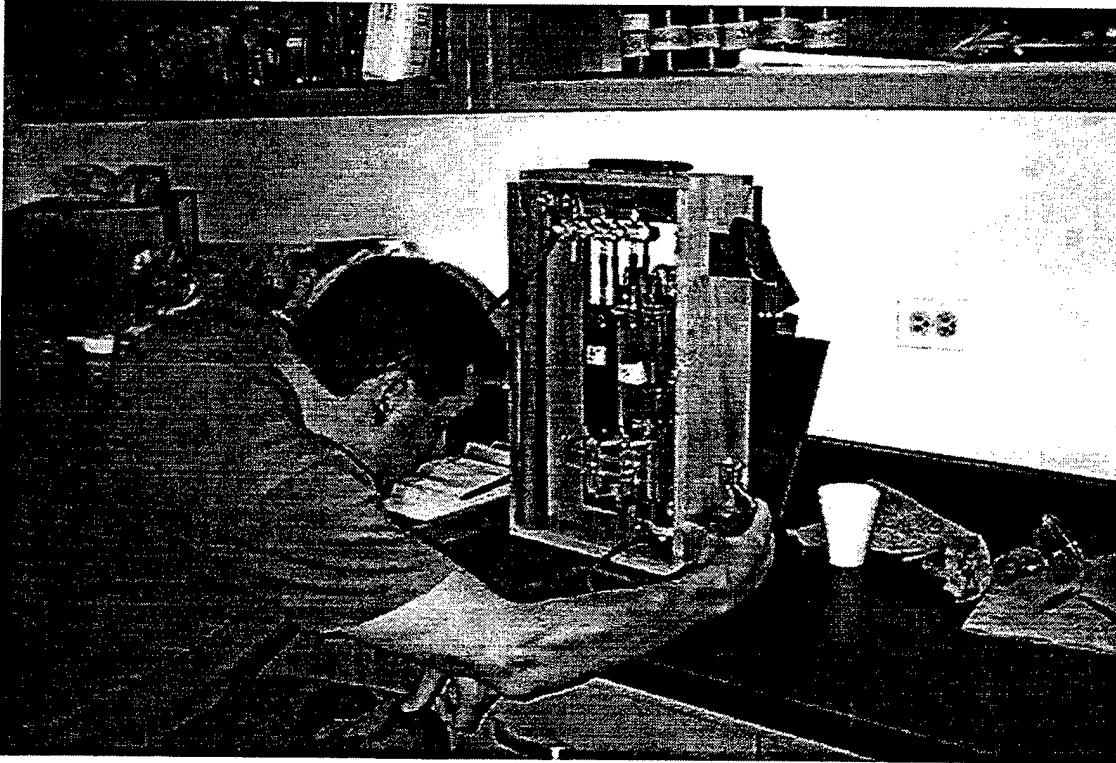


Figure 6. Orsat Analysis

For each representative sample, 3 sampling runs were conducted and the results averaged to determine the final emission value. All sampling runs were 60 minutes in duration.

The particulate matter content, moisture, velocity, and temperature of the exhaust stack gas were determined using an EPA Method 5 sampling train. The train consisted of a button-hook probe nozzle, heated stainless steel probe, heated glass-fiber filter, impingers, and a pumping/metering device (meter box). A schematic of the Method 5 sampling train is shown in Figure 7 and a picture of a Method 5 sampling train in the field is shown in Figure 8. Calibration data for the Method 5 equipment are found in Appendix C. Calibrations were performed in accordance with EPA's Quality Assurance Handbook.⁵ Stack gas velocity pressure was measured at the nozzle tip using a Type S pitot tube connected to a 10-inch inclined-vertical manometer and the procedures described in EPA Method 2. The probe nozzle was sized (with a micrometer) prior to sampling using EPA Method 5 criteria. Type K thermocouples were used to measure stack gas and sampling train temperatures. The probe liner was heated to minimize moisture condensation. The heated filter was used to filter out particulates prior to the impingers. The impinger train consisted of four glass impingers in series. The impinger train was placed in an ice bath which enabled the stack gas moisture to condense into the impingers. The first, third, and fourth impingers were of modified Greenburg-Smith design while the second impinger was a

standard Greenburg-Smith type. The first and second impingers each contained 100 milliliters (ml) of distilled water, the third impinger was empty, and the fourth impinger contained 200 grams (g) of silica gel.

The pumping and metering system was used to control and monitor the sample gas flow rate. The velocity and flow rate of the stack gas were calculated using the EPA's HP 41 "METH 2" Calculator Program. The percent moisture of the exhaust stack gas was calculated using the EPA's Hewlett-Packard 41 (HP 41) "METH 4" Calculator Program. Printouts from all the HP 41 programs run for this survey are found in Appendix D.

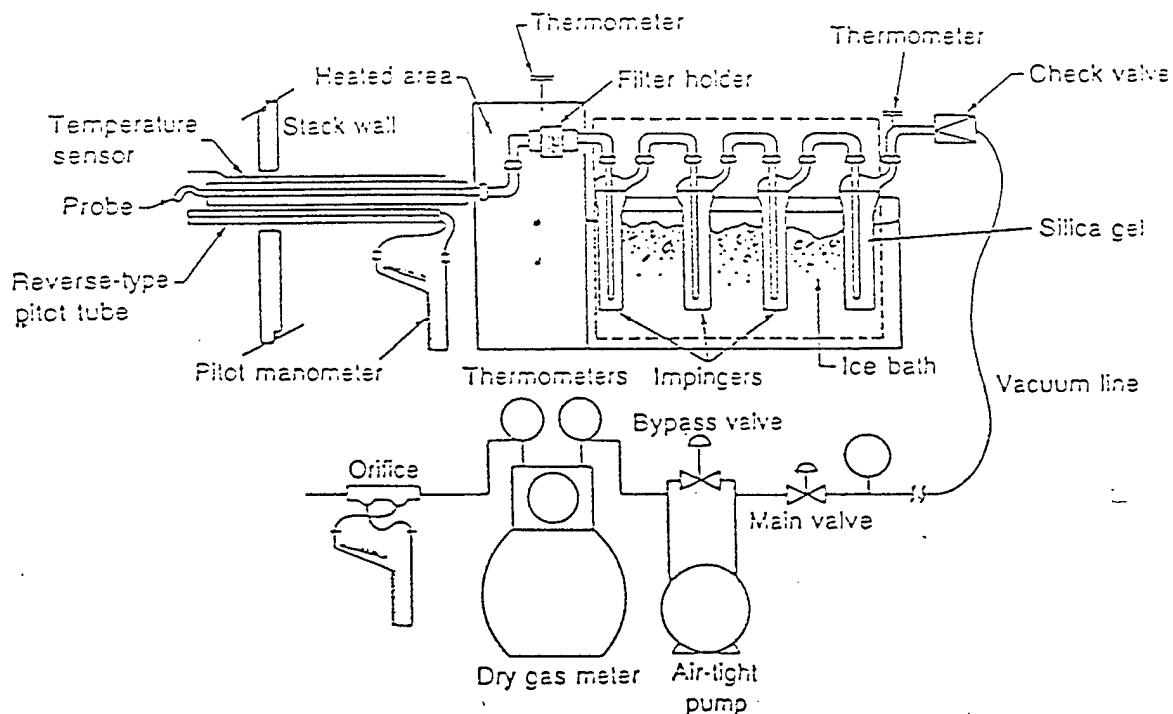


Figure 7.0 Schematic of EPA Method 5



Figure 8. EPA Method 5 sampling train

Front half particulate matter mass (material collected on sampling train surfaces up to and including the filter) was determined for compliance purposes according to the procedures specified in EPA Method 5. Field data from particulate sampling are presented in Appendix E. Emission calculations were accomplished using the "Source Test Calculation and Check Programs for Hewlett-Packard 41 Calculators" developed by the EPA Office of Air Quality Planning and Standards.

Quality Assurance/ Quality Control

Copies of all supporting calibration and quality assurance data are in the appendices.

Pre-survey

Prior to the survey, several steps were taken to calibrate equipment and prepare the sample filters. The meter box contains a dry gas meter that was calibrated using another dry gas meter. Although a dry gas meter is considered a secondary standard it can be used in lieu of a primary standard provided it is calibrated by a transfer standard whose calibration is traceable to a primary standard (i.e., wet test method). The purpose of this calibration is to ensure the volume collected as indicated by the meterbox is a measure of the true volume collected. Sample filters were pre-

dried in a dessicator for twenty-four hours and weighed to the nearest 0.1 milligram. They were placed back in the dessicator and re-weighed 6 hours later. If the weights were within 0.5 milligrams the average weight was recorded on a resealable plastic bag and the filter placed in it. Pitot tubes used to measure velocity were also calibrated within standards, correction factors determined, and recorded.

Survey

During the survey several steps were taken to ensure sample accuracy and precision. When the sampling train is assembled a leak test of the sample train and pitot tube was conducted before and after each sample run. Additionally, the nozzle selected for a particular run was measured using a micrometer and the diameter recorded on a calibration sheet.

Post-Survey

Upon completion of the sample run, the filter was removed and placed in aluminum foil which in-turn was labeled and placed in the resealable plastic bag. Post weighing was performed at Armstrong Laboratory using the same procedures indicated in EPA Method 5. The stainless steel probe was rinsed and brushed into a sample container at the on-site laboratory with acetone. This collects any particulate matter that may have adhered to the inside of the probe. The sample jars were labeled with run number, level of rinse (used to determine if a jar leaked during transport), and finally shipped to Armstrong Laboratory. At Armstrong Laboratory the acetone rinse was transferred to preweighed beakers. The volume of acetone was recorded and the beakers were placed in a controlled ventilation hood. After the acetone had evaporated the beakers were weighed in the same manner as the filters. The acetone residual weight was calculated and normalized to a QA/QC probe rinse. The impinger contents were measured using a graduated cylinder and electronic balance.

RESULTS

Sample results for particulate matter are shown in Table 1. Total particulate matter is a combination of PM collected on the filter and PM collected from rinsing the EPA Method 5 train components.

Table 1. Total Mass of Particulate Matter Collected

Test Run #	Filter PM Collected (lb)	Rinse PM Collected (lb)	Total Particulate Matter (lb)
TYPE"1" - 1	2.62E-04	1.84E-04	4.46E-04
TYPE"1" - 2	N/A	N/A	N/A
TYPE"1" - 3	4.80E-05	1.72E-04	2.28E-04
TYPE"1" - 4	8.16E-05	1.80E-04	2.62E-04

Table 2 shows the calculated particulate matter emissions rates. The amount of particulate matter captured in the EPA Method 5 train is adjusted to reflect the total particulate emissions from the stack. The sampling train's dry gas meter records the amount of exhaust gas collected through the train. At the same time, pitot tube readings from within the stack determine the stack gas velocity. By knowing the stack gas velocity, stack area and time sampled it is possible to determine the total gas exhausted through the stack. Total particulate matter is then determined by multiplying the particulate matter collected through the train by the ratio of gas collected through the train to the total gas exhausted through the stack. The total particulate matter value is then divided by the amount of waste incinerated to determine the emission rate.

Table 2. Total Mass of Particulate Matter Emitted

Test Run #	Total PM Emitted (lb)	Amount of Waste Incinerated (ton)	Total PM Emitted Per Waste Incinerated (lb/ton)
TYPE"1" - 1	4.46E-04	0.284	3.65
TYPE"1" - 2	N/A		N/A
TYPE"1" - 3	2.28E-04	0.147	3.61
TYPE"1" - 4	2.62E-04	0.132	4.61

Table 3 shows the average emissions and compliance standard.

Table 3. Incinerator Compliance Results

Test Run #	Total PM Emitted (lb/ton)	Total PM Standard (lb/ton)	Compliance Status
TYPE"1" - 1	3.80		
TYPE"1" - 2	N/A		
TYPE"1" - 3	3.48		
TYPE"1" - 4	4.39		
Average	3.89	4.0	Yes

DISCUSSION

Results from the particulate matter emissions testing for the Type "1" Incinerator are below State of Hawaii Permit limits. Operators of the incinerator should ensure that the temperature and retention time in the secondary chamber is sufficient to maintain complete combustion.

Results for the second run are not shown because the wrong input data was used in the HP41 calculator program. The values obtained were not considered valid. A fourth run was administered to obtain three complete and valid data sets.

Visual inspections of the stack exhausts showed a decrease in particulate matter released after the first forty minutes. This is consistent with the test methodology previously stated. Inspections of the incinerated material after a 2-4 hours showed very little remaining combustion and after 12 hours there were no visible cinders.

REFERENCES

1. Compilation of Air Pollution Emission Factors, Volume 1: Stationary Point and Area Sources, Fifth Edition, AP-42, Office of Air Quality Planning and Standards (OAQPS), U.S. Environmental Protection Agency (EPA), Research Triangle Park (RTP), North Carolina (NC), January 1995.
2. Hawaii Regulations, Title 11, Chapter 60.1, "Air Pollution Control"
3. Office of the Federal Register National Archives and Records Service, Code of Federal Regulations, Title 40, Part 60, Washington DC, July 1994.
4. U.S. Environmental Protection Agency, Source Test Calculation and Check Programs for Hewlett-Packard 41 Calculators, EPA-340/1-85-018, Research Triangle Park NC, May 1987
5. U.S. Environmental Protection Agency, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III. Stationary Sources Specific Methods, EPA/600/4-77/-07b, Research Triangle Park NC, December 1984

APPENDIX A

Personnel Information

Armstrong Laboratory Air Quality Test Team

Capt Kyle W. Blasch, Air Quality Consultant, Project Officer
Capt Thomas C. Moore, Air Quality Consultant
Capt Greg P. Durand, Air Quality Consultant

AL/OEBQ
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Brooks AFB TX 78235-5114
Phone: DSN 240-3305
Comm (210) 536-3305

Hickam AFB On-Site Representatives

Mr. Melvin Muraoka
15 CES/CEV
75 H Street
Hickam AFB, HI 96853-5233
Phone: DSN 449 - 8998
Comm (808) 449-8998

APPENDIX B



DEPARTMENT OF THE AIR FORCE
PACIFIC AIR FORCES

20 MAY 1996

MEMORANDUM FOR AL/OEBQ
2402 E. DRIVE, BUILDING 175W
BROOKS AFB TX 78235-5114

FROM: 15 CES/CEV
75 H Street
Hickam AFB HI 96853-5233

SUBJECT: Air Sampling Work - Title V

1. Armstrong Laboratory (AL) is scheduled to conduct National Emission Standard for Hazardous Air Pollutants (NESHAP) work on Hickam AFB during the Jul/Aug timeframe. During this period, we would like AL to conduct source sampling on two incinerators located on Hickam AFB.
2. During our annual air emission update/Title V permit review, we identified a possible compliance issue with our incinerators. EPA AP-42 air emission factors indicate the following emissions for PM-10 (Particulate Matter - less than 10 micron diameter).

<u>Type Incinerator</u>	<u>Emission Rate</u>
Type "O" waste incinerator	5.7 lb/ton
Silver reclamation incinerator	4.7 lb/ton

3. The State of Hawaii limitation for all incinerators is 4.0 lb/ton. Source testing for PM-10 needs to be conducted on these two incinerators to determine compliance status.
4. Please contact Mr. Melvin Muraoka at (808) 449-8998 to discuss any items.

MICHAEL F. MCGHEE, P.E.
Chief, Environmental Flight
15th Civil Engineer Squadron

APPENDIX C

METER BOX CALIBRATION DATA AND CALCULATION FORM

English Units

Meter Box Number:	4	Date:	12-Jul-96
Barometric Pressure, P _b , in.Hg:	29.41		

Preliminary Test Calibration

Orifice Manometer Setting (ΔH) in. H ₂ O	Gas Volume		Temperatures				Time (Θ) min	Y _i	ΔH@ _i in. H ₂ O
	Wet Test Meter (V _w) ft ³	Dry Gas Meter (V _d) ft ³	Wet Test Meter (t _w) °F	Dry Gas Meter					
				Inlet (t _{di}) °F	Outlet (t _{do}) °F	Avg (t _d) °F			
0.50	5	4.985	74	77	76	76.5	12.35	1.006447	1.747596
1.00	5	4.99	76	82	78	80	8.5	1.006964	1.657288
1.50	10	10.43	76	86	80	83	14.31	0.967665	1.751719
2.00	10	10.145	75	90	83	86.5	12.74	1.001886	1.832527
3.00	10	10.035	76	93	84	88.5	10.32	1.01216	1.803839
4.00	10	9.99	75	96	86	91	8.93	1.02073	1.786007
Average								1.002642	1.763163

$$Y_i = \frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6} \right) (t_w + 460)}$$

$$\Delta H@_i = \frac{0.0317}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\Theta}{V_w} \right]^2$$

Date:	Post Test Calibration								
Orifice Manometer Setting (ΔH) in. H ₂ O	Gas Volume		Temperatures				Time (Θ) min	Y _i	ΔH@ _i in. H ₂ O
	Wet Test Meter (V _w) ft ³	Dry Gas Meter (V _d) ft ³	Wet Test Meter (t _w) °F	Dry Gas Meter					
				Inlet (t _{di}) °F	Outlet (t _{do}) °F	Avg (t _d) °F			
2.50	10	10.265	68	74	73	73.5	12.17	0.978218	2.085541
2.50	10	10.29	70	80	74	77	12.31	0.978536	2.135983
2.50	10	10.17	72	85	77	81	12.24	0.993708	2.111996
Average								0.983487	2.111173

Run	Pre test Calibration Factor	Post Test Calibration Factor	Change	% Change
#1	1.002642	0.98349	0.019155	1.910453

Operator: Kyle Blarck Signature: [Signature]

TYPE S PITOT TUBE INSPECTION DATA FORM

Pitot Tube Assembly Level? yes no
 Pitot Tube Openings Damaged? yes (explain below) no

$\alpha_1 =$ $^\circ (<10^\circ)$
 $\beta_1 =$ $^\circ (<5^\circ)$

$\alpha_2 =$ $^\circ (<10^\circ)$
 $\beta_2 =$ $^\circ (<5^\circ)$

$\gamma =$ $^\circ$
 $\theta =$ $^\circ$
 $A =$ cm (in.)

$z = A \sin \gamma =$ cm (in.); <0.32 cm ($<1/8$ in.)
 $w = A \sin \theta =$ cm (in.); <0.08 cm ($<1/32$ in.)

$P_a =$ cm (in.)
 $P_b =$ cm (in.)
 $D_t =$ cm (in.)

Comments: 461 + .455 = A = .916

.461
.455

.916

Calibration Required? yes no

Operator: Kyle Marsh Signature: Kyle Marsh

APPENDIX D

XROM "METH

DIA INCHES?		
NIPPLE INCH ?	36,0000	RUN
POINTS ONE TRV?	5,2500	RUN
POINT 1,	12,0000	RUN
POINT 2,		6,3
POINT 3,		7,7
POINT 4,		9,5
POINT 5,		11,6
POINT 6,		14,3
POINT 7,		18,1
POINT 8,		28,4
POINT 9,		32,3
POINT 10,		34,9
POINT 11,		37,0

DIA INCHES?		
NIPPLE INCH ?	17,0000	
POINTS ONE TRV?	0,0000	
POINT 1,	10,0000	5
POINT 2,		
POINT 3,		
POINT 4,		
POINT 5,		
POINT 6,		1
POINT 7,		1
POINT 8,		1-
POINT 9,		1
POINT 10,		1

STACK DIA INCH? 36,0000 RUN
 NO TRAV PTS. ? 12,0000 RUN
 BAR PRESS ? 30,0200 RUN
 STATIC IN HOH ? .0900 RUN
 % MOISTURE ? 8,0000 RUN
 PITOT CP ? .8400 RUN
 % CO2 ? 8,0000 RUN
 % OXYGEN ? 8,0000 RUN
 % CO ? 8,0000 RUN
 MOL WT OTHER ? 8,0000 RUN

STACK TEMP? 620, RUN
 FPS = 8,
 DELTA P 2, .01 RUN
 STACK TEMP? 650, RUN
 FPS = 8,
 DELTA P 3, .01 RUN
 STACK TEMP? 730, RU
 FPS = 8,
 DELTA P 4, .01 RU
 STACK TEMP? 850, RU
 FPS = 9,
 DELTA P 5, .01 RU
 STACK TEMP? 950, RU
 FPS = 9,
 DELTA P 6, .01 RUN
 STACK TEMP? 1,083, RU
 FPS = 10,
 DELTA P 7, .01 RU
 STACK TEMP? 1,125, RU
 FPS = 10,
 DELTA P 8, .01 R.
 STACK TEMP? 1,125, R.
 FPS = 10,
 DELTA P 9, .01 RU
 STACK TEMP? 1,120, RU
 FPS = 10,
 DELTA P 10, .01 R.
 STACK TEMP? 1,116, R.
 FPS = 10,
 DELTA P 11, .01 R.
 STACK TEMP? 1,090, R.
 FPS = 10,
 DELTA P 12, .01 RUN
 STACK TEMP? 1,078, RUN
 FPS = 10,

STATIC HOH ? 7.09 RUN
 BAR PRESS ? 30,02 RUN
 STK TEMP ? 961,00 RUN
 HOH ? 8,00 RUN
 STACK FPS ? 8,00 RUN

AVE FPS = 9,
 AVE FPM = 552,
 AVE DELTA P = 0.01
 27:00

RUN NUMBER
HICKAM AFB
TYPE O INCIN ONE

METER BOX Y? RUN
DELTA H? 1,0030 RUN
BAR PRESS ? 3,5300 RUN
METER VOL ? 30,0100 RUN
MTR TEMP F? 34,2660 RUN
MTR TEMP F? 31,0000 RUN
% OTHER GAS
REMOVED BEFORE
DRY GAS METER ?
0,0000 RU
STATIC HOH IN ?
-1,0900 RU
STACK TEMP.
781,0000 RUN
ML. WATER ?
88,0000 RU

IMP. % HOH = 7,3
% HOH=7,3

% CO2? .0700 RU
% OXYGEN? 21,0000 RU
% CO ? 0,0000 RU
MOL WT OTHER? 0,0000 RU

MWd =28,85
MW WET=28,06

SOFT PSTS ?
TIME MIN ? 5,2665 R
NOZZLE DIA ? 60,0000 S
STK DIA INCH ? 7,470 F
36,0000 R

* VOL MTR STD = 52,774
STK PRES ABS = 30,00
VOL HOH GAS = 4,14
% MOISTURE = 7,28
MOL DRY GAS = 0,927
% NITROGEN = 78,93
MOL WT DRY = 28,85
MOL WT WET = 28,06
VELOCITY FPS = 13,03
STACK AREA = 7,07
STACK ACFM = 5,528,
* STACK DSCFM = 2,187.

RUN NUMBER
HICKAM AFB
TYPE O INCIN THREE

METER BOX Y? RUN
DELTA H? 1,0030 RUN
BAR PRESS ? .9900 RUN
METER VOL ? 30,0700 RUN
MTR TEMP F? 32,0650 RUN
MTR TEMP F? 32,0000 RUN
% OTHER GAS
REMOVED BEFORE
DRY GAS METER ?
0,0000 RU
STATIC HOH IN ?
-1,0900 RU
STACK TEMP.
781,0000 RUN
ML. WATER ?
81,5000 RU

IMP. % HOH = 11,0
% HOH=11,0

% CO2? 8,2700
% OXYGEN? 10,7300
% CO ? 0,0000
MOL WT OTHER? 0,0000

MWd =29,75
MW WET=28,46

SOFT PSTS ?
TIME MIN ? 4,0590 R
NOZZLE DIA ? 60,0000 R
STK DIA INCH ? 7,470 R
36,0000 R

* VOL MTR STD = 30,990
STK PRES ABS = 30,00
VOL HOH GAS = 3,34
% MOISTURE = 11,01
MOL DRY GAS = 0,890
% NITROGEN = 81,00
MOL WT DRY = 29,75
MOL WT WET = 28,46
VELOCITY FPS = 9,97
STACK AREA = 7,07
STACK ACFM = 4,226,
* STACK DSCFM = 1,201,
39,9

RUN NUMBER
HICKAM AFB
TYPE O INCIN FOUR

METER BOX Y? RUN
DELTA H? 1,0030 RUN
BAR PRESS ? 1,2300 RUN
METER VOL ? 30,0200 RUN
MTR TEMP F? 35,4340 RUN
MTR TEMP F? 33,0000 RUN
% OTHER GAS
REMOVED BEFORE
DRY GAS METER ?
0,0000 RU
STATIC HOH IN ?
-1,0900 RU
STACK TEMP.
781,0000 RUN
ML. WATER ?
102,5000 RU

IMP. % HOH = 12,4
% HOH=12,4

% CO2? 7,2000
% OXYGEN? 11,0000
% CO ? 0,0000
MOL WT OTHER? 0,0000

MWd =29,59
MW WET=28,16

SOFT PSTS ?
TIME MIN ? 3,8200 F
NOZZLE DIA ? 60,0000 R
STK DIA INCH ? 7,470 F
36,0000 R

* VOL MTR STD = 34,145
STK PRES ABS = 30,01
VOL HOH GAS = 4,82
% MOISTURE = 12,38
MOL DRY GAS = 0,876
% NITROGEN = 81,80
MOL WT DRY = 29,59
MOL WT WET = 28,16
VELOCITY FPS = 9,44
STACK AREA = 7,07
STACK ACFM = 4,002,
* STACK DSCFM = 1,387,
% ISOKINETIC = 101,.

APPENDIX E

Table E.1 Hickam AFB Incinerator Survey Filter Weights

Run #	1 st Weight 29Aug/0900 (g)	2 nd Weight 29Aug/1500 (g)	3 rd Weight 30Aug/0745 (g)	4 th Weight 30Aug/1500 (g)	5th Weight 3Sep/0730 (g)
T1I - 01	0.4072	0.4057	0.4069	0.4051	0.4048
T1I - 03	0.3122	0.3114	0.3121	0.3114	0.3112
T1I - 04	0.3272	0.3265	0.3269	0.3262	0.3258

Table E.2 Particulate Matter From Filter Collection

Run #	Filter Initial Weight (g)	Filter Final Weight (g)	Particulate Matter Weight (g)	Total PM For Each Run (g)
T1I - 01	0.2864	0.4050	0.119	0.119
T1I - 03	0.2895	0.3113	0.0218	0.0218
T1I - 04	0.2889	0.3260	0.0371	0.0371

Table E.3 Particulate Matter From Acetone Rinse

Run #	Initial Weight 29Aug/1600 (g)	1 st Weight 5Sep/0745 (g)	2 nd Weight 5Sep/1600 (g)	Final Weight (g)	Acetone Rinse Weight (g)
Blank	162.9687	162.9682	162.9680	162.9681	-0.0006
T1I - 01	165.8259	165.9099	165.9095	165.9097	0.0838
T1I - 03	162.7079	162.7862	162.7862	162.7862	0.0783
T1I - 04	166.1486	166.2308	166.2304	166.2306	0.0820

Table E.4 Type "1" Incinerator Stack Sampling Results

	Run 1	Run 3	Run 4	Average
Test Date	6 Aug 96	9 Aug 96	12 Aug 96	
Test Start Time (Military)	1045-1145	1000-1100	1400-1500	
Station Pressure ("Hg)	30.01	30.07	30.02	
Stack Static Pressure ("H ₂ O)	-0.09	-0.09	-0.09	
Average Stack Gas Temperature (° F)	781	1201	961	
Stack Gas Moisture Content (%H ₂ O)	7.3	11.0	12.4	
Stack Gas Oxygen Content (%O ₂)	21	10.73	11.0	
Stack Gas Carbon Dioxide Content (%CO ₂)	.070	8.27	7.2	
Stack Gas Velocity (ft/sec)	13.03	9.97	9.44	
Actual Stack Gas Flow Rate (ACFM)	5528	4226	4002	
Corrected Flow Rate (DSCFM)	2187	1201	1307	
Total Gas Volume (DSCF)	54.266	32.065	35.434	
Percent Isokinetic	93.47	99.93	102.20	
Waste Incinerated (ton)	0.284	0.147	0.132	
PM Collected (lb)	4.46E-04	2.28E-04	2.62E-04	
PM Emission Rate (lb/ton)	3.80	3.48	4.39	3.89

Units

"Hg = inches of mercury

"H₂O = inches of water

° F = degrees Fahrenheit

%H₂O = percent moisture

%O₂ = percent oxygen

ft/sec = feet per second

ACFM = actual cubic feet per minute

DSCFM = dry standard cubic feet per minute

lb/hr = pounds per hour Note: lb/hr = (ppm) (MW) (DSCFM) (1.55 x 10⁻⁷)

State of Hawaii Permit Limits

Particulate Matter: 4.0 lb/ton

Preliminary Survey Data Sheet

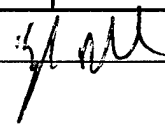
Dwell Time Calculation

Base: Wickham AFB Date: 2 Aug
 Source: Type "1" Incinerator Time: 10:00

Inside Stack Diameter (Inches):	<u>36 in</u>
Stack Static Pressure (In H ₂ O):	<u>-0.09</u>
Station Pressure (In. Hg):	<u>30.02</u>

Sampling Data:

Traverse Point Number	Stack Temperature (°F)	Velocity Head (Δp In. H ₂ O)	(Δp) ^{0.5}	Dwell Time (min)	Cyclonic Flow (°)	Abs Flow (°)
1	620	0.01			0	
2	650	0.01			0	
3	730	0.01			0	
4	850	0.01			5	
5	940	0.01			0	
6	1083	0.01			0	
7	1125	0.01			0	
8	1125	0.01			0	
9	1120	0.01			0	
10	1116	0.01			0	
11	1090	0.01			0	
12	1078	0.01			0	
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
Average =	961	0.01			0.42	

Operator: GREG Durand Signature: 

Impinger and Orsat Analysis Data Sheet

Base: HILKAM AFB

Date: 6 Aug 96

Source: TYPE "O"

Run: 1

Time: 13:55

I. IMPINGER ANALYSIS

ITEM	FINAL VOLUME (ml)	INITIAL VOLUME (ml)	VOLUME WATER (ml)
IMPINGER 1 (H ₂ O)	153	100	53
IMPINGER 2 (H ₂ O) Standard Tip	115	100	15
IMPINGER 3 (H ₂ O)	∅	0	∅
IMPINGER 4 (Silica Gel)	22∅	200 gm	20
Total Volume of Water Collected			88

II. MIGHTY ORSAT

Scratch Space:

0.0 0.0 .2 .2 0.0 0.0
 15.6 19.4 20.6 21.0 21.2 19.0 19.9
 21.0 21.2 21.0 21.0

6.72 0.088 + 6.72 = 22.554

CO₂ = Reading A; O₂ = Reading B-A; CO = Reading C-B; N₂ = (100% - %CO₂ - %O₂ - %CO);

DMW = 0.440(%CO₂) + 0.320(%O₂) + 0.280(%CO + %N₂)

ITEM	ANALYSIS			AVERAGE	COMMENT
	1	2	3		
Reading A	0.0	0.2	0.0		
Reading B	21.0	21.2	21.0		
Reading C	-	-	-		
VOL% CO ₂	0.0	0.2	0.0		
VOL% O ₂	21.0	21.0	21.0	21.0	
VOL% CO	-	-	-		
VOL% N ₂	79.0	78.0	79.0		
Dry Molecular Weight	28.87	28.872	28.87	28.857	

Fuel Factor: F_o = (20.9 - %O₂) / %CO₂ =

F_o (Natural Gas): 1.600 - 1.836

Operator: Kyle Blawie

Signature: Kyle Blawie

168.536
114.270
54.266

568 lbs

Particulate Sampling Data Sheet

Date: 6 Aug 96		Nozzle Diameter: 0.747		in		Pre Pitot Check: Yes		Schematic of Stack			
Base: HICKAM		Pitot Coefficient, Cp: 0.84		Post Pitot Check: Yes		Pre Train Check: Yes (at 15 "Hg)					
Source ID: Type "0" F.W.C.W		Meter Box Yi: 1.003		Post Train Check: Yes (at 22 "Hg)							
Run Number: 1		Meter Box ΔH@: 1.763									
Station Pressure: 30.01		Meter Box #: 4		Assumptions							
Static Pressure: -.09		Probe #: 6ft		%H ₂ O: 7.5		MW _D : 29.24					
Traverse Point Number	Sampling Time (min)	Dry Gas Meter Vol (ft ³)	Gas Meter Temp, T _m		Stack Temp, T _s (°F)	Velocity Head, Δp ("H ₂ O)	Orifice Diff Press, ΔH ("H ₂ O)	Probe Temp (°F)	Sample Box Temp (°F)	Impinger Outlet Temp (°F)	Vacuum Pressure ("Hg)
			In (°F)	Out (°F)							
1	2.5 min	144.067	90	88	330	.02	4.58	250	238	54	6
2		142.70	87	87	281	.02	4.25	249	235	50	6
3			87	87	327	.035	7.03	250	240	52	11
4			88	86	334	.035	4.96	249	241	54	19
5			88	86	345	.040	4.00	250	240	55	15
6			89	86	361	.035	6.71	251	238	56	15
7			89	86	360	.035	6.72	257	232	57	16
8			90	86	374	.035	6.02	253	225	60	17
9			90	87	383	.030	3.74	254	227	61	13
10			91	87	391	.035	4.64	254	253	61	14
11			93	88	1009	.015	1.62	266	246	63	11
12			94	89	1011	.015	1.62	269	263	63	10
13			95	89	1061	.025	2.61	267	248	62	14
14			96	90	1104	.020	2.03	268	250	62	14
15			97	90	1135	.025	2.50	267	250	63	16
16			98	91	1159	.025	2.46	270	243	64	17
17			98	91	1171	.020	1.96	270	253	64	17
18			98	91	1178	.020	1.95	269	252	64	17
19			98	92	1163	.020	1.97	263	250	64	18
20			98	92	1154	.020	1.98	254	236	65	18
21			98	92	1116	.020	2.03	243	247	65	18
22			98	92	1115	.020	2.03	234	250	64	18
23			98	92	1083	.020	2.07	230	248	65	20
24		168.576	98	93	894	.020	2.36	229	246	66	22
Total Gas Vol = 542.66		AVG T _m = 91		AVG T _s = 781		AVG ΔH = 3.59		AVG (P _s T _s) ^{0.5} = 52665			

Nov 95
Meter Box Operator: GREG DURAND
Signature: 

Impinger and Orsat Analysis Data Sheet

Base: HICKAM AFB Date: 8 Aug
 Source: TYPE "O" Inlet Run # 2 Time: 13:30

I. IMPINGER ANALYSIS			
ITEM	FINAL VOLUME (ml)	INITIAL VOLUME (ml)	VOLUME WATER (ml)
IMPINGER 1 (H ₂ O)	183	100	83
IMPINGER 2 (H ₂ O) Standard Tip	60	100	-40
IMPINGER 3 (H ₂ O)	0	0	0
IMPINGER 4 (Silica Gel)	206	200 gm	6
Total Volume of Water Collected			49

II. MIGHTY ORSAT			
Scratch Space:			
6.4 6.4	6.9 7.0 7.0	7.0 7.0	
17.2 18.2	15.8 18.6	16.4 18.9	
18.3 18.3	18.9 18.9	17.0 19.0	
2.816 + 3.800 + 22.876	3.0802 3.806 + 22.708	3.0807 + 3.84 + 22.6800	
CO ₂ = Reading A; O ₂ = Reading B-A; CO ₂ = Reading C-B; N ₂ = (100% - %CO ₂ - %O ₂ - %CO ₂);			
DMW = 0.440(%CO ₂) + 0.320(%O ₂) + 0.280(%CO + %N ₂)			

ITEM	ANALYSIS			AVERAGE	COMMENT
	1	2	3		
Reading A	6.4	7.0	7.0	6.8	
Reading B	18.3	18.9	19.0		
Reading C					
VOL% CO ₂	6.4	7.0	7.0	6.8	
VOL% O ₂	11.9	11.9	12.0	11.9333	
VOL% CO	-	-	-		
VOL% N ₂	81.7	81.1	81.0		
Dry Molecular Weight	29.500	29.5967	29.6007	29.5658	

Fuel Factor: F_o = (20.9 - %O₂) / %CO₂ = F_o (Natural Gas): 1.600 - 1.836

Operator: Kyle Blawch Signature: Kyle Blawch

lbs Burned 149

Particulate Sampling Data Sheet

Date: 6 8 Aug 96		Nozzle Diameter: 0.747 in		Pre Pitot Check: 4.5		Schematic of Stack					
Base: HUCAM AFB		Pitot Coefficient, Cp: 0.81		Post Pitot Check: 1.25							
Source ID: T-1000		Meter Box Yi: 1.003		Pre Train Check: 4.5 (at 15 "Hg)							
Run Number: T-1000		Meter Box ΔH@: 1.763		Post Train Check: 1.25 (at 6 "Hg)							
Station Pressure: 30.01 "Hg		Meter Box #: 4		Assumptions							
Static Pressure: -0.01 "H ₂ O		Probe #: 6 FT		%H ₂ O: 7.5	MW _D : 30.0						
Traverse Point Number	Sampling Time (min)	Dry Gas Meter Vol (ft ³)	Gas Meter Temp, T _m		Stack Temp, T _s (°F)	Velocity Head, Δp ("H ₂ O)	Orifice Diff Press, ΔH ("H ₂ O)	Probe Temp (°F)	Sample Box Temp (°F)	Impinger Outlet Temp (°F)	Vacuum Pressure ("Hg)
			In (°F)	Out (°F)							
1	2.5 min	217.572	89	90	124	.015	2.57	248	244	67	5
2	"		90	90	280	.020	2.70	250	248	64	6
3	"		91	90	345	.015	1.87	252	250	62	5
4	"		92	90	388	.015	1.77	252	248	62	5
5	"		92	90	400	.020	2.33	253	246	62	6
6	"		93	90	399	.020	2.33	253	238	62	7
7	"		94	90	1008	.015	1.03	257	232	65	5
8	"		94	90	999	.010	0.69	260	236	65	4
9	"		94	90	1026	.015	1.01	260	238	64	5
10	"		94	91	1048	.015	1.00	260	242	61	5
11	"		95	91	1066	.015	1.86	262	244	61	5
12	"		96	91	1077	.010	0.65	267	246	59	5
1	2.5 min	276.350	91	91	985	.010	0.69	244	228	51	4
2	"	236.450	92	91	1120	.015	0.95	245	232	50	5
3	"		92	91	1233	.015	0.89	250	236	52	6
4	"		94	92	1250	.015	0.88	250	242	53	6
5	"		94	92	1278	.015	0.87	250	242	54	6
6	"		95	92	1295	.015	0.86	249	244	55	6
7	"		96	93	1306	.015	0.86	248	248	56	6
8	"		97	93	1310	.010	0.57	244	248	57	4
9	"		97	93	1323	.010	0.57	247	248	59	4
10	"		98	94	1298	.010	0.58	249	246	58	5
11	"		98	94	1296	.010	0.58	257	246	58	5
12	"	252.209	98	94	1294	.010	0.58	250	246	58	5

Total Gas Vol = 34.037 Avg T_m = 113 Avg T_s = 964 Avg ΔH = 1.19 Avg (P_sT_s)^{0.5} = 4.3330

Nov 95
 Meter Box Operator: Greg Durand
 Signature: [Signature]
 15.259 108.778
 236.350 217.572
 15.257 128.770
 39.057

Impinger and Orsat Analysis Data Sheet

Base: Hickam AFB Date: 9 Aug 46
 Source: T03 Time: 1400

I. IMPINGER ANALYSIS			
ITEM	FINAL VOLUME (ml)	INITIAL VOLUME (ml)	VOLUME WATER (ml)
IMPINGER 1 (H ₂ O)	202	100	102
IMPINGER 2 (H ₂ O) Standard Tip	10 72	100	-28
IMPINGER 3 (H ₂ O)	0	0	0
IMPINGER 4 (Silica Gel)	207.5	200 gm	7.5
Total Volume of Water Collected			81.5

II. MIGHTY ORSAT

Scratch Space:

8.2 8.2 9.0 9.0 6.8 7.6 7.6
 19.0 19.0 18.6 13.6 19.4

3.6 + 3.456 + 22.68 3.96 + 3.072 + 27.792 3.344 + 3.776 + 27.568

CO₂ = Reading A; O₂ = Reading B-A; CO₂ = Reading C-B; N₂ = (100% - %CO₂ - %O₂ - %CO₂);
 DMW = 0.440(%CO₂) + 0.320(%O₂) + 0.280(%CO + %N₂)

ITEM	ANALYSIS			AVERAGE	COMMENT
	1	2	3		
Reading A	8.2	9.0	7.6	8.2667	
Reading B	19.0	18.6	19.4	19.00	
Reading C					
VOL% CO ₂	10.2 8.2	9.0	7.6	8.27	
VOL% O ₂	10.8	9.6	11.8	10.73	
VOL% CO	-	-	-		
VOL% N ₂	81.0	81.4	80.6	81	
Dry Molecular Weight	29.736	29.824	29.688	29.7493	

Fuel Factor: $F_o = (20.9 - \%O_2) / \%CO_2 =$ F_o (Natural Gas): 1.600 - 1.836

Operator: Kyle Blisch Signature: [Signature]

293 Ibs

Particulate Sampling Data Sheet												Schematic of Stack				
Date:	9 AUG 96			Nozzle Diameter:	0.747 in <th>Pre Pitot Check:</th> <td colspan="3">yes <th rowspan="4">Impinger Outlet Temp (°F)</th> <th rowspan="4">Sample Box Temp (°F)</th> <th rowspan="4">Vacuum Pressure (inHg)</th> </td>			Pre Pitot Check:	yes <th rowspan="4">Impinger Outlet Temp (°F)</th> <th rowspan="4">Sample Box Temp (°F)</th> <th rowspan="4">Vacuum Pressure (inHg)</th>			Impinger Outlet Temp (°F)	Sample Box Temp (°F)	Vacuum Pressure (inHg)		
Base:	HICKAM AFB			Pitot Coefficient, C _p :	0.84			Post Pitot Check:	yes							
Source ID:	TYPE "0" TAILW			Meter Box Y _i :	1.003			Pre Train Check:	yes (at 15 inHg)							
Run Number:	THREE			Meter Box ΔH@:	1.763			Post Train Check:	yes (at 3.5 inHg)							
Station Pressure:	30.07 inHg			Meter Box #:	4			Assumptions			Probe Temp (°F)	Velocity Head, Δp (inH ₂ O)	Orifice Diff Press, ΔH (inH ₂ O)	Temp (°F)	MW _D :	3.00
Static Pressure:	±0.09 inH ₂ O			Probe #:	6ft			%H ₂ O:	7.5							
Traverse Point Number	Sampling Time (min)	Dry Gas Meter Vol (ft ³)	In	Out	Gas Meter Temp, T _m (°F)	Stack Temp, T _s (°F)	Velocity Head, Δp (inH ₂ O)	Orifice Diff Press, ΔH (inH ₂ O)	Temp (°F)	Probe Temp (°F)	Sample Box Temp (°F)	Impinger Outlet Temp (°F)	Vacuum Pressure (inHg)			
1	A	2.5"	87	87	87	470	.01	1.79	252	252	250	61	1.5			
2	"	"	88	87	87	560	.01	1.55	253	253	249	58	2.0			
3	"	"	88	87	87	799	.01	1.85	254	254	253	57	2.0			
4	"	"	89	88	88	985	.01	1.09	256	256	250	59	2.0			
5	"	"	90	88	88	1168	.01	0.97	258	258	251	59	2.0			
6	"	"	91	88	88	1204	.01	0.94	257	257	247	57	2.0			
7	"	"	92	89	89	1295	.01	0.90	262	262	257	57	2.5			
8	"	"	93	89	89	1305	.01	0.90	260	260	252	57	2.5			
9	"	"	93	89	89	1312	.01	0.90	252	252	253	57	3.0			
10	"	"	93	89	89	1314	.01	0.89	252	252	253	57	3.0			
11	"	"	94	89	89	1319	.01	0.89	253	253	249	58	3.0			
12	"	"	94	89	89	1319	.01	0.89	254	254	248	58	3.0			
1	B	2.5"	94	91	91	1379	.01	0.89	254	254	248	58	3.5			
2	"	"	93	91	91	1115	.01	1.01	240	240	252	53	3.5			
3	"	"	94	92	92	1295	.01	0.91	242	242	252	54	3.5			
4	"	"	95	92	92	1354	.01	0.88	242	242	246	54	3.0			
5	"	"	95	92	92	1372	.01	0.87	242	242	252	55	3.0			
6	"	"	95	92	92	1391	.01	0.86	241	241	251	57	3.0			
7	"	"	96	93	93	1394	.01	0.86	243	243	248	59	3.0			
8	"	"	97	93	93	1389	.01	0.86	244	244	249	58	3.0			
9	"	"	97	94	94	1401	.01	0.86	247	247	249	60	3.0			
10	"	"	98	94	94	1405	.01	0.86	249	249	251	60	3.0			
11	"	"	98	94	94	1401	.01	0.86	249	249	251	60	3.0			
12	"	"	99	94	94	1398	.01	0.86	251	251	253	60	3.0			

Total Gas Vol = 38.065 Avg T_m = 92 Avg T_s = 1201 Avg ΔH = 0.99 Avg (P_sT_s)^{0.5} = 4.0591

Nov 95

Meter Box Operator: Greg Durand

Signature: *[Signature]*

268.545 7.742
 268.777 284.547
 16.333 15.734

Impinger and Orsat Analysis Data Sheet

Base: HICKAM AFB
 Source: TD-4

Date: 12 Aug 96
 Time: 16:00

I. IMPINGER ANALYSIS			
ITEM	FINAL VOLUME (ml)	INITIAL VOLUME (ml)	VOLUME WATER (ml)
IMPINGER 1 (H ₂ O)	215	100	115
IMPINGER 2 (H ₂ O) Standard Tip	81	100	-19
IMPINGER 3 (H ₂ O)	0	0	0
IMPINGER 4 (Silica Gel)	206.5	200 gm	6.5
Total Volume of Water Collected			102.5

II. MIGHTY ORSAT	
Scratch Space:	
7.3 7.3 7.0 7.0 17.4 18.8 17.8 17.9 18.9 18.9	7.2 7.372 17.5 17.8 17.8 3.212 + 3.712 + 22.70% 3.108 + 3.4800 + 22.98% 3.212 + 3.36 + 23.016
CO ₂ = Reading A; O ₂ = Reading B-A; CO ₂ = Reading C-B; N ₂ = (100% - %CO ₂ - %O ₂ - %CO ₂); DMW = 0.440(%CO ₂) + 0.320(%O ₂) + 0.280(%CO + %N ₂)	

ITEM	ANALYSIS			AVERAGE	COMMENT
	1	2	3		
Reading A	7.3	7.0	7.3		
Reading B	18.9	17.9	17.8		
Reading C					
VOL% CO ₂	7.3	7.0	7.3	7.2	
VOL% O ₂	11.6	10.9	10.5	11	
VOL% CO	-	-	-		
VOL% N ₂	81.1	82.1	82.2		
Dry Molecular Weight	29.632	29.584	29.585	29.603	

Fuel Factor: $F_o = (20.9 - \%O_2) / \%CO_2 =$ F_o (Natural Gas): 1.600 - 1.836

Operator: Kyle Blasch

Signature: Kyle Blasch


16.154
18.681
75.435

264 lbs

Particulate Sampling Data Sheet

Date: 12 Nov		Nozzle Diameter: 0.747 in		Pre Pitot Check: Yes		Schematic of Stack					
Base: HICKAM		Pilot Coefficient, C _p : 0.84		Post Pitot Check: Yes							
Source ID: TYPE "O"		Meter Box Y _i : 1.003		Pre Train Check: Yes		(at 15 "Hg)					
Run Number: 4		Meter Box ΔH@: 1.763		Post Train Check:		(at "Hg)					
Station Pressure: 30.09 "Hg		Meter Box #: 4		Assumptions							
Static Pressure: .045 "H ₂ O		Probe #: 6ft		%H ₂ O: 75	MWp: 30.0						
Traverse Point Number	Sampling Time (min)	Dry Gas Meter Vol (ft ³)	Gas Meter Temp, T _m		Stack Temp, T _s (°F)	Velocity Head, Δp ("H ₂ O)	Orifice Diff Press, ΔH ("H ₂ O)	Probe Temp (°F)	Sample Box Temp (°F)	Impinger Outlet Temp (°F)	Vacuum Pressure ("Hg)
			In (°F)	Out (°F)							
1	2.5 min	345.702	93	92	250	.01	2.24	253	254	64	3
2	"		92	92	480	.01	1.69	257	257	59	3
3	"		93	92	680	.01	1.40	258	257	59	3
4	"		94	92	805	.015	1.89	253	252	60	3.5
5	"		95	92	830	.015	1.85	256	257	60	4.0
6	"		96	92	870	.01	1.20	255	244	58	3.0
7	"		96	93	930	.01	1.15	255	247	58	3.5
8	"		96	93	980	.01	1.11	259	255	59	3.5
9	"		96	93	1020	.01	1.08	258	250	58	3.5
10	"		96	93	1060	.01	1.05	260	257	59	4.0
11	"		97	93	1130	.01	1.01	256	246	59	4.0
12	"	36% 383	97	93	1144	.01	1.00	259	250	59	4.0
1	2.5 min	36% 573	91	90	440	.01	1.76	248	257	58	5.0
2	"		92	91	820	.01	1.24	249	250	50	4.5
3	"		93	91	970	.01	1.11	250	248	57	4.5
4	"		93	91	985	.01	1.10	250	252	52	5.0
5	"		94	91	1016	.01	1.08	254	245	52	5.0
6	"		94	91	1057	.01	1.05	253	252	53	5.0
7	"		95	91	1072	.01	1.04	256	253	55	5.0
8	"		95	91	1198	.01	0.96	255	257	56	5.0
9	"		95	92	1295	.01	0.91	253	257	57	5.0
10	"		96	92	1326	.01	0.89	254	252	59	5.0
11	"		96	92	1340	.01	0.89	257	257	59	5.0
12	"	38% 297	96	92	1355	.01	0.88	255	252	59	5.0

Total Gas Vol = 35.474 Avg T_m = 93 Avg T_s = 961 Avg ΔH = 1.23 Avg (P_sT_s)^{0.5} = 3.8155

Nov 95 36% 4283 38% 277 Meter Box Operator: Greg Durand Signature: 

345-7023 26% 543

18.68 16.754