CONTROL EFFICIENCY DETERMINATION OF
SUDDEN EXPANSION INCINERATOR
BLDG 348, KELLY AFB, TEXAS

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June 1996


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Control Efficiency Determination of Sudden Expansion Incinerator
Bldg 348, Kelly AFB, Texas

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Compliance emissions testing and Volatile Organic Compound (VOC) destruction efficiency determination were conducted on the Sudden Expansion (SUE) Incinerator located at the Kelly AFB Fuel Accessory Test Facility, Bldg 348. Compliance standards and requirements are found in Operating Permit No. 6493, as amended/renewed by the State of Texas on 24 March 1994. The purpose of the Kelly AFB SUE Incinerator is to destroy calibration fluid vapors emitted from fuel accessory test stands located in Bldg 348. The incinerator can also be used to destroy liquid waste calibration fluid by burning it as a supplemental fuel. Emissions testing was conducted during combustion of both vapors and liquid calibration fluid. For purposes of determining the incinerator VOC destruction efficiency, monitoring for Total VOC concentration in the inlet air stream was conducted on 19-20 July 1995. Emissions testing of the incinerator exhaust was conducted on 10-11 January 1996 and included monitoring for Total VOC, oxides of nitrogen (NOx), carbon monoxide (CO), and visible emissions. Results indicate that the SUE Incinerator is in compliance with all applicable emission standards and with the VOC destruction efficiency requirement.
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CONTROL EFFICIENCY DETERMINATION OF
SUDDEN EXPANSION INCINERATOR, BLDG 348,
KELLY AFB, TEXAS

INTRODUCTION

Background

On 19-20 Jul 95 and 10-11 Jan 96, emissions testing was
conducted on the Sudden Expansion (SUE) Vapor Incinerator located
at the Kelly AFB Fuel Accessory Test Facility (Bldg 348).
Testing was performed by the Air Quality Function of the Air
Force Armstrong Laboratory. This survey was requested by the
Kelly AFB Environmental Management Office to satisfy State of
Texas permit requirements. Pollutants monitored during this
survey included Total Volatile Organic Compounds (VOC), Oxides of
Nitrogen (NOₓ), and Carbon Monoxide. Personnel involved with on-
site testing are listed in Appendix A.

Site Description

The Kelly AFB Fuel Accessory Test Facility performs testing of
F-100 unified fuel control and nozzle units. The inspection
process involves passing a calibration fluid (Stoddard solvent,
Military Specification MIL-C-7024D Type II) through fuel control
units which are set up in functional test stands. Information on
the calibration fluid is found in Appendix B. The test stands
are large computer-controlled modules which simulate actual
operation of the fuel control assemblies.¹²³ There are
currently 57 test stands located in Bldg 348. Figure 1 provides
a layout of Bldg 348's 1st floor showing the locations of the
test stands. A view of a typical test stand is shown in Figure
2.

At each test stand, fuel control units are tested directly
over a sink equipped with a down draft ventilation system. The
calibration fluid used for testing is pumped from a 500 gallon
(gal) reservoir located at each test stand. Testing of the fuel
control units is accomplished using one of two configurations,
closed loop or open body, depending on which section of the fuel
control assembly is being tested. In the closed loop
configuration, calibration fluid is pumped through the fuel
control unit in a closed system. After the test is completed,
the flow control unit is disconnected from the test stand and any
residual calibration fluid is dumped into the sink. In the open
body configuration, calibration fluid is continuously pumped
through the fuel control unit and directly into the sink.¹²

Calibration fluid dumped into the test stand sink is drained
back into the 500 gal reservoir. The fluid in the reservoir is
Figure 1. Locations of Test Stands.
Figure 2. View of a Typical Test Stand.
reused for testing until the lab determines (through visual, specific gravity, and viscosity tests) that the fluid is unuseable, at which point it is considered spent (waste) fluid.\textsuperscript{3} The spent calibration fluid is then drained out and replaced with clean fluid. Vapors from the calibration fluid dumped into the sink are captured by the ventilation system. 24 of the 57 test stands are ventilated to the SUE Incinerator while the other 33 test stands are vented to the atmosphere.

The calibration fluid used for testing the fuel control units is stored in two 20,000 gal underground storage tanks located at the northeast side of Bldg 348 (see Fig. 1). One tank supplies the clean fluid to the 500 gal reservoirs while the other tank receives the spent fluid drained from the reservoirs. Both tanks are vented to the sink vapor air entering the SUE Incinerator system.\textsuperscript{1,2,3} A flow diagram showing calibration fluid use at a typical test stand is presented in Figure 3.

A Robinson Industries blower is used to draw calibration fluid vapors through the ventilation system and into the SUE Incinerator. The blower is rated at 20,000 standard cubic feet per minute (SCFM) and 250 horsepower (hp).\textsuperscript{3} A flow diagram showing the vapor ventilation system is presented in Figure 4.

The SUE Incinerator (Model F20,000 manufactured by Kaiser Marquardt) consists of four 5,000 SCFM stainless steel burners equipped with integral recuperative heat exchangers which pre-heat incoming air. The incinerator is located in the courtyard on the northeast side of Bldg 348 (see Fig. 1). A view of the SUE Incinerator is shown in Figure 5. A schematic of a similar single burner SUE Incinerator (Model F5,000) is shown in Figure 6. Each burner of the SUE Incinerator includes a cylindrical combustion chamber which is joined to a smaller inlet pipe by a flat circular plate. Fuel nozzles protrude through the flat plate into the combustion chamber. The sudden expansion between the smaller inlet duct and the combustion chamber acts as a flame holder permitting stable combustion over a wide range of pressures, temperatures, and flows.\textsuperscript{3} A schematic showing the combustion process within a typical burner is presented in Figure 7.

The SUE Incinerator is currently fueled with either natural gas or natural gas supplemented with waste calibration fluid. Although the State operating permit also allows Kelly AFB to use waste shelf life oil as a supplemental fuel, shelf life oil is currently not burned in the SUE Incinerator. The waste calibration fluid burned by the SUE Incinerator comes from the "Spent" 20,000 gal underground storage tank located at Bldg 348 and from a 30,000 gal aboveground storage tank located at Bldg
Figure 3. Flow Diagram of Calibration Fluid Use.
Figure 4. Flow Diagram of Vapor Ventilation System.
Figure 5. View of Kelly AFB's SUE Incinerator.
Figure 6. Schematic of a Model F5,000 SUE Incinerator.
Figure 7. Schematic of Burner Combustion Process.
A flow diagram showing fuel and vapor input into the SUE Incinerator is presented in Figure 8.

**Applicable Standards and Guidelines**

The emission standards, destruction efficiency, and operating requirements for the SUE Incinerator are specified in Texas Natural Resource Conservation Commission (TNRCC) Permit No. 6493, as amended/renewed on 24 Mar 94. The entire permit is located in Appendix C and the major provisions applicable to the SUE Incinerator are summarized below:

1. The maximum allowable emission rates for VOC are 5.53 pounds per hour (lb/hr) and 24.20 tons per year (TPY).

2. The maximum allowable emission rates for NO₅ are 7.69 lb/hr and 33.70 TPY.

3. The maximum allowable emission rates for CO are 21.80 lb/hr and 95.00 TPY.

4. Opacity of emissions from the SUE Incinerator stack must not exceed 5 percent averaged over a six-minute period.

5. A VOC destruction efficiency of 98 percent for the SUE Incinerator shall be demonstrated while burning Stoddard solvent and shelf life oils.

6. The exhaust exit gas temperature of the SUE Incinerator must be continuously monitored and recorded to ensure a minimum temperature of 1450°F is maintained whenever burning VOCs, Stoddard solvent, or shelf life oils.

7. Records listed under Item 10 of the permit (e.g., quantity of liquid fuel burned, hours of incinerator operation, incinerator temperature charts, etc.) shall be maintained for a period of 2 years.

**METHODS AND MATERIALS**

To determine compliance with the TNRCC Operating Permit, sampling was conducted on both the inlet and outlet sides of the SUE Incinerator. Sampling on the inlet side included measurements for VOC, moisture, temperature, and velocity determination. The velocity was multiplied by the cross-sectional area of the duct to calculate the duct gas flow rate. Sampling on the outlet (exhaust) side of the SUE Incinerator included measurements for VOC, NOₓ, CO, Opacity, moisture, temperature, velocity, oxygen (O₂), and carbon dioxide (CO₂).
Figure 8. Flow Diagram of Fuel and Vapor Input into SUE Incinerator.
The stack gas velocity was multiplied by the cross-sectional area of the stack to calculate the stack gas flow rate. Measurements for moisture, O₂, and CO₂ were required for gas molecular weight determination. Field data from both the inlet and exhaust sampling are found in Appendix D.

The locations of the port holes and sampling points were determined using EPA Method 1. For velocity measurements, Method 1 requires the port holes to be located a minimum of 2 duct diameters downstream and 0.5 duct diameters upstream of the nearest flow disturbances. All EPA Methods used in this survey are found in 40 Code of Federal Regulations, Part 60 (40 CFR 60). 5

Sampling of the inlet gas stream was performed on a horizontal rectangular duct which is 5' high, 2' wide, and 8' 7" long. This section of duct is located in a small room (closet) adjacent to the SUE Incinerator (see Fig. 1). The effective inside diameter of this section of duct was calculated to be 2.86 feet using the equation \(2HW/(H+W)\) where H equals the height and W equals the width. Four port holes, located on the same vertical plane, were used for measuring the velocity, temperature, and moisture. These four port holes are located approximately 5.75 feet (2.0 duct diameters) downstream from the nearest disturbance. A fifth port hole, located approximately 1.5 feet (0.52 duct diameters) downstream from the first four port holes, was used to monitor Total VOC. A view of the inlet duct sampling ports is shown in Figure 9. In accordance with EPA Method 1, a total of 16 sampling points were used for measuring the velocity, temperature, and moisture. Total VOC were measured at a single point in the cross-sectional center of the duct. Figure 10 shows the locations of the five port holes for the inlet duct. Figure 11 shows the locations of the 16 sampling points used for measuring the velocity, temperature, and moisture.

Sampling of the exhaust gas stream was performed on the 30' high vertical stack located in the same courtyard as the SUE Incinerator. A view of the exhaust stack is shown in Figure 12. The exhaust stack is triangular with the inside opening having two 4' sides and one 5.66' side. The effective inside diameter of this stack was calculated to be 2.34 feet using the equation \(4A/P\) where A equals the cross-sectional area and P equals the perimeter. Four port holes (located on the same horizontal plane) were used for measuring the velocity, temperature, and moisture. These port holes are located approximately 7 feet (3 stack diameters) downstream from the nearest disturbance (i.e., the horizontal exhaust duct connected to the side of the stack). A fifth port hole, located approximately 2 feet (0.85 stack diameters) above the first four port holes, was used to monitor the gaseous parameters (i.e., O₂, CO₂, NOₓ, CO, and VOC). In
Figure 9. View of Inlet Duct Sampling Ports.
Figure 10. Locations of Inlet Duct Sampling Ports.

Figure 11. Locations of Inlet Duct Sampling Points for Velocity, Temperature, and Moisture.
Figure 12. View of Exhaust Stack.
accordance with EPA Method 1, a total of 16 sampling points was used for measuring the velocity, temperature, and moisture. The concentrations of O₂, CO₂, NOₓ, CO, and VOC were measured at a single point in the geometric cross-sectional center of the stack. Figure 13 shows the locations of the five port holes for the exhaust stack. Figure 14 shows the locations of the 16 sampling points used for measuring the velocity, temperature, and moisture.

Prior to sampling at both the inlet and outlet locations, the degree of cyclonic flow was determined by measuring the gas rotational angle at each of the 16 sampling points chosen for velocity, temperature, and moisture monitoring. Measurements were made using a Type S pitot tube, a 10-inch inclined-vertical manometer, an angle finder, and the procedures described in Paragraph 2.4 of EPA Method 1. Flow conditions are considered acceptable when the arithmetic mean average of the rotational angles is 20 degrees or less. Rotational angle measurements showed the air flow in both the inlet duct and exhaust stack to be within the acceptable limit. Preliminary velocity, temperature, and static pressure readings were also taken at the same time the cyclonic flow measurements were conducted.

The 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 15 and a view of the meter box is shown in Figure 16. Calibration data for the Method 5 equipment are found in Appendix E. Calibrations were performed in accordance with EPA's Quality Assurance Handbook. The probe nozzle was sized (with a micrometer) prior to sampling using EPA Method 5 criteria. 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. Type K thermocouples were used to measure stack gas as well as 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 200 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. In accordance with EPA Method 4, moisture sampling
Figure 13. Locations of Exhaust Stack Sampling Ports.
Figure 14. Locations of Exhaust Stack Sampling Points for Velocity, Temperature, and Moisture.
Figure 15. Schematic of Method 5 Sampling Train.
Figure 16. View of Meter Box.
was conducted at a constant flow rate and for an equal time (3.75 minutes) at each of the 16 sampling points. 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 F.

The moisture and temperature of the inlet duct gas were determined using wet bulb-dry bulb temperature readings. Measurements were taken at each of the 16 sampling points using mercury-in-glass thermometers. The percent moisture of the inlet duct gas was calculated using the EPA's HP 41 "WBDB" Calculator Program.

The velocity of the inlet duct gas was determined using a Type S pitot tube and a 10-inch inclined-vertical manometer. Calculations for the velocity and flow rate of the inlet duct gas were performed using the EPA's HP 41 "METH 2" Calculator Program.

The VOC concentration in both the inlet duct and exhaust stack gas was measured with a JUM Model 3-300A Flame Ionization Detector (FID) analyzer and the procedures described in EPA Method 25A. Prior to entering the analyzer, the sample gas traveled through a sampling system consisting of a heated stainless steel probe, a particulate filter, and a heated Teflon line. The sample was drawn through the system by a heated pump built into the analyzer. A 40% Hydrogen/60% Helium gas mixture was used as the fuel for the FID. A view of the VOC analyzer is shown in Figure 17. Information on the VOC analyzer, including calibration procedures, is found in Appendix G. A member of the survey team recorded VOC concentration measurements at 1-minute intervals during each sampling run. Measurements were in units of parts per million by volume (ppmv) as propane. The average VOC concentration for each sampling run was later converted to a mass emission rate in pounds per hour (lb/hr) using the following equation:

\[
E = (C) \times (MW) \times (FR) \times (1.55 \times 10^{-7})
\]

where,

- \( E \) = The pollutant emission rate in pounds per hour (lb/hr)
- \( C \) = The measured pollutant concentration in ppmv.
- \( MW \) = The molecular weight of the pollutant [Note - for VOC, the molecular weight of the calibration gas (propane) is used].
- \( FR \) = The flow rate of the stack (or duct) gas in DSCFM.
- \( 1.55 \times 10^{-7} \) = Conversion Factor \([(\text{min} \cdot \text{g-mole} \cdot \text{lb})/(\text{hr} \cdot \text{g} \cdot \text{ft}^3)]\)
Initial plans were to sample for NO\textsubscript{x}, O\textsubscript{2}, and CO\textsubscript{2} in the exhaust stack gas with a Continuous Emission Monitoring (CEM) system manufactured by the Anarad Corporation. This system includes a sample conditioning/flow control module, a chemiluminescent NO\textsubscript{x} analyzer, an infrared CO\textsubscript{2} analyzer, and an electrochemical O\textsubscript{2} analyzer. Unfortunately, because of mechanical problems with the sample flow control module, the analyzers could not be properly calibrated. Therefore, sampling for these parameters was instead accomplished using a backup method consisting of an ENERAC 3000 portable analyzer. This analyzer uses an electrochemical cell to measure O\textsubscript{2} concentration. NO\textsubscript{x} concentration is computed by the analyzer by adding together the concentrations of nitric oxide (NO) and nitrogen dioxide (NO\textsubscript{2}), both of which are measured via electrochemical cells. The analyzer computes CO\textsubscript{2} based on the O\textsubscript{2} content and the type of combustion fuel. A member of the survey team recorded NO\textsubscript{x}, O\textsubscript{2} and CO\textsubscript{2} concentration measurements at 2-minute intervals during each sampling run. O\textsubscript{2} and CO\textsubscript{2} measurements were in units of percent while NO\textsubscript{x} measurements were in units of ppm as NO\textsubscript{x}. The average NO\textsubscript{x} concentration for each sampling run was later converted to a mass emission rate (lb/hr) using Equation 1. A view of the ENERAC 3000 analyzer is shown in Figure 18. Specifications and information, including calibration procedures, for the ENERAC 3000 analyzer are found in Appendix H.

Sampling for CO in the exhaust stack gas was attempted using an Anarad Model AR-411 non-dispersive infrared (NDIR) analyzer. However, due to excessive drift, this instrument was not used. Instead, CO was determined using the ENERAC 3000 analyzer. The analyzer measures CO concentration via an electrochemical cell. A member of the survey team recorded CO concentration measurements at 2-minute intervals during each sampling run. Measurements were in units of ppm. The average CO concentration for each sampling run was later converted to a mass emission rate (lb/hr) using Equation 1.

The rate of liquid waste calibration fluid (lb/hr Stoddard solvent) combusted in the SUE Incinerator during each sampling run was recorded from the incinerator's main console.

The VOC destruction efficiency of the SUE Incinerator was calculated using the following equation:

\[
\text{DE} = \frac{[(\text{CF} - E_{ex})/\text{CF}] \times 100}{(2)}
\]

Where,

DE = Destruction Efficiency (%)
CF = Calibration Fluid combusted by SUE Incinerator (lb/hr as Stoddard solvent) [Note - includes both the VOC vapors in the inlet gas stream and the liquid waste calibration fluid]
Figure 17. View of VOC Analyzer.

Figure 18. View of ENERAC 3000 Analyzer.
burned as supplemental fuel]
\[ E_{ex} = \text{VOC emission rate in exhaust stack (lb/hr as Stoddard solvent)} \]

The VOC destruction efficiency was calculated based on the total Stoddard solvent burned by the incinerator. This includes the VOC vapors in the inlet gas stream (i.e., vapors removed from the test stands in Building 348) and the liquid waste Stoddard solvent burned as a supplemental fuel. Since the liquid waste solvent is included, it was necessary to convert both the inlet VOC vapor concentration and the exhaust VOC concentration from "ppmv as propane" to "ppmv as Stoddard solvent." This was done by first converting "ppmv as propane" to "ppmv as carbon" by multiplying by 3 (the carbon equivalent correction factor) in accordance with EPA Method 25A. \(^5\) The concentration in "ppmv as carbon" was then converted to "ppmv as Stoddard solvent" by dividing by 7.05 (response factor determined by a contractor, Engineering Science, during emissions testing performed at Bldg 348 in Sep 92). \(^2\) The molecular weight of Stoddard solvent (140) was then used with Equation 1 to convert "ppmv as Stoddard solvent" to a mass flow rate (lb/hr Stoddard solvent).

Example calculations, using Equations 1 and 2 above, are shown in Appendix I.

Opacity (visible emission) readings were recorded by a person who is certified by the Texas Natural Resources Conservation Commission. Three opacity runs were conducted. Each run consisted of taking readings every 15 seconds for 30 minutes. Due to a man-power shortage, each opacity run was conducted shortly before a stack sampling run. The incinerator was operated under the same conditions for the opacity runs and the corresponding stack sampling runs.

RESULTS

Sampling of the inlet duct gas stream was performed on 19-20 Jul 95 during normal test stand operations in Bldg 348. Although the SUE Incinerator was not operational at this time, permission to proceed with the inlet testing was given by the TNRCC. Table 1 provides a summary of the results from the inlet testing. The average VOC mass flow rate for the three sampling runs was 10.2 lb/hr as propane.

The SUE Incinerator became fully operational in early Jan 96. Sampling of the exhaust stack gas was therefore performed on 10-11 Jan 96 during normal test stand operations in Bldg 348. During testing, the incinerator was operated at approximately 70% capacity. The incinerator fuel combustion rate during all three
sampling runs was approximately 108 pounds per hour (lb/hr) of liquid waste calibration fluid and 4,000 standard cubic feet per hour (scfh) of natural gas. Table 2 provides a summary of the results from the exhaust testing. In brief, the average VOC mass emission rate for the three sampling runs was 0.66 lb/hr as propane, the average NOx mass emission rate was 1.9 lb/hr as NO2, and the average CO emission rate was 3.4 lb/hr. All visible emission readings showed 0 percent opacity.

Based on the VOC inlet and VOC exhaust mass emission rates and on the amount of liquid waste calibration fluid burned, the average VOC destruction efficiency was calculated to be 99.3 percent. A summary of the data used to calculate this destruction efficiency is found in Table 3.

DISCUSSION

Results show that the VOC, NOx, and CO mass emission rates from the SUE Incinerator were all well below TNRCC Permit limits. With no opacity readings above 0 percent, the SUE Incinerator also met the TNRCC limit for opacity. Finally, the 99.3 percent destruction efficiency demonstrated by the SUE Incinerator was above the TNRCC minimum requirement of 98 percent.

RECOMMENDATIONS

The following recommendations are provided to ensure compliance with TNRCC Permit No. 6493 regarding the Bldg 348 test stands and the SUE Incinerator:

1. Ensure the temperature inside the incinerator is always maintained above 1450°F during operation.

2. Ensure the following records are maintained on base for a period of at least two years:
   a. Records of the amount of calibration fluid purchased and of waste calibration fluid sent to reclamation.
   c. Records of the quantity of calibration fluid (Stoddard solvent) or shelf life oil burned in the SUE Incinerator.
   d. Records of the hours of operation of the SUE Incinerator.
## Table 1. Inlet Duct Sampling Results

<table>
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<th>Run 2</th>
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<td>82</td>
<td>80</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>Avg Wet Bulb Temperature (°F)</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Gas Moisture Content (%H₂O)</td>
<td>2.1</td>
<td>2.2</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Gas Oxygen Content (%O₂)¹</td>
<td>20.9</td>
<td>20.9</td>
<td>20.9</td>
<td></td>
</tr>
<tr>
<td>Avg Velocity Pressure (&quot;H₂O&quot;)</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>Avg Gas Velocity (ft/sec)</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Actual Gas Flow Rate (ACFM)</td>
<td>10,858</td>
<td>10,901</td>
<td>10,847</td>
<td>10,869</td>
</tr>
<tr>
<td>Corrected Flow Rate (DSCFM)</td>
<td>10,094</td>
<td>10,132</td>
<td>10,028</td>
<td>10,085</td>
</tr>
<tr>
<td>Avg VOC Reading (ppmv)²</td>
<td>202</td>
<td>100</td>
<td>144</td>
<td>149</td>
</tr>
<tr>
<td>VOC Emission Rate (lb/hr)³</td>
<td>13.9</td>
<td>6.9</td>
<td>9.8</td>
<td>10.2</td>
</tr>
</tbody>
</table>

**Units**

"Hg = inches of mercury
"H₂O = inches of water
°F = degrees Fahrenheit
%H₂O = percent water
%O₂ = percent oxygen
ft/sec = feet per second
ACFM = actual cubic feet per minute
DSCFM = dry standard cubic feet per minute
ppmv = parts per million by volume
lb/hr = pounds per hour

**Note:** lb/hr = (ppm) (MW) (DSCFM) \(1.55 \times 10^{-7}\)

**Notes**

¹ Based on ambient air
² Measured as propane
³ Calculated as propane
Table 2. Exhaust Stack Sampling Results

<table>
<thead>
<tr>
<th></th>
<th>Run 1</th>
<th>Run 2</th>
<th>Run 3</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Date</td>
<td>10 Jan 96</td>
<td>11 Jan 96</td>
<td>11 Jan 96</td>
<td></td>
</tr>
<tr>
<td>Test Start Time (Military)</td>
<td>1416</td>
<td>1155</td>
<td>1442</td>
<td></td>
</tr>
<tr>
<td>Station Pressure (&quot;Hg&quot;)</td>
<td>29.305</td>
<td>29.460</td>
<td>29.410</td>
<td></td>
</tr>
<tr>
<td>Stack Static Pressure (&quot;H₂O&quot;)</td>
<td>-0.20</td>
<td>-0.20</td>
<td>-0.20</td>
<td></td>
</tr>
<tr>
<td>Average Stack Gas Temperature (°F)</td>
<td>606</td>
<td>632</td>
<td>629</td>
<td>622</td>
</tr>
<tr>
<td>Stack Gas Moisture Content (%H₂O)</td>
<td>2.9</td>
<td>1.7</td>
<td>2.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Stack Gas Oxygen Content (%O₂)</td>
<td>18.8</td>
<td>18.7</td>
<td>18.8</td>
<td>18.8</td>
</tr>
<tr>
<td>Stack Gas Carbon Dioxide Content (%CO₂)</td>
<td>1.6</td>
<td>1.7</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Stack Gas Velocity (ft/sec)</td>
<td>41</td>
<td>41</td>
<td>42</td>
<td>41</td>
</tr>
<tr>
<td>Actual Stack Gas Flow Rate (ACFM)</td>
<td>19,440</td>
<td>19,446</td>
<td>19,940</td>
<td>19,609</td>
</tr>
<tr>
<td>Corrected Flow Rate (DSCFM)</td>
<td>9,155</td>
<td>9,097</td>
<td>9,297</td>
<td>9,183</td>
</tr>
<tr>
<td>Average CO Reading (ppmv)</td>
<td>91</td>
<td>108</td>
<td>54</td>
<td>84</td>
</tr>
<tr>
<td>Average NOₓ Reading (ppmv)</td>
<td>26</td>
<td>29</td>
<td>31</td>
<td>29</td>
</tr>
<tr>
<td>Average VOC Reading (ppmv as propane)</td>
<td>14.7</td>
<td>9.1</td>
<td>8.1</td>
<td>10.6</td>
</tr>
<tr>
<td>CO Emission Rate (lb/hr)</td>
<td>3.6</td>
<td>4.3</td>
<td>2.2</td>
<td>3.4</td>
</tr>
<tr>
<td>NOₓ Emission Rate (lb/hr as NO₂)</td>
<td>1.7</td>
<td>1.9</td>
<td>2.1</td>
<td>1.9</td>
</tr>
<tr>
<td>VOC Emission Rate (lb/hr as propane)</td>
<td>0.92</td>
<td>0.56</td>
<td>0.51</td>
<td>0.66</td>
</tr>
<tr>
<td>Opacity (%)*</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* Opacity readings were taken just prior to the stack gas sampling with the incinerator operating under the same conditions.

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 = actual cubic feet per minute
ppmv = parts per million by volume
lb/hr = pounds per hour

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

TNRCC Permit Limits
CO: 21.80 lb/hr
NOₓ: 7.69 lb/hr as NO₂
VOC: 5.53 lb/hr as propane
Opacity: 5%
Table 3. VOC Destruction Efficiency Data

<table>
<thead>
<tr>
<th></th>
<th>Run 1</th>
<th>Run 2</th>
<th>Run 3</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Stack Gas Flow Rate (DSCFM)</td>
<td>9,155</td>
<td>9,097</td>
<td>9,297</td>
<td>9,183</td>
</tr>
<tr>
<td>Measured Stack Gas VOC Concentration (ppmv as propane)</td>
<td>14.7</td>
<td>9.1</td>
<td>8.1</td>
<td>10.6</td>
</tr>
<tr>
<td>Converted Stack Gas VOC Concentration (ppmv as Stoddard solvent)</td>
<td>6.3</td>
<td>3.9</td>
<td>3.4</td>
<td>4.5</td>
</tr>
<tr>
<td>Converted Stack Gas VOC Emission Rate (lb/hr as Stoddard solvent)</td>
<td>1.25</td>
<td>0.77</td>
<td>0.69</td>
<td>0.90</td>
</tr>
<tr>
<td>Corrected Inlet Air Flow Rate (DSCFM)</td>
<td></td>
<td></td>
<td></td>
<td>10,085*</td>
</tr>
<tr>
<td>Measured Inlet Air Stream Solvent Vapor Concentration (ppmv as propane)</td>
<td></td>
<td></td>
<td></td>
<td>149*</td>
</tr>
<tr>
<td>Converted Inlet Air Stream Solvent Vapor Concentration (ppmv as Stoddard solvent)</td>
<td></td>
<td></td>
<td></td>
<td>63.4</td>
</tr>
<tr>
<td>Converted Inlet Air Stream Solvent Vapor Rate (lb/hr as Stoddard solvent)</td>
<td></td>
<td></td>
<td></td>
<td>13.9</td>
</tr>
<tr>
<td>Liquid Waste Solvent Consumption Rate (lb/hr Stoddard solvent)</td>
<td>108</td>
<td>107</td>
<td>108</td>
<td>107.7</td>
</tr>
<tr>
<td>Total Stoddard Solvent Consumption Rate (lb/hr)</td>
<td>121.9</td>
<td>120.9</td>
<td>121.9</td>
<td>121.6</td>
</tr>
<tr>
<td>VOC Destruction Efficiency (%)</td>
<td>99.0</td>
<td>99.4</td>
<td>99.4</td>
<td>99.3</td>
</tr>
</tbody>
</table>

* Determined from testing performed in Jul 95

Units
DSCFM = dry standard cubic feet per minute
ppmv = parts per million by volume
lb/hr = pounds per hour  
Note: lb/hr = (ppm) (MW) (DSCFM) (1.55 x 10^-7)

TNRCC Permit Requirement: VOC Destruction Efficiency ≥ 98%
e. Charts from the temperature monitor for the SUE Incinerator.

3. Ensure another VOC destruction efficiency determination is performed on the SUE Incinerator if the base decides to use waste shelf life oil as a supplemental fuel.

4. Ensure the VOC emissions from the 33 test stands vented directly to the atmosphere are calculated and tabulated monthly. The emission calculations shall be based on calibration fluid usage (i.e., mass-balance). The calculated emissions must also be reported in the annual base air emissions inventory.

Armstrong Laboratory will remain active in supporting the base’s present and future needs.

REFERENCES

1. USAF Occupational and Environmental Health Laboratory, Volatile Organic Compound (VOC) Testing at Building 348, Kelly AFB TX, USAF/OEH Report 87-147EQ0094LEF, Brooks AFB TX, November 1987

2. Engineering-Science, Inc., VOC Testing of the Carbon Adsorption Unit, Building 348, Kelly Air Force Base, Texas, Austin TX, April 1993

3. San Antonio Air Logistics Center, Vapor Incineration System Program, Kelly AFB TX, 12 June 1995

4. Texas Natural Resource Conservation Commission, Permit Number 6493, Austin TX, 24 March 1994


APPENDIX A

Personnel Information
PERSONNEL INFORMATION

1. Armstrong Laboratory Air Quality Test Team

   Maj Larry Kimm, Chief, Air and Hazardous Waste Branch  
   Capt Robert O'Brien, Air Quality Consultant, Project Officer  
   Capt Gregory Durand, Air Quality Consultant  
   Capt T.C. Moore, Air Quality Meteorologist  
   2Lt Kyle Blasch, Air Quality Consultant  
   MSgt Kurt Jagielski, Air Quality Technician  
   SSgt Michael Dobbins, Air Quality Technician  

   AL/OEBQ  
   2402 E Drive  
   Brooks AFB TX 78235-5114  
   Phone: DSN 240-3305  
       Comm (210) 536-3305

2. Kelly AFB On-Site Representatives

   Capt Michael Blank, Air Quality Program Manager  
   SA-ALC/EMC  
   307 Tinker Dr. (Bldg 306)  
   Kelly AFB, TX 78241-5917  
   Phone: DSN 945-3100 ext 306  
       Comm (210) 925-3100 ext 306

   Mr Robert Burns, Mechanical Engineer  
   SA-ALC/LPPEC  
   505 Perrin Road (Bldg 324)  
   Kelly AFB, TX 78241-6435  
   Phone: DSN 945-8655  
       Comm (210) 925-8655

   Mr John Jurek, Mechanical Engineer  
   SA-ALC/LPPEC  
   505 Perrin Road (Bldg 324)  
   Kelly AFB, TX 78241-6435  
   Phone: DSN 945-7581  
       Comm (210) 925-7581

3. Kaiser Marquardt On-Site Representative

   Mr Ray Wieveg, Design Engineer  
   Kaiser Marquardt  
   16555 Saticoy Street  
   Van Nuys, CA 91406-1739  
   Phone: (818) 989-6542
APPENDIX B

Calibration Fluid Information
MIL-C-7024D Calibrating Fluids, Aircraft Fuel System Components

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**Rev D:** 30 Aug 1990
**FSCM (CAGE):** 81349
**NSN:** 6850-00-656-0810

---

**Classification:** Type II Special Run Stoddard Solvent CH4*B6, M.W. = 140

**Chemical Family:** Paraffinic and Naphthenic Hydrocarbons

**Synonyms:** Stoddard Solvent, Mineral Spirits, Short Range Mineral Spirits

---

**Locator Code:** H-24-15
**Film Loc:** X552-1268
**Microfiche:** 011268 Loc: 0163D06

---

**Specific Gravity:** 0.770 ± 0.005 @ 60°F, 15.6°C ASTM Test Method D1298

**Viscosity:** 1.17 ± 0.05 centistokes @ 77°F, 25°C ASTM Test Method D445

**Particulate Matter (min):** 2.0 mg/liter ASTM Test Method D2276

**Flash Point (min):** 100°F, 38°C ASTM Test Method D56

**Initial/Final Boiling Points:** 300°F/410°F ASTM Test Method D86

**Aromatics, Volume Percent (max):** 20.0% ASTM Test Method D1319

**Olefins, Volume Percent (max):** 5.0% ASTM Test Method D1319

**Total Acid Number (max):** 0.015 mg KOH/g ASTM Test Method D3242

**Gum, Existent (max):** 5.0 mg/100 ml ASTM Test Method D381

**Vapor Pressure:** 0.1 psi @ 100°F ASTM Test Method D323

---

**Autoignition Temperature:** >400°F

**Percent Volatile:** essentially 100%

**Flammability Limits in Air:**
  - Lower Explosive Limit: 0.9%
  - Upper Explosive Limit: 6.0%

**Vapor Density (air=1):** <1.0

**Solubility in Water:** Negligible

**Appearance and Odor:** Water white liquid with mild hydrocarbon odor

**Fire:** Moderate (2)

**Specific Hazard:** not applicable

**Weight:** 6.47 lbs/gal at 60°F and 6.34 lbs/gal at 80°F

---

**SUPPLIERS**

1. Solvents & Chemicals, Inc.
   4707 Shank Road, P.O. Box 490
   Pearland, Texas 77588-0490
   Tel: (713) 485-5377

2. Southwest Solvents & Chemicals
   225 Two Twenty-One Drive
   Buda, Texas 78610
   Tel: (512) 282-6390

---
## FUELS COMPARISON

<table>
<thead>
<tr>
<th>FUEL</th>
<th>FLASHPOINT (°F)</th>
<th>SPEC GRAVITY (KG/L)</th>
<th>VISCOSITY (CENTISTOKES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JP8 MIL-T-83133</td>
<td>100</td>
<td>0.775 min</td>
<td>8.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.840 max</td>
<td></td>
</tr>
<tr>
<td>JP5/JP8 ST MIL-T-5624N</td>
<td>140</td>
<td>0.815 min</td>
<td>8.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.845 max</td>
<td></td>
</tr>
<tr>
<td>JP5 MIL-F-5624</td>
<td>140</td>
<td>0.788 min</td>
<td>8.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.845 max</td>
<td></td>
</tr>
<tr>
<td>CAL FLUID MIL-C-7024D</td>
<td>100</td>
<td>0.765 min</td>
<td>3.3</td>
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<tr>
<td>TYPE 2</td>
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<td>0.775 max</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C

Operating Permit
Mr. Lawrence O. Bailey, Jr.
Director, Environmental Management
KELLY AIR FORCE BASE (AFB)
307 Tinker Drive, Building 306
Kelly AFB, Texas 78241-5917

Re: Permit Amendment and Renewal
Permit No. 6493
Fuel Accessory Test Facility
Incinerator
Kelly AFB, Bexar County
Account ID No. 5G-0113-P

Dear Mr. Bailey:

This is in response to your permit application, Form PI-1, and renewal application, Form PI-1R, concerning the proposed amendment and renewal of Permit No. 6493. We understand that you propose to replace the current carbon absorption unit with a thermal oxidizer that will achieve 95 percent destruction of the volatile organic compounds (VOC) routed through it.

Pursuant to Texas Natural Resource Conservation Commission (TNRCC) Rule 116.115(a) of 30 Texas Administrative Code §116 (30 TAC §116) (commonly known as Regulation VI), Permit No. 6493 is hereby amended in accordance with your proposal. This information will be incorporated into the existing permit file.

Also, pursuant to TNRCC Rule 116.314(a) of 30 TAC §116, your permit is hereby renewed. Enclosed are new provisions and an emission allowable table. Please attach these to your permit. We will appreciate your carefully reviewing the conditions of the permit and assuring that all requirements are consistently met.

We have enclosed two operations certification forms (Form PI-3A and Form PI-3B). Rule 116.115(b) of 30 TAC §116 (commonly known as Regulation VI) requires you to certify that operations addressed in this permit are in conformance with representations in the permit application.
March 24, 1994

Mr. Lawrence O. Bailey, Jr.

Please file these certifications with both the TNRCC Austin New Source Review Program and the appropriate TNRCC regional office in a timely manner as prescribed by rule.

Thank you for your cooperation in sending us the information necessary to evaluate your operations and for your commitment to air pollution control. Please let us know if you have any questions.

Sincerely,

[Signature]

Anthony C. Grigsby
Executive Director

Enclosures

cc: Mr. James Menke, Air Program Manager, San Antonio
    Mr. Sam Sanchez, Chief Sanitarian, Division of Environmental Services, San Antonio Metropolitan Health District, City of San Antonio
TEXAS NATURAL RESOURCE CONSERVATION COMMISSION
Office of Air Quality
New Source Review Program
Post Office Box 13087
Austin, Texas 78711-3087

FORM PI-3A
Operations Certification (Part 1 of 2)
TNRCC Rule 116.110(b)(1)(A)

For facilities permitted by authority of Title 30 Texas Administrative Code, Chapter 116.

This certification must be signed by an individual with process knowledge in a managerial capacity and must be submitted upon completion of construction and prior to start of operation of the authorized facilities.

For Permit Number ________________
Date of Permit Issuance or Last Amendment: ________________

I. Permittee
Permit Issued To: __________________________________________
Mailing Address: __________________________________________

Technical Contact: (Person, Title, Mailing Address)
Telephone: ( ) ______-_______

II. Permit Unit Information
Permit Unit Name: _________________________________________
Location: Nearest City ___________________ County: ____________
TNRCC Air Quality Account Number: ______-_____ -

III. Construction and Operating Schedule Dates
Start of Construction: ________________ Proposed Start of Operation: ________________
Completion of Construction: ________________

IV. A copy of this certification must be sent to the TNRCC Regional Office.
Regional Office (city) sent to: __________________________________________

V. Certification
I, ____________________________________________
Name - please print or type
Title - Owner, Plant Manager, President, Vice President, Environmental Director

state that I have knowledge of the facts herein set forth and that the same are true and correct to the best of my knowledge. I certify that the facilities or changes authorized by the referenced permit have been accomplished as represented, if those representations affect emissions, method of control, or character of emissions.

DATE ___________ SIGNATURE ________________

Note: Original signature in ink required.

A second certification, FORM PI-3B, must be submitted simultaneously with any report of testing or monitoring results required by the permit or, if no testing or monitoring is required, within 60 days of the commencement of operation.

Version 11/01/1993

40
TEXAS NATURAL RESOURCE CONSERVATION COMMISSION
Office of Air Quality
New Source Review Program
Post Office Box 13087
Austin, Texas 78711-3087

FORM PI-3B
Operations Certification (Part 2 of 2)
TNRCC Rule 116.110(b)(1)(B)

For facilities permitted by authority of Title 30 Texas Administrative Code, Chapter 116.

This certification must be signed by an individual with process knowledge in a managerial capacity, and must be submitted simultaneously with any report of testing or monitoring results required by the permit or, if no testing or monitoring is required, within 60 days of the commencement of operation.

Permit Number: __________________________
Date of Permit Issuance or Last Amendment: __________________________

Submittal Date of Form PI-3A (Part 1 of Operations Certification): __________________________

I. Permittee
Permit Issued To: __________________________
Mailing Address: __________________________

Technical Contact: (Person, Title, Mailing Address)
________________________________________ Telephone: ( ) ______-________

II. Permit Unit Information
Permit Unit Name: __________________________
Location: Nearest City: __________________________ County: __________________________
TNRCC Air Quality Account Number: ______-________

III. Construction and Operating Schedule Dates
Start of Construction: __________________________ Start of Operation: __________________________
Completion of Construction: __________________________

IV. A copy of this certification must be sent to the TNRCC Regional Office.
Regional Office (city) sent to: __________________________

V. Certification
I, __________________________

Name - please print or type

Title - Owner, Plant Manager, President, Vice President, Environmental Director

state that I have knowledge of the facts herein set forth and that the same are true and correct to the best of my knowledge. I certify that the facility complies with all terms of the preconstruction permit and that operations of the facility are in compliance with the Texas Clean Air Act (Chapter 382, Texas Health & Safety Code) and the air quality rules of the TNRCC.

DATE _______ SIGNATURE __________________________

Note: Original signature in ink required.

Version 11/01/1993
1. **Equivalency of Methods** - It shall be the responsibility of the holder of this permit to demonstrate or otherwise justify the equivalency of emission control methods, sampling or other emission testing methods and monitoring methods proposed as alternatives to methods indicated in the provisions of this permit. Alternative methods shall be applied for in writing and shall be reviewed and approved by the Executive Director prior to their use in fulfilling any requirements of this permit.

2. **Sampling Requirements** - If sampling of stacks or process vents is required, the holder of this permit must contact the Source and Mobile Monitoring Section of the Texas Natural Resource Conservation Commission (TNRCC) prior to sampling to obtain the proper data forms and procedures. The holder of this permit is also responsible for providing sampling facilities and conducting the sampling operations at his own expense.

3. **Appeal** - This permit may be appealed pursuant to Rule 103.81 of the Procedural Rules of the TNRCC and Section 382.032 of the Texas Clean Air Act. Failure to take such appeal constitutes acceptance by the applicant of all terms of the permit.

4. **Construction Progress** - Start of construction, construction interruptions exceeding 45 days and completion of construction shall be reported to the appropriate regional office of the TNRCC not later than 10 working days after occurrence of the event.

5. **Recordkeeping** - Information and data concerning production, operating hours, sampling and monitoring data, if applicable, fuel type and fuel sulfur content, if applicable, shall be maintained in a file at the plant site and made available at the request of personnel from the TNRCC or any local air pollution control program having jurisdiction. The file shall be retained for at least two years following the date that the information or data is obtained.

6. **Maintenance of Emission Control** - The facilities covered by this permit shall not be operated unless all air pollution emission capture equipment and abatement equipment are maintained in good working order and operating properly during normal facility operations.
1. This permit covers only those sources of emissions listed in the attached table entitled "Emission Sources - Maximum Allowable Emission Rates," and those sources are limited to the emission limits and other conditions specified in the attached table. The annual rates are based on any consecutive 12-month period.

2. Compliance with the Volatile Organic Compound (VOC) emission limitation for the SUE Incinerator (EPN No. 20) shall be demonstrated by monitoring the temperature of the secondary chamber. Compliance with the VOC emissions for test stands vented to the atmosphere will be demonstrated by calculating emissions from carbon compound usage. The emissions shall be tabulated monthly and reported annually with the facility emissions inventory.

3. All waste carbon compounds must be stored in closed containers.

4. Opacity of emissions from the SUE incinerator stack must not exceed 5 percent averaged over a six-minute period.

5. Fuel for the SUE incinerator shall be limited to stoddard solvent, shelf life hydrocarbon materials, and pipeline-quality natural gas containing no more than 0.25 grains hydrogen sulfide and 5.0 grains total sulfur per 100 dscf.

6. The minimum exhaust exit gas temperature of the SUE incinerator of 1450°F must be continuously monitored and recorded whenever burning VOCs, stoddard solvent, or shelf life oils.

7. A copy of this permit shall be kept at the plant site and made immediately available at the request of personnel from the Texas Natural Resource Conservation Commission (TNRCC), Environmental Protection Agency (EPA), or any local air pollution control agency having jurisdiction. In addition, the holder of this permit shall clearly identify all equipment at the facility covered by this permit that has the potential of emitting air contaminants. Permitted emission points shall be clearly identified corresponding to the emission point numbering on the maximum allowable emission rates table. Grandfathered or exempt facilities shall be clearly identified corresponding to the emission point numbering used in the most recent emissions inventory submitted to the TNRCC.
INITIAL DETERMINATION OF COMPLIANCE

8. The holder of this permit shall perform stack sampling and other testing as required to establish the actual pattern and quantities of air contaminants being emitted into the atmosphere from the SUE incinerator stack. The holder of this permit is responsible for providing sampling and testing facilities and conducting the sampling and testing operations at his expense.

A. The appropriate TNRCC regional office in the region where the source is located shall be contacted as soon as testing is scheduled but not less than 45 days prior to sampling to schedule a pretest meeting. The notice shall include:

(1) Date for pretest meeting.
(2) Date sampling will occur.
(3) Name of firm conducting sampling.
(4) Type of sampling equipment to be used.
(5) Method or procedure to be used in sampling.

The purpose of the pretest meeting is to review the necessary sampling and testing procedures, to provide the proper data forms for recording pertinent data, and to review the format procedures for submitting the test reports.

A written proposed description of any deviation from sampling procedures specified in permit provision or TNRCC or EPA sampling procedures shall be made available to the TNRCC prior to the pretest meeting. The Regional Manager or the Manager of the Source and Mobil Monitoring Section shall approve or disapprove of any deviation from specified sampling procedures.

Requests to waive testing for any pollutant specified in B of this provision shall be submitted to the TNRCC New Source Review Program.

B. Air contaminants emitted from the incinerator stack to be tested for include (but are not limited to) VOC, nitrogen oxides (NOx), and carbon monoxide (CO).

C. If sampling ports and platforms meeting the specifications set forth in the attachment entitled "Chapter 2, Stack Sampling Facilities" are not required, alternate designs may be approved at the pretest meeting.
D. Sampling shall occur within 60 days after initial start-up of the SUE incinerator. Requests for additional time to perform sampling shall be submitted to the regional office.

E. The VOC destruction efficiency of 98 percent for the SUE incinerator while burning stoddard solvent and shelf life oils shall be demonstrated at the maximum test stand VOC generation rate during stack emission testing. Primary operating parameters that enable determination of VOC generation rate shall be monitored and recorded during the stack test. These parameters will be determined at the pretest meeting.

F. Copies of the final sampling report shall be forwarded to the TNRCC within 90 days after sampling is completed. Sampling reports shall comply with the attached provisions of Chapter 14 of the TNRCC Sampling Procedures Manual. The reports shall be distributed as follows:

One copy to the appropriate TNRCC regional office.
One copy to the TNRCC New Source Review Program, Austin.

G. At least two 6-minute visual opacity readings will be taken during the testing.

CONTINUOUS DEMONSTRATION OF COMPLIANCE

9. Temperature in the SUE incinerator must be continuously monitored and recorded to ensure the minimum temperature of 1450°F is maintained.

RECORDKEEPING REQUIREMENTS

10. The following records shall be maintained by the source for a period of two years and shall be made available to the Executive Director or his designated representative upon request:

A. Records of the amount of calibrating fluid purchased and spent calibrating fluid sent to reclamation.
B. Inventory records on the contents of the Calibrating Fluid Supply Tank and the Spent Calibrating Fluid Storage Tank.

C. Records of the quantity of stoddard solvent and shelf life oil burned in the SUE incinerator.

D. Records of hours of operation of the SUE incinerator.

E. Charts from the temperature monitor for the SUE incinerator.

F. Inventory records of additions, recovery, and disposal of all degreasing solvents and cleaning solvents.

G. Records of inspection and replacement of bags in the grit blast filter system.

Dated 3/24/94
EMISSION SOURCES - MAXIMUM ALLOWABLE EMISSION RATES

This table lists the maximum allowable emission rates and all sources of air contaminants on the applicant’s property covered by this permit. The emission rates shown are those derived from information submitted as part of the application for permit and are the maximum rates allowed for these facilities. Any proposed increase in emission rates may require an application for a modification of the facilities covered by this permit.

**AIR CONTAMINANTS DATA**

<table>
<thead>
<tr>
<th>Emission Point No. (1)</th>
<th>Source Name (2)</th>
<th>Air Contaminant Name (3)</th>
<th>Emission Rates* #/hr</th>
<th>TPY</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Vapor Degreaser</td>
<td>VOC</td>
<td>0.80</td>
<td>2.50</td>
</tr>
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<td>8</td>
<td>Drying Oven</td>
<td>VOC</td>
<td>1.81</td>
<td>5.65</td>
</tr>
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<td>9</td>
<td>Vapor Blasting</td>
<td>PM/PM10</td>
<td>0.46</td>
<td>1.44</td>
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<tr>
<td></td>
<td></td>
<td>VOC</td>
<td>0.10</td>
<td>0.31</td>
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<tr>
<td>10</td>
<td>Abrasive Blasting</td>
<td>PM/PM10</td>
<td>0.03</td>
<td>0.09</td>
</tr>
<tr>
<td>11</td>
<td>3 Test Stands</td>
<td>VOC</td>
<td>0.12</td>
<td>0.37</td>
</tr>
<tr>
<td>12</td>
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<td>13</td>
<td>2 Test Stands</td>
<td>VOC</td>
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<td>0.16</td>
</tr>
<tr>
<td>14</td>
<td>5 Test Stands</td>
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<td>0.79</td>
<td>2.46</td>
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<td>15</td>
<td>4 Test Stands</td>
<td>VOC</td>
<td>0.08</td>
<td>0.25</td>
</tr>
<tr>
<td>16</td>
<td>Abrasive Blasting</td>
<td>PM/PM10</td>
<td>0.03</td>
<td>0.09</td>
</tr>
<tr>
<td>17</td>
<td>2 Test Stands</td>
<td>VOC</td>
<td>0.21</td>
<td>0.66</td>
</tr>
<tr>
<td>18</td>
<td>2 Test Stands</td>
<td>VOC</td>
<td>0.20</td>
<td>0.62</td>
</tr>
<tr>
<td>19</td>
<td>Nitric Acid Tank</td>
<td>HNO3</td>
<td>0.05</td>
<td>0.16</td>
</tr>
<tr>
<td>20</td>
<td>Sue Incinerator 20,000 SCFM</td>
<td>VOC, NOx, CO</td>
<td>5.53, 7.69, 21.80</td>
<td>24.20, 33.70, 95.00</td>
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<td>VOC</td>
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<td>0.37</td>
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<td>VOC</td>
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<td>VOC</td>
<td>0.12</td>
<td>0.37</td>
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</table>
APPENDIX D

Field Data
**PRELIMINARY SURVEY DATA SHEET NO. 2**  
(Velocity and Temperature Traverse)

**BASE**  
Kelly AFB

**DATE**  
19 Jul 75

**BOILER NUMBER**  

**SOURCE**  
Fuel Oil Duct to Fuel Accessory Ships Incinerator (Run #1)

**INSIDE STACK DIAMETER**  
Area $\frac{5'}{2'} = 10 \text{ ft}^2$

**STATION PRESSURE**  
2.9, 2.60 In Hg

**STACK STATIC PRESSURE**  
1.46 In H2O

**SAMPLING TEAM**  
AL/OE/OEE

<table>
<thead>
<tr>
<th>TRAVERSE POINT NUMBER</th>
<th>VELOCITY HEAD, $V_p$ in H2O</th>
<th>$\sqrt{V_p}$</th>
<th>STACK TEMPERATURE (°F)</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
<td>Dry Bulb</td>
</tr>
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</tr>
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<td>5</td>
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<td>0.283</td>
<td>85</td>
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<td>0.102</td>
<td>0.319</td>
<td>78</td>
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<td>0.105</td>
<td>0.324</td>
<td>77</td>
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<tr>
<td>8</td>
<td>0.100</td>
<td>0.316</td>
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</tr>
<tr>
<td>12</td>
<td>0.100</td>
<td>0.316</td>
<td>83</td>
</tr>
<tr>
<td>13</td>
<td>0.150</td>
<td>0.387</td>
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<td>0.130</td>
<td>0.361</td>
<td>80</td>
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<td>0.139</td>
<td>0.371</td>
<td>81</td>
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<tr>
<td>16</td>
<td>0.141</td>
<td>0.373</td>
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</tbody>
</table>

Avg $V_p = 0.10$

AVG = 82

Avg FPS = 18

AVG FPM = 1.086

ACFM = 10,858

1, H2O = 2.1

SCFM = 10,094

AVERAGE

**OEHL FORM APR 78**  
16 50
## PRELIMINARY SURVEY DATA SHEET NO. 2

### (Velocity and Temperature Traverse)

**BASE**: Kelly AFB  
**DATE**: 20 Jul 75

- **BOILER NUMBER**
  - Inlet Duct to Fuel Accessory Shuts
  - Flue Incinerator

- **INSIDE STACK DIAMETER AREA**: 5' by 2' = 10 ft²

- **STATION PRESSURE**: 29.205 in Hg
- **STACK STATIC PRESSURE**: -1.46 in H2O

**SAMPLING TEAM**: AL/0EB8

<table>
<thead>
<tr>
<th>TRAVERSE POINT NUMBER</th>
<th>VELOCITY HEAD, Vp in H2O</th>
<th>( \sqrt{V_p} )</th>
<th>STACK TEMPERATURE (°F)</th>
<th>PM ( \frac{1}{2} ) Hr. ( \frac{1}{2} ) Hr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>0.211</td>
<td>81° 72°</td>
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</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>5</td>
<td>0.100</td>
<td>0.316</td>
<td>83° 71°</td>
<td></td>
</tr>
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<td>6</td>
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<td>0.338</td>
<td>79° 70°</td>
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</tr>
<tr>
<td>7</td>
<td>0.110</td>
<td>0.336</td>
<td>79° 70°</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0.090</td>
<td>0.300</td>
<td>79° 69°</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>0.115</td>
<td>0.338</td>
<td>81° 70°</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>0.105</td>
<td>0.316</td>
<td>80° 70°</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>0.110</td>
<td>0.336</td>
<td>80° 69°</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>0.090</td>
<td>0.300</td>
<td>80° 69°</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>0.175</td>
<td>0.420</td>
<td>84° 71°</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>0.135</td>
<td>0.368</td>
<td>80° 70°</td>
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</tr>
<tr>
<td>15</td>
<td>0.140</td>
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</tr>
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<td>16</td>
<td>0.155</td>
<td>0.393</td>
<td>80° 69°</td>
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</table>

**AVG AP = 0.10**  
**AVG = 80° 70°**  
**AVG FPM = 1,090**  
**DSCFM = 10,132**

**OEH Form APR 78 16**

<table>
<thead>
<tr>
<th><strong>AVERAGE</strong></th>
</tr>
</thead>
</table>
**PRELIMINARY SURVEY DATA SHEET NO. 2**  
(*Velocity and Temperature Traverse*)

**BASE**  
**KELLY AFB**  
**DATE**  
20 JUL 95

**BOILER NUMBER**  
Inlet Duct to Fuel Accessory_AR'S 5' by 2' = 10 ft²  
INSIDE STACK DIAMETER  
**STATION PRESSURE**  
2.9 x 10⁻⁵ in Hg  
**STACK STATIC PRESSURE**  
-1.46 in H₂O

**SAMPLING TEAM**  
AL/DEBQ

| TRAVERSE POINT NUMBER | VELOCITY HEAD, Vp in H₂O | √Vp | STACK TEMPERATURE (OF)  
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.055</td>
<td></td>
<td>86° 72°</td>
</tr>
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<td>2</td>
<td>0.055</td>
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<td>83° 69°</td>
</tr>
<tr>
<td>3</td>
<td>0.055</td>
<td></td>
<td>85° 71°</td>
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<td>4</td>
<td>0.040</td>
<td></td>
<td>82° 69°</td>
</tr>
<tr>
<td>5</td>
<td>0.110</td>
<td></td>
<td>89° 70°</td>
</tr>
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<td>6</td>
<td>0.115</td>
<td></td>
<td>84° 69°</td>
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<td>8</td>
<td>0.095</td>
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<td>84° 70°</td>
</tr>
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<td>9</td>
<td>0.090</td>
<td></td>
<td>85° 70°</td>
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<tr>
<td>10</td>
<td>0.120</td>
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<td>84° 69°</td>
</tr>
<tr>
<td>11</td>
<td>0.115</td>
<td></td>
<td>84° 69°</td>
</tr>
<tr>
<td>12</td>
<td>0.095</td>
<td></td>
<td>84° 69°</td>
</tr>
<tr>
<td>13</td>
<td>0.135</td>
<td></td>
<td>82° 70°</td>
</tr>
<tr>
<td>14</td>
<td>0.145</td>
<td></td>
<td>84° 69°</td>
</tr>
<tr>
<td>15</td>
<td>0.165</td>
<td></td>
<td>84° 69°</td>
</tr>
<tr>
<td>16</td>
<td>0.160</td>
<td></td>
<td>86° 69°</td>
</tr>
<tr>
<td>Avg ΔP = 0.10</td>
<td></td>
<td>Avg = 84° 70</td>
<td></td>
</tr>
</tbody>
</table>

**Avg FPM = 18**

**Avg FPM = 4.085**  
**ACFM = 10,841**  
**9. H₂O = 2.0**

**GSFEM = 10,028**

**AVERAGE**

OEHL  
FORM APR 78 16  
52
### VOC Emissions Data Sheet

**Base:** Kelly AFB  
**Date:** 19 Jul 95  
**Source:** Intake duct to Fuel Accessory Shop's  
**Run #:** 1  
**SU E Incinerator**

**Calibration Data:** (Note - meter readings must be within ± 5% of actual gas concentrations)

<table>
<thead>
<tr>
<th>Gas Concentration (ppm)</th>
<th>Meter Reading (ppm)</th>
<th>Mil Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Span: 803</td>
<td>803</td>
<td>1:41</td>
</tr>
<tr>
<td>Medium Span: 504</td>
<td>505</td>
<td>12:44</td>
</tr>
<tr>
<td>Low Span: 25</td>
<td>250</td>
<td>13:47</td>
</tr>
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</table>

#### Sampling Data:

<table>
<thead>
<tr>
<th>Military Time</th>
<th>Reading (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00 pm</td>
<td>192</td>
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<tr>
<td>7:01</td>
<td>222</td>
</tr>
<tr>
<td>7:02</td>
<td>218</td>
</tr>
<tr>
<td>7:03</td>
<td>208</td>
</tr>
<tr>
<td>7:04</td>
<td>191</td>
</tr>
<tr>
<td>7:05</td>
<td>209</td>
</tr>
<tr>
<td>7:06</td>
<td>214</td>
</tr>
<tr>
<td>7:07</td>
<td>194</td>
</tr>
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<td>7:08</td>
<td>190</td>
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<td>7:09</td>
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<td>7:18</td>
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<td>7:19</td>
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<td>7:20</td>
<td>166</td>
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<td>7:21</td>
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<td>7:22</td>
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<td>7:27</td>
<td>192</td>
</tr>
<tr>
<td>7:28</td>
<td>191</td>
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</table>

**Average Reading (ppm) = 202**
## VOC Emissions Data Sheet

**Base:** Kelly AFB  
**Date:** 20 Jul 95

**Source:** Inlet Duct to Fuel Accessory Ships' SUE Incinerator  
**Run #:**

**Calibration Data:** (Note - meter readings must be within ± 5% of actual gas concentrations)

<table>
<thead>
<tr>
<th>Gas Concentration (ppm)</th>
<th>Meter Reading (ppm)</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Span: 80 3</td>
<td>80 3</td>
<td>1006</td>
</tr>
<tr>
<td>Medium Span: 50 6</td>
<td>50 1</td>
<td>10 08</td>
</tr>
<tr>
<td>Low Span: 25 1</td>
<td>25 1</td>
<td>1010</td>
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### Sampling Data:

<table>
<thead>
<tr>
<th>Time</th>
<th>Reading (ppm)</th>
<th>Time</th>
<th>Reading (ppm)</th>
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<tr>
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<td>112</td>
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<td>88</td>
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<td>10 43</td>
<td>113</td>
<td>11 17</td>
<td>87</td>
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<td>10 44</td>
<td>109</td>
<td>11 18</td>
<td>87</td>
</tr>
<tr>
<td>10 45</td>
<td>111</td>
<td>11 19</td>
<td>84</td>
</tr>
<tr>
<td>10 46</td>
<td>110</td>
<td>11 20</td>
<td>84</td>
</tr>
<tr>
<td>10 47</td>
<td>110</td>
<td>11 21</td>
<td>87</td>
</tr>
<tr>
<td>10 48</td>
<td>108</td>
<td>11 22</td>
<td>94</td>
</tr>
<tr>
<td>10 49</td>
<td>106</td>
<td>11 23</td>
<td>94</td>
</tr>
<tr>
<td>10 50</td>
<td>105</td>
<td>11 24</td>
<td>94</td>
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<td>10 51</td>
<td>104</td>
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<td>94</td>
</tr>
<tr>
<td>10 53</td>
<td>103</td>
<td>11 27</td>
<td>95</td>
</tr>
<tr>
<td>10 54</td>
<td>102</td>
<td>11 28</td>
<td>98</td>
</tr>
<tr>
<td>10 55</td>
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<td>11 29</td>
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<td>120</td>
</tr>
<tr>
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<td>98</td>
<td>11 31</td>
<td>117</td>
</tr>
<tr>
<td>10 58</td>
<td>96</td>
<td>11 32</td>
<td>118</td>
</tr>
<tr>
<td>10 59</td>
<td>95</td>
<td>11 33</td>
<td>118</td>
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<tr>
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**Average Reading (ppm) = 100**
## VOC Emissions Data Sheet

**Base:** Kelly & B  
**Date:** 20 Jul 95  
**Source:** Twist & Duct to Fuel Accessory Shop  
**Run #:** 3  
**Incinerators**

**Calibration Data:** (Note - meter readings must be within ± 5% of actual gas concentrations)

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<th>Gas Concentration (ppm)</th>
<th>Meter Reading (ppm)</th>
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**Sampling Data:**

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**Average Reading (ppm) = 14.4**
### Preliminary Survey Data Sheet No. 1

**Stack Geometry**

**Base:** Kelly AFB  
**Plant:** 81d 348  
**Date:** 29 Aug 95  
**Sampling Team:**

**Source Type and Make:** SUE Incinerator

**Source Number**  
**Inside Stack Diameter**

<table>
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<tr>
<th>RELATED CAPACITY</th>
<th>TYPE FUEL</th>
<th>DISTANCE FROM OUTSIDE OF NIPPLE TO INSIDE DIAMETER</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Natural Gas</td>
<td>24.75 Inches</td>
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</tbody>
</table>

**Number of Traverses:** 4  
**Number of Points/Traverse:** 7, 5, 3, and 1 respectively

**Location of Sampling Points Along Traverse**

<table>
<thead>
<tr>
<th>Point</th>
<th>Percent of Diameter</th>
<th>Distance From Inside Wall (Inches)</th>
<th>Total Distance From Outside of Nipple to Sampling Point (Inches)</th>
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<tr>
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<tr>
<td>2</td>
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<tr>
<td>3</td>
<td>16&quot;</td>
<td>40.75</td>
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<tr>
<td>4</td>
<td>22&quot;</td>
<td>46.75</td>
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**Form:** OEHL Form 15  
**APR 79 56**
# Preliminary Survey Data Sheet No. 2

**Velocity and Temperature Traverse**

**Base:** Kelly AFB  
**Date:** 8 Jan 95  
**Start Time:** 1444

**Boiler Number:**  
**Inside Stack Diameter:** Triangular stack with effective diameter of 28.06 inches, Area of 8.4 ft²

**Station Pressure:** 29.625 in Hg

**Stack Static Pressure:** -0.20 in H20

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<thead>
<tr>
<th>Traverse Point Number</th>
<th>Velocity Head, $V_p$ in H2O</th>
<th>Cyclonic Angle</th>
<th>Stack Temperature ($^\circ$F)</th>
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**Average:** 57
## Particulate Sampling Data Sheet

**Date:** 10 Jan 96  
**Base:** Kelly  
**Source ID:** NW Incinerator  
**Run Number:** 1  
**Station Pressure:** 29.205 "Hg  
**Static Pressure:** 9.2 "HgO  
**Nozzle Diameter:** 0.347 in  
**Pilot Coefficient, C_p:** 0.84  
**Meter Box Y:** 1.022  
**Meter Box ΔH:** 1.244  
**Meter Box #:** 6  
**Probe #:** 0-1  
**% H_2O:** 8  
**MWp:** 29

<table>
<thead>
<tr>
<th>Traverse Point Number</th>
<th>Sampling Time (min)</th>
<th>Dry Gas Meter Vol (ft³)</th>
<th>Gas Meter In Temp, T_in (°F)</th>
<th>Gas Meter Out Temp, T_out (°F)</th>
<th>Stack Temp, T_s (°F)</th>
<th>Velocity Head, Δp (&quot;HgO)</th>
<th>Orifice Diff Press, ΔH (&quot;HgO)</th>
<th>Probe Temp (°F)</th>
<th>Sample Box Temp (°F)</th>
<th>Impinger Outlet Temp (°F)</th>
<th>Vacuum Pressure (&quot;Hg)</th>
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**Total Gas Vol:** 42.082  
**Avg T_m:** 52  
**Avg T_s:** 60.6  
**Avg ΔH:** 1.7  
**Avg (P_s T_s)0.6:** 29

---

**Meter Box Operator:** R. O'Brien  
**Signature:** [Signature]
# Particulate Sampling Data Sheet

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<th>O K</th>
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<td>89</td>
<td>79</td>
<td>63.2</td>
<td>0.113</td>
</tr>
<tr>
<td>8</td>
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<td>89</td>
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<td>63.3</td>
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<tr>
<td>9</td>
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<td>91</td>
<td>82</td>
<td>63.8</td>
<td>0.285</td>
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<td>83</td>
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<td>99</td>
<td>90</td>
<td>61.0</td>
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</tbody>
</table>

**Total Gas Vol:** 42.32 ft³  
**Avg T_m:** 8.5 °F  
**Avg T_s:** 6.32 °F  
**Avg ΔH:**  
**Avg (P_sT_s)^0.5:**  

---

**Schematic of Stack**

---

**Meter Box Operator:** R. O'Brien  
**Signature:** [Signature]
### Particulate Sampling Data Sheet

<table>
<thead>
<tr>
<th>Traverse Point Number</th>
<th>Sampling Time (min)</th>
<th>Dry Gas Meter Vol (m³/hr)</th>
<th>Gas Meter Temp, Tm (°F)</th>
<th>Stack Temp, Ts (°F)</th>
<th>Velocity Head, Δp (&quot;H₂O)</th>
<th>Orifice Diff Press, ΔH (&quot;H₂O)</th>
<th>Probe Temp (°F)</th>
<th>Sample Box Temp (°F)</th>
<th>Impinger Outlet Temp (°F)</th>
<th>Vacuum Pressure (&quot;Hg)</th>
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<tbody>
<tr>
<td>1</td>
<td>3.75</td>
<td>273.3</td>
<td>79</td>
<td>78</td>
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<td>0.340</td>
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</tr>
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<td>2</td>
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<td>79</td>
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<td>80</td>
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<td>80</td>
<td>630</td>
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<td>2.41</td>
<td>2.44</td>
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</table>

Total Gas Vol = 42,478
Avg Tm = 84
Avg Ts = 12.9
Avg ΔH = 2.5
Avg (P₁Tv)⁰.⁵ =

---

**Notes:**
- Sampling point numbers are for reference only.
- The table includes data for each traverse point, including gas meter temp, stack temp, velocity, and other measurements.
- The table also includes assumptions and other related data.

**Signature:**

- Meter Box Operator: [Signature]
- Signature: [Signature]
### AIR POLLUTION PARTICULATE ANALYTICAL DATA

**BASE**
Kelly AFB

**DATE**
10 Jan 76

**RUN NUMBER**
1

**BUILDING NUMBER**
348

**SOURCE NUMBER**
SUE Incinerator

#### I. PARTICULATES

<table>
<thead>
<tr>
<th>ITEM</th>
<th>FINAL WEIGHT (gm)</th>
<th>INITIAL WEIGHT (gm)</th>
<th>WEIGHT PARTICLES (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FILTER NUMBER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACETONE WASHINGS (Probe, Front Hott Film)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BACK HALF (If needed)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Weight of Particulates Collected**

#### II. WATER

<table>
<thead>
<tr>
<th>ITEM</th>
<th>FINAL WEIGHT (gm)</th>
<th>INITIAL WEIGHT (gm)</th>
<th>WEIGHT WATER (gm)</th>
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</thead>
<tbody>
<tr>
<td>IMPINGER 1 (H2O)</td>
<td>216</td>
<td>200</td>
<td>16</td>
</tr>
<tr>
<td>IMPINGER 2 (H2O)</td>
<td>204</td>
<td>200</td>
<td>4</td>
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<tr>
<td>IMPINGER 3 (D7)</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>IMPINGER 4 (Silica Gel)</td>
<td>206 gm</td>
<td>200</td>
<td>6</td>
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**Total Weight of Water Collected**

#### III. GASES (Dry)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>ANALYSIS 1</th>
<th>ANALYSIS 2</th>
<th>ANALYSIS 3</th>
<th>ANALYSIS 4</th>
<th>AVERAGE</th>
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</thead>
<tbody>
<tr>
<td>VOL % CO₂</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOL % O₂</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>VOL % CO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOL % N₂</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vol % N₂ = (100% - % CO₂ - % O₂ - % CO)

OEHL FORM 20
MAY 78
### AIR POLLUTION PARTICULATE ANALYTICAL DATA

**BASE**

Kelly AFB

**DATE**

11 347 96

**RUN NUMBER**

-

**BUILDING NUMBER**

348

**SOURCE NUMBER**

SUE Incinerator

### I. PARTICULATES

<table>
<thead>
<tr>
<th>ITEM</th>
<th>FINAL WEIGHT (gm)</th>
<th>INITIAL WEIGHT (gm)</th>
<th>WEIGHT PARTICLES (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FILTER NUMBER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACETONE WASHINGS (Probe, Front Half Filter)</td>
<td></td>
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</tr>
<tr>
<td>BACK HALF (if needed)</td>
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<td></td>
</tr>
</tbody>
</table>

- Total Weight of Particulates Collected

### II. WATER

<table>
<thead>
<tr>
<th>ITEM</th>
<th>FINAL WEIGHT (gm)</th>
<th>INITIAL WEIGHT (gm)</th>
<th>WEIGHT WATER (gm)</th>
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</thead>
<tbody>
<tr>
<td>IMPINGER 1 (H2O)</td>
<td>207</td>
<td>200</td>
<td>7</td>
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<tr>
<td>IMPINGER 2 (H2O)</td>
<td>200</td>
<td>200</td>
<td>0</td>
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<td>IMPINGER 3 (Dry)</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>IMPINGER 4 (Silica Gel)</td>
<td>208</td>
<td>200</td>
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- Total Weight of Water Collected

### III. GASES (Dry)

<table>
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<tr>
<th>ITEM</th>
<th>ANALYSIS 1</th>
<th>ANALYSIS 2</th>
<th>ANALYSIS 3</th>
<th>ANALYSIS 4</th>
<th>AVERAGE</th>
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<tbody>
<tr>
<td>VOL % CO₂</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOL % O₂</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>VOL % CO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOL % N₂</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \text{Vol} \% \text{ N}_2 = (100\% - \% \text{CO}_2 - \% \text{O}_2 - \% \text{CO}) \]

OEHL FORM MAY 78
## AIR POLLUTION PARTICULATE ANALYTICAL DATA

**BASE**
Kelly AFB

**DATE**
11 Jan 96

**RUN NUMBER**
3

**BUILDING NUMBER**
348

**SOURCE NUMBER**
SU E Incinerator

### I. PARTICULATES

<table>
<thead>
<tr>
<th>ITEM</th>
<th>FINAL WEIGHT (gm)</th>
<th>INITIAL WEIGHT (gm)</th>
<th>WEIGHT PARTICLES (gm)</th>
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</thead>
<tbody>
<tr>
<td>FILTER NUMBER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACETONE WASHINGS (Probe, Front Half Filter)</td>
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</tr>
<tr>
<td>BACK HALF (If needed)</td>
<td></td>
<td></td>
<td></td>
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</table>

**Total Weight of Particulates Collected**

### II. WATER

<table>
<thead>
<tr>
<th>ITEM</th>
<th>FINAL WEIGHT (gm)</th>
<th>INITIAL WEIGHT (gm)</th>
<th>WEIGHT WATER (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPINGER 1 (H2O)</td>
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</tr>
<tr>
<td>IMPINGER 2 (H2O)</td>
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<td>200</td>
<td>0</td>
</tr>
<tr>
<td>IMPINGER 3 (Dry)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>IMPINGER 4 (Silica Gel)</td>
<td>207</td>
<td>200</td>
<td>7</td>
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</table>

**Total Weight of Water Collected**

19 gm

### III. GASES (Dry)

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<th>ANALYSIS 1</th>
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<tr>
<td>VOL % O2</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>VOL % CO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOL % N2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

**Vol % N2 = (100% - % CO2 - % O2 - % CO)**
**Visible Emission Observation Form**

### Source Name
Fuel: Accessories Repair & Test Facility
Fuel: Incinerator

### Address

### City
Kelly AFB

### State
TX

### Zip

### Phone

### Source ID Number

### Observation Date
10 Jan 96

### Start Time
1200 CST

### Stop Time
1230 CST

### Operating Mode
- **Process Equipment**
  - Thermal Oxidizer
  - Operating Mode: 70%
- **Control Equipment**
  - Fume Extractor
  - Operating Mode: 50%

### Emission Point Details
- Ten brick stack located within the walled/enclosed area on the north side of Bldg 319B (FACT Building)
- Height Relative to Observer: 20'
- Distance from Observer: 250'
- Direction from Observer: 320'

### Emission Description
- Plume shape: Not visually detectable
- Emission Color: Clear
- Water Droplets Present: Yes

### Background
- **Background Color:** Blue sky with scattered white cirrus clouds
- **Sky Conditions:** Mostly clear (scattered high cirrus clouds)
- **Wind Speed:** 5 kts
- **Wind Direction:** E 150°
- **Ambient Temperature:** 68°F
- **Relative Humidity:** 62%

### Source Layout/Sketch
[Diagram of the emission point and surroundings]

### Range of Opacity Readings
- **Minimum:** 0
- **Maximum:** 0

### Observer's Name (Print)
Thomas C. Moore

### Observer's Signature
[Signature]

### Date
10 Jan 96

### Organization
U.S. Air Force (ALL/BB)

### I Have Received a Copy of These Opacity Observations
- **Certified By:** Philip J. Clark (FNC)
- **Date:** 15 Sep 95

### Title
[Title]

### Date
[Date]

---

64
### VISIBLE EMISSION OBSERVATION FORM

**Source Name:** USAF Fuel Accessories Repair Test Facility Incinerator

### Observed Emissions

**Process Equipment:** Thermal Oxidizer

**Control Equipment:** After Bradley Inc.

**Describe Emission Point:** Incinerator stack located in fenced/walled area or north direction.

**Height Above Ground Level:** 350 ft

**Distance from Observer:** 250 ft

**Direction from Observer:** 320°

**Describe Emissions:** Emission/plume characteristics not visually detectable.

**Emission Color:** Clear

**Water Droplets Present:** No

**Wet or Dry Atmosphere:** Yes

**At What Point in the Plume was Opacity Determined:** Just above stack tip (6"")

### Background

**Background Color:** Clear sky w/lots of haze in distance

**Sky Conditions:** Clear w/lots of haze away

**Wind Speed:** 10 knots

**Wind Direction:** E 360°

### Environmental Conditions

**Ambient Temperature:** 63°

**Relative Humidity:** 31% (Cdr: 29, 40)

### Observations

<table>
<thead>
<tr>
<th>Observation Date</th>
<th>Start Time</th>
<th>Stop Time</th>
</tr>
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<tbody>
<tr>
<td>11 Jan 96</td>
<td>1030 CST</td>
<td>1140 CST</td>
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</tbody>
</table>

### Observers

**Observer’s Name:** Thomas C. Moore

**Signature:**

**Date:** 11 Jan 96

**Organizations:**

**Usaf (Al/OEB) Brooks AFB TX**

**Certified By:** Philip B. Clark (TARCC)

**Date:** 15 Sep 95

---

**I Have Received a Copy of these Opacity Observations**

**Signature:**

**Title:**

**Date:**

---

65
**Visible Emission Observation Form**

<table>
<thead>
<tr>
<th>Source Name</th>
<th>Observation Date</th>
<th>Start Time</th>
<th>Stop Time</th>
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<tbody>
<tr>
<td>USAF Fuel Accessories Repair &amp; Test Facility Incinerator</td>
<td>11 Jan 95</td>
<td>1:45 CST</td>
<td>2:15 CST</td>
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</tbody>
</table>

**Address**

**City** | **State** | **Zip** |
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Kelly AFB</td>
<td>TX</td>
<td></td>
</tr>
</tbody>
</table>

**Source ID Number**

**Process Equipment**
- Thermal Oxidizer
- Operating Mode: 70%

**Control Equipment**
- Allen Bradley PLC-S
- Operating Mode: Automatic

**Describe Emission Point**
- (Square stack with triangle inside)
- Incinerator stack located in front of wall area on north side

**Height Above Ground Level**
- 30 ft

**Height Relative to Observer**
- 30°

**Distance from Observer**
- 250 ft

**Direction from Observer**
- 320°

**Describe Emissions**
- Emission characteristics not visually detectable

**Emission Color**
- Clean

**PLume Type**
- Continuous

**Water Droplets Present**
- No

**Attached Detached**
- Attached

**At What Point in the Plume Was Opacity Determined**
- Just above stack tip (6")

**Describe Background**
- Clear sky

**Background Color**
- Blue sky

**Sky Conditions**
- Clear

**Wind Speed**
- 15 kts

**Wind Direction**
- SE 340°

**Ambient Temperature**
- 68°

**Relative Humidity**
- 44%

**Source Layout**
- Block 348

**Remarks**
- Observer's Name (Print): Thomas C. Moore
- Observer's Signature: Thomas C. Moore
- Date: 11 Jan 96
- Organization: USAF (AL/OE&Q, Brook AFB, TX)
- I have received a copy of these opacity observations certified by Philip J. Clark (TNAEC) on date 15 Sep 95

**Comments**

**Range of Opacity Readings**

<table>
<thead>
<tr>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
</table>

**Observer's Name (Print)**

**Observer's Signature**

**Date**

**Organization**

**Date**

**I Have Received a Copy of These Opacity Observations**

**Certified By**

**Title**

**Date**

**Verified By**

**Date**
ENERAC Field Data Sheet

Base: Kelly 4FB
Source: SUF Incinerator
Run #: 1
Fuel Type: 
Recorder's Name: JAG

Calibration Information: 5/1 3100016 Model 3000 C/old by: The JAGMAR

Date/Time Analyzer was last zeroed: 10 JAN 1332
Date/Time Analyzer was last calibrated: 9 JAN 2259

Sampling Data: (Note - readings should be taken at 2-minute intervals)

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Operator: KURT D. JAGIELSKI, MSGT, USAF
Superintendent, Air Quality and Hazardous Waste Branch

Signature: [Signature]
## ENERAC Field Data Sheet

**Base:** KELLY  
**Date:** 11 JAN 96  
**Source:**  
**Run #:** 2  
**Fuel Type:**  
**Recorder's Name:** JAG  

### Calibration Information:
- **Date/Time Analyzer was last zeroed:** 11 JAN/1139  
- **Date/Time Analyzer was last calibrated:** 9 JAN/2259  

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**Operator:** KURT D. JAGIELSKI, MSgt. USAF  
**Superintendent, Air Quality and Hazardous Waste Branch**

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**Signature:** [Signature]

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**Nov 95**
ENERAC Field Data Sheet

Base: KELLY
Source: 54th Incinerator
Run #: 3
Fuel Type:
Recorder's Name: JAC

Calibration Information:
Date/Time Analyzer was last zeroed: 11Jan96
Date/Time Analyzer was last calibrated: 9Jul95

Sampling Data: (Note - readings should be taken at 2-minute intervals)

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Average = 18.8 54 0 1.6 31 0

Operator: KURT D. JAGIELSKI, MSgt, USAF
Superintendent, Air Quality and Hazardous Waste Branch
Signature: [Signature]
## VOC Emissions Data Sheet

**Base:** KELLY AFB  
**Source:**  
**Date:** 18 JAN 96  
**Run #:** 1

### Calibration Data:
(Note - meter readings should be within ± 5% of actual gas concentrations)

<table>
<thead>
<tr>
<th>Gas Concentration (ppm)</th>
<th>Meter Reading (ppm)</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero:</td>
<td>8</td>
<td>12:07</td>
</tr>
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<td>High Span:</td>
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<td>13:12</td>
</tr>
<tr>
<td>Mid Span:</td>
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<td>13:14</td>
</tr>
<tr>
<td>Low Span:</td>
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<td>13:16</td>
</tr>
</tbody>
</table>

**System bias check using High Span Gas: 85.0**

### Sampling Data:
(Note - readings should be taken at 1-minute intervals)

<table>
<thead>
<tr>
<th>Time</th>
<th>Reading (ppm)</th>
<th>Comments</th>
<th>Time</th>
<th>Reading (ppm)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:16</td>
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<td></td>
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<tr>
<td>15:17</td>
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<td></td>
<td>15:49</td>
<td>15.2</td>
<td></td>
</tr>
<tr>
<td>16:19</td>
<td>15.4</td>
<td></td>
<td>16:59</td>
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<td></td>
<td>17:59</td>
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</tr>
<tr>
<td>18:18</td>
<td>17.3</td>
<td></td>
<td>18:01</td>
<td>13.0</td>
<td>INCINERATOR TEMPERATURE INCREASED BY 20°</td>
</tr>
<tr>
<td>19:21</td>
<td>17.1</td>
<td></td>
<td>19:04</td>
<td>12.6</td>
<td>DURING PERIOD SO DURING PERIOD READINGS SHOULD BE OBSERVED</td>
</tr>
<tr>
<td>20:22</td>
<td>17.1</td>
<td>TEMPERATURE DECREASED</td>
<td>21:03</td>
<td>12.6</td>
<td>FUEL RATE CHECKED</td>
</tr>
<tr>
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<td>15.4</td>
<td></td>
<td>24:06</td>
<td>13.5</td>
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</tr>
<tr>
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<td>14.9</td>
<td></td>
<td>26:07</td>
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<td>12.8</td>
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<td>30:14</td>
<td>12.8</td>
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</tr>
<tr>
<td>31:15</td>
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<td>15.3</td>
<td></td>
<td>38:15</td>
<td>12.9</td>
<td>FUEL RATE CHECKED</td>
</tr>
</tbody>
</table>

**Average = 14.7**

**Operator:** LT KYLE BLYEY  
**Signature:** [Signature]

---

**Nov 95**
### VOC Emissions Data Sheet

**Base:** KELLY A & B  
**Date:** 11 JAN 96  
**Source:** INCINERATOR  
**Run #:** 2

#### Calibration Data:  
(Note - meter readings should be within ±5% of actual gas concentrations)

<table>
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<th>Gas Concentration (ppm)</th>
<th>Meter Reading (ppm)</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero:</td>
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</tr>
<tr>
<td>High Span:</td>
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<td>10:40</td>
</tr>
<tr>
<td>Mid Span:</td>
<td>49.6</td>
<td>10:45</td>
</tr>
<tr>
<td>Low Span:</td>
<td>24.4</td>
<td>10:51</td>
</tr>
<tr>
<td>SYSTEM BOTT CHECK:</td>
<td>80.3</td>
<td>11:26</td>
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</tbody>
</table>

#### Sampling Data:  
(Note - readings should be taken at 1-minute intervals)

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<thead>
<tr>
<th>Time</th>
<th>Reading (ppm)</th>
<th>Comments</th>
<th>Time</th>
<th>Reading (ppm)</th>
<th>Comments</th>
</tr>
</thead>
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<tr>
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<tr>
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<td>12:27</td>
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<td>12:27</td>
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</tbody>
</table>

Average = 9.1

---

**Operator:** KYLE BLACH  
**Signature:** KYLE BLACH
# VOC Emissions Data Sheet

**Base:** KELLY AFB  
**Source:** UNNAT.  
**Date:** 11 JAN 96  
**Run #:** 3

**Calibration Data:** (Note - meter readings should be within ± 5% of actual gas concentrations)

<table>
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<tr>
<th>Gas Concentration (ppm)</th>
<th>Meter Reading (ppm)</th>
<th>Time</th>
</tr>
</thead>
<tbody>
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<td>Zero: 0</td>
<td>0</td>
<td>13 46</td>
</tr>
<tr>
<td>High Span: 100</td>
<td>82.0</td>
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<tr>
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<tr>
<td>Low Span: 20</td>
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<td>13 57</td>
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</table>

**Sampling Data:** (Note - readings should be taken at 1-minute intervals)

<table>
<thead>
<tr>
<th>Time</th>
<th>Reading (ppm)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
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<td></td>
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</tr>
<tr>
<td>74</td>
<td>46</td>
<td></td>
</tr>
</tbody>
</table>

**Average:** 8.1

---

**Operator:** KYLE BLAUL  
**Signature:** [Signature]

---

Nov 95  
Signature: [Signature]
### Calibration Fluid Consumption During Emissions Testing of SUE Incinerator

<table>
<thead>
<tr>
<th>Sample Run #</th>
<th>Initial Fluid Reading (lb)</th>
<th>End Fluid Reading (lb)</th>
<th>Fuel Consumed (lb)</th>
<th>Initial Fluid Flow Rate Reading (pph)</th>
<th>End Fluid Flow Rate Reading (pph)</th>
<th>Average Fluid Flow Rate Reading (pph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Not Recorded</td>
<td>Not Recorded</td>
<td>—</td>
<td>107</td>
<td>107</td>
<td>108</td>
</tr>
<tr>
<td>2</td>
<td>Not Recorded</td>
<td>Not Recorded</td>
<td>—</td>
<td>107.5</td>
<td>107.5</td>
<td>107</td>
</tr>
<tr>
<td>3</td>
<td>1917</td>
<td>19307</td>
<td>108</td>
<td>108.1</td>
<td>107.5</td>
<td>108</td>
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</table>

### Incinerator Burner Temperatures During Emissions Testing of SUE Incinerator

<table>
<thead>
<tr>
<th>Sample Run #</th>
<th>Set Burner Temperature (°F)</th>
<th>Initial Burner Temperature (°F)</th>
<th>End Burner Temperature (°F)</th>
<th>Average Burner Temperature (°F)</th>
</tr>
</thead>
<tbody>
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<td>1</td>
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<td>Not Recorded</td>
<td>Not Recorded</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>151.2</td>
<td>1510</td>
<td>152.7</td>
<td>151.5</td>
</tr>
<tr>
<td>3</td>
<td>151.5</td>
<td>152.0</td>
<td>152.0</td>
<td>152.0</td>
</tr>
</tbody>
</table>

### Sampling Date/Time

- Run #1: 10 Jun 94 1416 - 1516 hrs
- Run #2: 11 Jul 94 1155 - 1255 hrs
- Run #3: 11 Jul 94 1442 - 1542 hrs
SUE Incinerator Temperature Chart During Exhaust Stack Sampling

8 Jan 96
Monday
0824 hrs
Startup

10 Jan 96
Wednesday
0220 hrs

10 Jan 96
Wednesday
2320 hrs

11 Jan 96
Thursday
2020 hrs

1700 hrs

Shutdown
APPENDIX E

Calibration Data
**METER BOX CALIBRATION DATA AND CALCULATION FORM**

(English units)

Date **7 June 95**

Barometric pressure, \(P_b = 28.990\) in. Hg

Calibrated by **Dobbs/JAG**

<table>
<thead>
<tr>
<th>Orifice manometer setting ((\Delta H)), in. H₂O</th>
<th>Gas volume</th>
<th>Temperatures</th>
<th>Dry gas meter</th>
<th>Time, (\Theta)</th>
<th>(Y_i)</th>
<th>(\Delta H), in. H₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V_w)</td>
<td>(V_d)</td>
<td>(t_w)</td>
<td>(t_d)_i</td>
<td>(t_d)_o</td>
<td>Avg</td>
<td>(\Theta)</td>
</tr>
<tr>
<td>ft³</td>
<td>ft³</td>
<td>ºF</td>
<td>ºF</td>
<td>ºF</td>
<td>ºF</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.5</td>
<td>5</td>
<td>4.99</td>
<td>72</td>
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<td>72</td>
<td>102</td>
<td>87.5</td>
</tr>
<tr>
<td>6.5</td>
<td>4.0</td>
<td>10</td>
<td>10.085</td>
<td>72</td>
<td>104</td>
<td>88.5</td>
</tr>
<tr>
<td>Avg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(\Delta H = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \Delta H) (t_w + 460)}\)

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

If there is only one thermometer on the dry gas meter, record the temperature under \(t_d\).
**NOZZLE CALIBRATION DATA FORM**

**Kelly AFB**  
*Exhaust sampling of SUE Incinerator*

<table>
<thead>
<tr>
<th>Nozzle identification number</th>
<th>Nozzle Diameter&lt;sup&gt;a&lt;/sup&gt;</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$D_1'$ mm (in.)</td>
<td>$D_2'$ mm (in.)</td>
<td>$D_3'$ mm (in.)</td>
<td>$\Delta D$, b mm (in.)</td>
<td>$D_{avg}$ c</td>
</tr>
<tr>
<td>28</td>
<td>0.346</td>
<td>0.347</td>
<td>0.347</td>
<td>0.001</td>
<td>0.347</td>
</tr>
</tbody>
</table>

where:

<sup>a</sup> $D_{1,2,3} = \text{three different nozzles diameters, mm (in.); each diameter must be within (0.025 mm) 0.001 in.}$

<sup>b</sup> $\Delta D = \text{maximum difference between any two diameters, mm (in.), } \Delta D \leq (0.10 \text{ mm}) 0.004 \text{ in.}$

<sup>c</sup> $D_{avg} = \text{average of } D_1, D_2, \text{ and } D_3$. 
1 Apr 43

Pitot tube assembly level? __________ yes __________ no
Pitot tube openings damaged? __ yes (explain below) __ no

α₁ = __1__° (<10°), α₂ = __2__° (<10°), β₁ = __1.5__° (<5°),
β₂ = __1.5__° (<5°)

γ = __0__°, θ = __10__°, A = __.66__ cm (in.)

z = A sin γ = __0__ cm (in.); <0.32 cm (<1/8 in.),
    w = A sin θ = __.015__ cm (in.); <.08 cm (<1/32 in.)

P_A __.433__ cm (in.) P_B __.433__ cm (in.)

D_L = __.372__ cm (in.)

Comments: _Calibrated by O'Brien and Magelssen._

Calibration required? __ yes __ no
STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date: April 93  Thermocouple number: 6-1

Ambient temperature: 21.3°C  Barometric pressure: 29.250 in. Hg

Calibrator: 0ºBrie/ 29ºC  Reference: mercury-in-glass  ASTM 3°F  Other:  

<table>
<thead>
<tr>
<th>Reference point number</th>
<th>Source (specify)</th>
<th>Reference thermometer temperature, °C</th>
<th>Thermocouple potentiometer temperature, °C</th>
<th>Temperature difference, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ice water</td>
<td>0.0</td>
<td>1.1</td>
<td>0.40</td>
</tr>
<tr>
<td>100</td>
<td>Boiling water</td>
<td>99.1</td>
<td>100.6</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>Heated corn oil</td>
<td>298.9</td>
<td>304.4</td>
<td>0.96</td>
</tr>
</tbody>
</table>

a Every 30°C (50°F) for each reference point.
b Type of calibration system used.
c \[
\frac{(\text{ref temp, } ^\circ\text{C} + 273) - (\text{test thermom temp, } ^\circ\text{C} + 273)}{\text{ref temp, } ^\circ\text{C} + 273}\] 100 ≤ 1.5%.
APPENDIX F

HP 41 Program Printouts
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>METER BOX V?</td>
<td>1.0220</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>DELTA H?</td>
<td>1.7000</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>BAR PRESS ?</td>
<td>29.3050</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>METER VOL ?</td>
<td>42.0320</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>MTR TEMP F?</td>
<td>83.0000</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>% OTHER GAS REMOVED BEFORE DRY GAS METER ?</td>
<td>RUN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STATIC H2O IN ?</td>
<td>-2.0000</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>STACK TEMP.</td>
<td>66.8000</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>ML. WATER ?</td>
<td>26.8000</td>
<td></td>
<td>RUN</td>
</tr>
</tbody>
</table>

**IMP. % H2O = 2.9**

**% H2O = 2.9**

---

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>METER BOX V?</td>
<td>1.0220</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>DELTA H?</td>
<td>1.7000</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>BAR PRESS ?</td>
<td>29.4600</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>METER VOL ?</td>
<td>42.3280</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>MTR TEMP F?</td>
<td>85.0000</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>% OTHER GAS REMOVED BEFORE DRY GAS METER ?</td>
<td>RUN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STATIC H2O IN ?</td>
<td>-2.0000</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>STACK TEMP.</td>
<td>-1.2000</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>ML. WATER ?</td>
<td>62.0000</td>
<td></td>
<td>RUN</td>
</tr>
</tbody>
</table>

**IMP. % H2O = 1.7**

**% H2O = 1.7**

---

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>METER BOX V?</td>
<td>1.0220</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>DELTA H?</td>
<td>1.7000</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>BAR PRESS ?</td>
<td>29.4100</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>METER VOL ?</td>
<td>42.4230</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>MTR TEMP F?</td>
<td>84.0000</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>% OTHER GAS REMOVED BEFORE DRY GAS METER ?</td>
<td>RUN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STATIC H2O IN ?</td>
<td>-2.0000</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>STACK TEMP.</td>
<td>-1.2000</td>
<td></td>
<td>RUN</td>
</tr>
<tr>
<td>ML. WATER ?</td>
<td>19.0000</td>
<td></td>
<td>RUN</td>
</tr>
</tbody>
</table>

**IMP. % H2O = 2.1**

**% H2O = 2.1**
HP 41 "METH 2" Program Printout for Exhaust Stack Sampling Run 1

<table>
<thead>
<tr>
<th>SITE</th>
<th>XROM &quot;METH 2&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>KELLY AFB INCINERATOR</td>
<td></td>
</tr>
<tr>
<td>STACK, RUN 1, 10 JAN 96</td>
<td></td>
</tr>
<tr>
<td>AREA 50 FT?</td>
<td>RUN</td>
</tr>
<tr>
<td>NO TRAV Pts.?</td>
<td>RUN</td>
</tr>
<tr>
<td>BAR PRESS?</td>
<td>RUN</td>
</tr>
<tr>
<td>STATIC IN HOM?</td>
<td>RUN</td>
</tr>
<tr>
<td>% MOISTURE?</td>
<td>RUN</td>
</tr>
<tr>
<td>PITOT CP?</td>
<td>RUN</td>
</tr>
<tr>
<td>% CO2?</td>
<td>RUN</td>
</tr>
<tr>
<td>% OXYGEN?</td>
<td>RUN</td>
</tr>
<tr>
<td>% CO?</td>
<td>RUN</td>
</tr>
<tr>
<td>MOL WT OTHER?</td>
<td>RUN</td>
</tr>
<tr>
<td>MWG = 29.01</td>
<td></td>
</tr>
<tr>
<td>MW WET = 28.69</td>
<td></td>
</tr>
</tbody>
</table>

DELTA P 7.
STACK TEMP? .115 RUN
FPS = 27.

DELTA P 8.
STACK TEMP? .412 RUN
FPS = 52.

DELTA P 9.
STACK TEMP? .275 RUN
FPS = 42.

DELTA P 10.
STACK TEMP? .151 RUN
FPS = 32.

DELTA P 11.
STACK TEMP? .128 RUN
FPS = 29.

DELTA P 12.
STACK TEMP? .160 RUN
FPS = 32.

DELTA P 13.
STACK TEMP? .461 RUN
FPS = 55.

DELTA P 14.
STACK TEMP? .360 RUN
FPS = 49.

DELTA P 15.
STACK TEMP? .225 RUN
FPS = 38.

DELTA P 16.
STACK TEMP? .430 RUN
FPS = 52.

AVE FPS = 41.
AVE FPM = 2,430.
AVE DELTA P = 0.26
STK P55, ABS = 29.29
AVE STK TEMP = 606.
STACK ACFM = 19,440.
SCFM = 9,155.
### HP 41 "METH 2" Program Printout for Exhaust Stack Sampling Run 2

| DELTA P 7. | STACK TEMP? | .125 | RUN |
| FPS = 25.  | 630.        | RUN  |
| DELTA P 8. | STACK TEMP? | .415 | RUN |
| FPS = 53.  | 631.        | RUN  |
| DELTA P 9. | STACK TEMP? | .280 | RUN |
| FPS = 43.  | 633.        | RUN  |
| DELTA P 10.| STACK TEMP? | .178 | RUN |
| FPS = 34.  | 635.        | RUN  |
| DELTA P 11.| STACK TEMP? | .132 | RUN |
| FPS = 30.  | 635.        | RUN  |
| DELTA P 12.| STACK TEMP? | .170 | RUN |
| FPS = 34.  | 635.        | RUN  |
| DELTA P 13.| STACK TEMP? | .445 | RUN |
| FPS = 54.  | 619.        | RUN  |
| DELTA P 14.| STACK TEMP? | .368 | RUN |
| FPS = 60.  | 635.        | RUN  |
| DELTA P 15.| STACK TEMP? | .250 | RUN |
| FPS = 41.  | 633.        | RUN  |
| DELTA P 16.| STACK TEMP? | .419 | RUN |
| FPS = 51.  | 557.        | RUN  |

| AVE FPS = 42. |
| AVE FPM = 2,492. |
| AVE DELTA P = 0.27 |
| STKPRS. ABS = 29.40 |
| AVE STK TEMP = 629. |
| STACK ACFM = 19,940. |
| DSCFM = 9,237. |

- SITE: KELLY AFB INCINERATOR
- STACK: RUN 2; 11 JAN 96
- STACK DIR INCH? RUN
- AREA 50 FT? 8.0000 RUN
- NO TRAV PTS.? 16.0000 RUN
- BAR PRESS? 24.1000 RUN
- STATIC HM? .2000 RUN
- % MOISTURE? 2.1000 RUN
- PITOT CP? .8400 RUN
- % CO2? 1.6000 RUN
- % OXYGEN? 18.8000 RUN
- MOL WT OTHER? RUN

**Mwd = 29.01**
**MW WET = 28.78**
<table>
<thead>
<tr>
<th>Delta P</th>
<th>Stack Temp</th>
<th>FPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>.340</td>
<td>630</td>
</tr>
<tr>
<td>2.</td>
<td>.350</td>
<td>632</td>
</tr>
<tr>
<td>3.</td>
<td>.285</td>
<td>641</td>
</tr>
<tr>
<td>4.</td>
<td>.225</td>
<td>636</td>
</tr>
<tr>
<td>5.</td>
<td>.185</td>
<td>636</td>
</tr>
<tr>
<td>6.</td>
<td>.135</td>
<td>638</td>
</tr>
</tbody>
</table>

Delta P 7:
Stack Temp: .113
FPS: 27.

Delta P 8:
Stack Temp: .416
FPS: 53.

Delta P 9:
Stack Temp: .285
FPS: 44.

Delta P 10:
Stack Temp: .144
FPS: 31.

Delta P 11:
Stack Temp: .123
FPS: 28.

Delta P 12:
Stack Temp: .155
FPS: 32.

Delta P 13:
Stack Temp: .410
FPS: 52.

Delta P 14:
Stack Temp: .348
FPS: 48.

Delta P 15:
Stack Temp: .210
FPS: 37.

Delta P 16:
Stack Temp: .436
FPS: 53.

Average FPS: 41.7
Average FPM: 2,431.
Average Delta P: 0.26
Average Stack Temp (ABT): 635.
Average Stack ACFM: 19,446.
DSCFM: 9,973.
Kelly AFB
Inlet Duct, Run 1
19 Jul '95

P BAR ? 23.2600 RUN
STATIC HOH? -1.4600 RUN
DRY BULB TEMP? 82.0000 RUN
WET BULB TEMP? 70.0000 RUN
V.P. WET BULB? 0.7392 RUN
% HOH = 2.1

Kelly AFB
Inlet Duct, Run 2
20 Jul '95

P BAR ? 23.2050 RUN
STATIC HOH? -1.4600 RUN
DRY BULB TEMP? 82.0000 RUN
WET BULB TEMP? 70.0000 RUN
V.P. WET BULB? 0.7392 RUN
% HOH = 2.2

Kelly AFB
Inlet Duct, Run 3
20 Jul '95

P BAR ? 23.2050 RUN
STATIC HOH? -1.4600 RUN
DRY BULB TEMP? 84.0000 RUN
WET BULB TEMP? 70.0000 RUN
V.P. WET BULB? 0.7392 RUN
% HOH = 2.0
HP 41 “METH 2” Program Printout for Inlet Duct Sampling Run 1

SITE ?
KELLY AFB
SUE INCINERATOR
INLET DUCT, RUN 1
STACK DIA INCCH? RUN
AREA SQ FT? 10,000 RUN
NO TRAV PTS.? 16,000 RUN
BAR PRESS? 29.2600 RUN
STATIC IN MOH? .4600 RUN
% MOISTURE? 2.1000 RUN
PITOT CP? .8400 RUN
% CO2? RUN
% OXYGEN? 20.9000 RUN
% CO? RUN
MOL WT OTHER? RUN
MWD = 28.97
MW WET = 28.74

DELTA P 1.
STACK TEMP? .05 RUN
FPS = 13.

DELTA P 2.
STACK TEMP? .06 RUN
FPS = 16.

DELTA P 3.
STACK TEMP? .078 RUN
FPS = 16.

DELTA P 4.
STACK TEMP? .04 RUN
FPS = 12.

DELTA P 5.
STACK TEMP? .08 RUN
FPS = 16.

DELTA P 6.
STACK TEMP? .102 RUN
FPS = 18.

DELTA P 7.
STACK TEMP? .105 RUN
FPS = 19.

DELTA P 8.
STACK TEMP? 77. RUN
FPS = 18.

DELTA P 9.
STACK TEMP? .102 RUN
FPS = 18.

DELTA P 10.
STACK TEMP? .115 RUN
FPS = 20.

DELTA P 11.
STACK TEMP? .10 RUN
FPS = 18.

DELTA P 12.
STACK TEMP? 83. RUN
FPS = 18.

DELTA P 13.
STACK TEMP? .15 RUN
FPS = 22.

DELTA P 14.
STACK TEMP? .13 RUN
FPS = 21.

DELTA P 15.
STACK TEMP? .139 RUN
FPS = 22.

DELTA P 16.
STACK TEMP? .141 RUN
FPS = 22.

AVE FPS = 18.
AVE FPM = 1,086.
AVE DELTA P = 0.10
STK PPS. ABS = 29.15
AVE STK TEMP = 82.
STACK ACFM = 10,650.
DSCFM = 10,094.

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HP 41 "METH 2" Program Printout for Inlet Duct Sampling Run 2

SITE?          XROM "METH 2"
KELLY AFB
SUE INCINERATOR
INLET DUCT, RUN 2

STACK Dia. INCH? RUN
AREA SQ FT?    10.000 RUN
NO TRAV PTS.?  16.000 RUN
BAR PRESS?     29.2050 RUN
STATIC IN H2O? -1.4600 RUN
% MOISTURE?    2.2000 RUN
PITOT CP?      .8400 RUN
% CO2?         RUN
% OXYGEN?      20.9000 RUN
% CO?          RUN
MOL WT OTHER?  RUN

Mwd = 28.97
MW WET = 28.73

DELTA P 1.
STACK TEMP?    .045 RUN
FPS = 12.

DELTA P 2.
STACK TEMP?    .065 RUN
FPS = 15.

DELTA P 3.
STACK TEMP?    .075 RUN
FPS = 16.

DELTA P 4.
STACK TEMP?    .025 RUN
FPS = 9.

DELTA P 5.
STACK TEMP?    .10 RUN
FPS = 18.

DELTA P 6.
STACK TEMP?    .115 RUN
FPS = 20.

DELTA P 7.
STACK TEMP?    .11 RUN
FPS = 19.

DELTA P 8.
STACK TEMP?    .09 RUN
FPS = 17.

DELTA P 9.
STACK TEMP?    .115 RUN
FPS = 20.

DELTA P 10.
STACK TEMP?    .105 RUN
FPS = 19.

DELTA P 11.
STACK TEMP?    .11 RUN
FPS = 19.

DELTA P 12.
STACK TEMP?    .09 RUN
FPS = 17.

DELTA P 13.
STACK TEMP?    .175 RUN
FPS = 24.

DELTA P 14.
STACK TEMP?    .135 RUN
FPS = 21.

DELTA P 15.
STACK TEMP?    .14 RUN
FPS = 22.

DELTA P 16.
STACK TEMP?    .155 RUN
FPS = 23.

Ave FPS = 18.
Ave FPM = 1,090.
AVE Delta P = 0.10
STK PRS. ABS = 23.10
Ave STK TEMP = 80.
STK ACFM = 10,901.
DSCFM = 10,132.
HP 41 "METH 2" Program Printout for Inlet Duct Sampling Run 3

XROM "METH 2"

SITE ? KELLY AFS
SUE INCINERATOR ? INLET DUCT, RUN 3
STACK DIA INCH ? RUN
AREA SQ FT ? 10,000 RUN
NO TRAV PTS ? 16,000 RUN
BAR PRESS ? 29.2850 RUN
STATIC IN MH ? 1.4600 RUN
% MOISTURE ? 2.0000 RUN
PITOT CP ? .8403 RUN
% CO2 ? RUN
% OXYGEN ? 20.9000 RUN
% CO ? RUN
MOL WT OTHER ? RUN

MWd = 28.97
MW WET = 28.75

DELTA P 1.
STACK TEMP? .03 RUN
FPS = 10.

DELTA P 2.
STACK TEMP? .955 RUN
FPS = 14.

DELTA P 3.
STACK TEMP? .055 RUN
FPS = 14.

DELTA P 4.
STACK TEMP? .04 RUN
FPS = 12.

DELTA P 5.
STACK TEMP? .11 RUN
FPS = 19.

DELTA P 6.
STACK TEMP? .115 RUN
FPS = 20.

DELTA P 7.
STACK TEMP? .125 RUN
FPS = 19.

DELTA P 8.
STACK TEMP? .397 RUN
FPS = 18.

DELTA P 9.
STACK TEMP? .09 RUN
FPS = 17.

DELTA P 10.
STACK TEMP? 84. RUN
FPS = 20.

DELTA P 11.
STACK TEMP? .113 RUN
FPS = 20.

DELTA P 12.
STACK TEMP? .095 RUN
FPS = 18.

DELTA P 13.
STACK TEMP? .135 RUN
FPS = 21.

DELTA P 14.
STACK TEMP? .145 RUN
FPS = 22.

DELTA P 15.
STACK TEMP? .135 RUN
FPS = 24.

DELTA P 16.
STACK TEMP? .16 RUN
FPS = 23.

AVG FPS = 19.
AVG CM = 1,085.
AVG DELTA P = 0.10
AVG STK TEMP = 84.
STACK TEMP = 10,047.
DISCM = 12,093.
APPENDIX G

VOC Analyzer Information
GENERAL DESCRIPTION

The J.U.M. Flame Ionization Analyzer Model 3-300A is an analyzer designed to continuously measure the concentration of total organic hydrocarbons in a gaseous sample. The sample can be ambient air, or the exhaust gases from a combustion process. This measurement is obtained by using the Flame Ionization Detector (FID).

The Model 3-300A is supplied in various versions through the use of options. The standard instrument has five Total Hydrocarbons measuring ranges: from 0-10 to 100,000 ppm with 10:1 Decade Range adjustment; Flame Out Indication of the front panel Dual Color LED (Red LED - Flame is Out, Green LED - Flame is Lit); 0-10 VDC Recorder Output, and two (2) internal calibration valves. Calibration gases are introduced into the analyzer using the rear panel zero gas- and span gas inlet fittings. The standard 3-300A has a backpurge function for the built-in permanent stainless mesh sample filter. This sample filter backpurge function is activated by selecting PURGE via the front panel mode turn switch. An air line (max. pressure 90 psig) must be connected to the back of the 3-300A to manually backpurge the sample filter.
HEATED TOTAL HYDROCARBON ANALYZER
MODEL 3-300 A

The J.U.M. Engineering Model 3-300 A is a very compact, heated total hydrocarbon analyzer for high accuracy, sensitivity and stability.

The Model 3-300 A uses a hydrogen flame ionization detector (FID) in a heated oven to prevent the loss of high molecular weight hydrocarbons, and to provide reliable performance in the analysis of trace levels of contaminants in high purity gases, in air and in other gases.

The permanent sample filter is cleaned by backpurring and has a replaceable stainless steel filter disc. A rear adapter plate allows quick installation of a heated sample line inside of the oven without the need for special tools.

Features

- 19 inch relay rack mount or table top case
- Precision 1% full scale
- Digital output display
- All heated components
- Adjustable oven temperature control up to 400 °F (204 °C)
- Permanent heated stainless steel 2 micron sample filter with replaceable disc
- Backpurge system allows filter to be cleaned without dismantling
- Fast response – within one second
- Automatic flame-out indicator with fuel shut-off valve
- Five selectable ranges can be gained by factor 10
- Automatic fuel enrichment for ignition
- Solenoid Valves for Sample, Zero Gas and Span Gas
- Remote control for sample, calibrate and backpurge is standard
- Automatic Sample Filter Backpurg (Option)

Applications

- Raw exhaust vehicle emissions
- Catalytic converter testing
- Detection of trace hydrocarbon levels in purity gases used in the semiconductor industry
- Monitors hydrocarbon contaminants in air and other gases
- Carbon adsorption regeneration control
- Measuring engine combustion efficiency
- LEL monitor of solvent-laden air
- Cryogenics/liquefaction
- Clean room applications
- Stack gas hydrocarbon emissions monitoring

Model 3-300 A □ Bulletin 17052
Principle of Operation:
The Model 3-300A uses the flame ionization detection (FID) method to determine the presence of total hydrocarbon concentrations in a gaseous sample. Burning hydrocarbon-free hydrogen in hydrocarbon-free air produces a negligible number of ions. A hydrocarbon sample introduced into this flame starts a very complex ionization which creates a larger number of ions. A polarizing high voltage is applied between two electrodes around the burner jet and produces an electrostatic field. Now positive ions migrate to the collector electrode, and negative ions migrate to the high voltage electrode. The so generated ionization current between the two electrodes is directly proportional to the hydrocarbon concentration in the flame and is measured by the electrometer amplifier. A sample pressure regulator provides a controlled back pressure at the sample capillary which gives admittance of a constant sample flow rate to the burner. This technique without the conventional sample back pressure regulator is used by J.U.M. Engineering since 20 years for highest sample flow rate stability and lowest maintenance. A compactly designed flow control module for the control of fuel and air flow rates via needle valve restrictions uses high precision pressure regulators. The needle valves are adjustable for easy optimization of the burner.

Options:
- 0–20 mA or 4–20 mA recorder output
- Adjustable 100 mV to 5 mV DC recorder output
- Remote range control
- Automatic range control

Standard specifications:
- Analysis Method: Flame Ionization Detector (FID)
- Sensitivity: Max.: 1 ppm CH, full scale
- Response Time: 90% of full scale in less than 1 second
- Zero Drift: 1.5% of full scale per 24 hours
- Span Drift: 1.5% of full scale per 24 hours
- Linearity: Within 1%
- Oxygen Synergism: Less than 1% of selected range
- Ranges: Any five of the following: 0–10, 100, 1000, 10,000, 100,000 ppm or 50, 100, 500, 1000, 5000, 10,000 or 0–100% LEL or other to be specified
- Outputs: 0–10 Volts D.C. and 4–20 mA
- Display: Digital
- Zero/Span Adjust: Manual on front panel
- Fuel Consumption: Hydrogen: 20 cc min at 22 psig (1.5 Bar)
  40% H₂, 60% He: 60 cc min at 22 psig (1.5 Bar)
- Analysis Temperature: Adjustable 200 to 420 °F (93 to 210 °C)
- Power Requirements: 110 Volts, 60 Hertz AC, 800 Watts
  220 Volts, 50 Hertz AC, 800 Watts
- Ambient Temperature: 41°F to 110°F (5 to 45 °C)
- Dimensions: 19 Inch
- Weight: 483 mm
- Weight: 33 lbs (15 kg)

J.U.M. Engineering Ges.m.b.H.: reserves the right, at any time and without notice, to change specifications presented within this data sheet, and assumes no responsibility for the application or use of devices herein described.

Warranty
J.U.M. Engineering Ges.m.b.H.: warrants each new unit of its manufacture to be free of defects in material and workmanship for one year from the date of delivery.

Made in Germany

© J.U.M. Engineering GmbH

Repr

Environmental Equipment Systems
5922 Portal Drive
Houston, TX 77096
Ph 713/723-0642
FAX 713/635-3004
Procedures Used for Calibrating VOC Analyzer

The VOC analyzer was calibrated (prior to each sample run) in the following manner:

a. A zero gas (Pure Nitrogen) was introduced into the analyzer and the Zero Control adjusted so that the analyzer read zero.

b. A high-level calibration gas, with a concentration equal to approximately 80% of the applicable analyzer span, was introduced into the analyzer and the Span Control adjusted so that the analyzer read the tagged value of the calibration gas.

c. A mid-level calibration gas, with a concentration equal to approximately 50% of the applicable analyzer span, was then be introduced into the analyzer. The analyzer reading was compared to the tagged value of the calibration gas.

d. A low-level calibration gas, with a concentration equal to approximately 25% of the applicable analyzer span, will next introduced into the analyzer. As with the mid-level gas, the analyzer reading was then compared to the tagged value.

e. The analyzer was considered acceptable for testing if the readings obtained during the mid-level and low-level calibration gas checks were both within ± 5% of the tagged value.
APPENDIX H

ENERAC 3000 Analyzer Information
ENERAC™ 3000SEM

ENERAC 3000SEM quality assured, compliance level emission analyzer provides a sound, cost-effective approach to establishing a complete, comprehensive and reliable emissions database. Advanced SEM™ sensor technology, Quality Assured/Precision Control Modules (QA/PCM), Integrated Sample Conditioning System, and documented Quality Assured/Calibration Certification Protocol (QAVCCP) provide positive assurance of instrument performance, and the generation of compliance-level NO, NO₂, NOₓ, SO₂, and CO data.

The ENERAC 3000SEM provides facility operators a low cost, easy-to-implement capability to develop timely and representative data for CAAA requirements:

- NOₓ PACT
- Operating Permits
- CEIMS Back-up
- Enhanced Monitoring
- Audits
- Emission Rates
### TEL 3000SEM Specifications

**ICAL:**
- 18 x 13 x 6 Aluminum carrying case with
- Weight: 22 lbs
- 120VAC 6 x 360/CR, incline probe with
- Assay X sintered filter and 1/2" deflector mount.
- lonization detection. Housing probe
- Knob set to set first 10 ft. Volta base.
- Optional temperature - 1600 deg. F.
- Sample dwell at (past dye) 50 deg. F.
- 10 cc/min. (Natural gas fuel @ 0% oxygen)

**TRIAL POWER:**
- 6V rechargeable, sealed lead-acid cell.
- Rechargeable battery operation. Quick 6
- hour recharge. 3120/100 Hz, and 220/30V /Hz standard.
- 1140VDC/3A standard.

**LAY:**
- 5" by 24 Character single line LCD with
- Assay illuminator and adjustable viewing angle.

**TER:**
- KNO 4, 40 char. per line thermal printer with line
- edit button and with end of paper override.
- Operates in any of four modes:
- 5 THER: 25 line printout of instant values of all
- measured paramaters (time, 20 sec.)
- 6 THER: Any one parameter vs. time plotted.
- Note: Selectable, 1 sec/0.1min/1min in 1
- GSt intervals.
- Parameter plot CO/OXYGEN-NOx EFFICIENCY.
- Scale.

**ALIBRICATION CERTIFICATION**
- ROTOCOL (QA/CAP): Automatic
- Reprintout of calibration test results.
- Document sensor and filter performance
- Status and diagnostics.

**EXTERNAL PRINT MODE:** Prints messages sent via
- RS-232 port.

**TAGE:**
- Select 10 individually selectable buffers hold one.
- Complete set of measurements each in non volatile
- memory. Buffer contents can be sent to printer or
- RS-232 port.

**MUNICATIONS:**
- RS-232 PORT: 9600/120 baud.
- 9600/120 baud user selectable, half
- duplex, 1 start bit, 8 data bits, 1 stop bit, no parity.
- TELEPHONE PORT: Internal 1200 baud modem
- Connects to a modulator telephone line for remote
- Communication.

**SOFTWARE:**
- ENEAPRO for WINDOWS® software. 3.5" diskette,
- Includes monitor, alarms, programming
- Software, bar graphs and multiple time plots. Also
- Available on DOS.

**FILLER:**
- Complete package for ENSP 1600 pocket
- Computer.

**ELEONAEUS:**
- UEL: 15 fuels, 3 in foreground, 12 in
- Background standard. Custom fuel available
- In request.
- CO ALARMS: Selectable 0-2000 PPM in 10 ppm steps.
- COABILITIEST IN AIR: Presentable 0-100% in
- 1% steps.
- GES: User friendly diagnostic and help
- Messages.
- JUBLIATION: Autoscale span plus user selectable
- 0-6000 on zero span.

<table>
<thead>
<tr>
<th>MEASURED PARAMETERS</th>
<th>Range</th>
<th>Resolution</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. AMBIENT TEMPERATURE</td>
<td>0-150°F</td>
<td>1°F or C</td>
<td>3°F</td>
</tr>
<tr>
<td>2. STACK TEMPERATURE</td>
<td>0-2,000°F (1,100°C)</td>
<td>1°F</td>
<td>5°F</td>
</tr>
<tr>
<td>3. OXYGEN (O2)</td>
<td>0-25%</td>
<td>0.1%</td>
<td>0.2%</td>
</tr>
<tr>
<td>4. EMISSIONS NITRIC OXIDE (NO)</td>
<td>0-1,000 PPM</td>
<td>1 PPM</td>
<td>2% of reading*</td>
</tr>
<tr>
<td>5. EMISSIONS NITROGEN DIOXIDE (NO2)</td>
<td>0-500 PPM**</td>
<td>1 PPM</td>
<td>2% of reading*</td>
</tr>
<tr>
<td>6. EMISSIONS CARBON MONOXIDE (CO)</td>
<td>0-2,000 PPM**</td>
<td>1 PPM</td>
<td>2% of reading*</td>
</tr>
<tr>
<td>7. EMISSIONS SULFUR DIOXIDE (SO2)</td>
<td>0-2,000 PPM**</td>
<td>1 PPM</td>
<td>2% of reading*</td>
</tr>
<tr>
<td>8. COMBUSTIBLES (COGAS)</td>
<td>0-6%</td>
<td>0.01%</td>
<td>10% of reading in CH4 gas</td>
</tr>
<tr>
<td>9. EMISSIONS SINGLE &quot;DUAL RANGE&quot; SENSOR</td>
<td>0-2,000 PPM*</td>
<td>1 PPM</td>
<td>2% of reading*</td>
</tr>
<tr>
<td>10. EMISSIONS SINGLE &quot;DUAL RANGE&quot; SENSOR</td>
<td>0-4,000 PPM</td>
<td>1 PPM</td>
<td>2% of reading*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COMPUTED PARAMETERS</th>
<th>Range</th>
<th>Resolution</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. COMBUSTION EFFICIENCY</td>
<td>0-100%</td>
<td>0.1%</td>
<td>5% of reading</td>
</tr>
<tr>
<td>2. CARBON DIOXIDE (CO2)</td>
<td>0-100%</td>
<td>0.1%</td>
<td>5% of reading</td>
</tr>
<tr>
<td>3. OXIDES OF NITROGEN (NOx)</td>
<td>0-1500 PPM**</td>
<td>1 PPM</td>
<td>2% of reading*</td>
</tr>
<tr>
<td>5. EMISSIONS 1. (CO, NOx, SO2)</td>
<td>0-2500 milligrams/cubic meter</td>
<td>2 mg/m3</td>
<td>2% of reading*</td>
</tr>
<tr>
<td>7. EMISSIONS 3.</td>
<td>0-9.99 grams/brake hp-hr</td>
<td>0.001 grams/brake hp-hr</td>
<td>10% of reading*</td>
</tr>
</tbody>
</table>

*When tested according to 40 CFR 60, RAA test.
*Low range measurements.

### Operational Flexibility

Historically, Clean Air Permits have been established using emission factors – half of this permits may be grossly understated, thus reducing long term operational flexibility. Many of the strategies being developed to provide future plant operational flexibility will rely on establishing accurate, defensible and cost-effective emissions data. ENERAC 3000SEM provides the most complete and accurate NOx measurement available. Numerous independent studies have demonstrated ENERAC's ability to supply data that meets EPA enhanced monitoring performance requirements.

- Passed 40 CFR 60, Appendix B Performance Specification 2
- Passed NOx Conversion Efficiency of Method 20, 40 CFR 60, App. A
- Passed Method 6C, 5.1.5 and 7E Integrated Sample Conditioning requirements, 40 CFR 60, App. A
- Received Blue Ribbon Certificate of Verification from the Center for Emissions Research & Analysis

### Operator Training & Certification

ENERAC electrochemical portable instrumentation is an important, cost-effective method to acquire compliance-level emission data. To ensure proper implementation, the operator should be trained as to the instrument's capabilities. ENERAC offers a Factory Training and Certification Program as proposed under 40 CFR 64 and detailed in the Enhanced Monitoring Reference document.

### Remote Operation

- 2-way advanced communication and remote operation includes remote factory check and repair, and remote operation and reporting.

### Accessories

A complete line of supporting accessories is available, and includes:
- Portable Gas Calibration Kit
- Dilution Kit for very high concentrations
- Computer Interface Software
- High Temperature Heat Shield
- ENSP single, "Dual Range" Sensors CO and/or NO
CHAPTER 1

FUNDAMENTALS

The ENERAC Model 3000 Integrated Emissions System is a portable state of the art analyzer designed for the following tasks:

A. To measure the oxide of nitrogen emissions from stationary combustion sources in accordance with the EPA Provisional Reference Method (EMTIC CTM-022.WPF) for portable NOX analyzers.

B. To measure the emissions of carbon monoxide, sulfur dioxide and gaseous combustibles and oxygen from stationary and mobile combustion sources.

C. (OPTIONAL) To measure the stack gas velocity and volumetric flow rate and emission rates according to Method 2 Appendix A of 40CFR60.

C. To assist the operator of a combustion source with the task of optimizing its performance and saving fuel.

D. To be used as a management tool to assist the plant manager with keeping records and controlling costs.

The ENERAC Model 3000 is the most advanced instrument of its type. It uses the latest proprietary (SEM INSIDE (TM)) electrochemical sensor technology to measure emissions. To meet the accuracy requirements of the EPA reference methods each SEM sensor is supplied with three Precision Control Modules whose function is to select the measurement range (low, mid and high) that is appropriate for a particular measurement.

The ENERAC also uses the best available conditioning system technology (proprietary permeation drier configuration) for accurate transport of the sample gas to the instrument. It also uses sophisticated electronics and programming design for increased accuracy and flexibility. It measures 3 temperatures and 6 different stack gases. It computes efficiency of combustion as well as excess air
and carbon dioxide. In addition, it computes emissions in five different systems of units (ppm, milligrams/m3, lbs/MBTU, grams/brake horsepower-hour and lbs/hour). It stores, prints and plots data. It communicates with a variety of other computers located near by via its RS-232 port, or remotely by telephone connection. It has a library of 15 fuels and over 100 diagnostic and help messages and can operate either on its rechargeable batteries, AC power, or from an external 6 Volt battery, or an 11-36 VDC (external battery system).

ENERGY EFFICIENCY SYSTEMS has years of experience in the manufacture and marketing of combustion and portable emission analyzers. The model 3000 is based on this experience, together with the latest innovations in electronic and sensor technology. It also expresses our basic conviction that communications and artificial intelligence are the basic ingredients of the instrument of the future.

The instrument operates basically as follows:

You select a sensor module (CO, NO and SO2) whose range is appropriate to the measurement and set the Enerac for the chosen modules. You then insert the probe in the stack of an operating combustion source such as a boiler, furnace or combustion engine. A pump located inside the instrument draws a small sample of the stack gas. The sample is conditioned before entering the analyzer. A number of sensors analyze the contents of the stack gas and its temperature and calculate and display the results. The results can also be printed, stored or send to another computer either by direct connection or by the telephone lines. The source operator makes the required adjustments based on the analysis of the stack conditions to optimize performance.

A. UNPACKING THE INSTRUMENT

Every ENERAC model 3000 includes as standard equipment:

1. One Emissions Analyzer model 3000 (includes a roll of printer thermal paper).

2. One stack probe and permeation drier housing.

3. One 14" inconel probe extension and Hastelloy X sintered filter.
CHAPTER 11
CALIBRATION

Every instrument must occasionally be calibrated against some known value of a parameter in order to make sure that its accuracy has not deteriorated.

The instrument software make sure that the display readout is always a linear function of the source excitation (i.e. gas concentration or temperature etc.). You therefore need only two points on the straight line to calibrate a parameter over its entire range. Usually, the first point chosen is the zero value (called zeroing the instrument). The second point has to be set by using some known value of the parameter being calibrated (i.e. using for example 200 PPM certified carbon monoxide gas to set the display to read 200). Sometimes the second point is not needed, if the slope of the parameter is known and is always the same (for example for the stack temperature the slope of the curve is well known and you don't need a span calibration).

Traditionally, both zeroing and span (i.e. second point) calibration was done manually, by rotating suitable potentiometers until the display was set to read first zero in ambient air and then the correct value using span gas.

With the introduction of microprocessors, it became a simple matter for instruments to zero themselves automatically upon start up (AUTOZERO), without having to use any adjustments. However, this simplification requires caution. The instrument must be started in a true "zero" environment. Otherwise it will assume as "zero" non zero conditions and give erroneous readings. (Example: Never autozero the ENERAC, if the probe tip is still hot following a recent measurement.)

The ENERAC carries out this improvement in automatic calibration procedure one step further. It does away with all potentiometric span adjustments. You just tell it the value of the calibrating parameter that you are using and the instrument adjusts itself automatically.

In addition, it carries out a systematic checkout of sensor performance and instrument integrity through a novel approach called the "ENERAC
CALIBRATION PROTOCOL. This protocol is explained below.

The ENERAC will "auto zero" itself every time you start the instrument, provided you push the ENTER key. Span calibration will be carried out on request.

You should carry out a span calibration every 3-4 months to maintain an instrument accuracy within specifications. Some regulatory requirements specify that a span calibration be carried out before each measurement. In that case you may find the EES portable calibration kit very useful.

A. THE ENERAC CALIBRATION PROTOCOL

To maintain the integrity and accuracy demanded of a regulatory compliance apparatus, the ENERAC 3000 has been given an extensive and comprehensive "calibration protocol", that will appear on its printer every time a calibration is carried out.

The protocol checks both instrument zero and span performance and serves to instill to the operator confidence on the integrity of his data.

1. The autozero protocol.

   Every time the ENERAC is autozeroed, the performance of the sensors is checked to make sure that sensor zero baselines are within the prescribed limits.

   If one or more of the sensors are outside the specified limits a message will appear on the display and printed simultaneously on the ENERAC's printer for documentation.

2. The span calibration protocol.

   *Since the calibration protocol checks the sensor's selectivity against interfering gases, you must always use SINGLE TOXIC GAS MIXTURES* (i.e. do not use mixtures containing two of the following gases in one cylinder: carbon monoxide, nitric oxide, nitrogen dioxide and sulfur dioxide).
(The only exception to the SINGLE TOXIC GAS rule is to use a blend of NO and SO2 gas bal. Nitrogen, in order to determine the performance of the NO sensor filter media. Cross interference of the NO sensor to SO2 gas is detected only, if NO gas is present! Do not use, however, this blend to carry out any calibrations. Use it just to check sensor response.)

Every time the ENERAC is calibrated using span gas, a number of different parameters are checked for satisfactory performance.

The following messages appear always on the ENERAC printer:

"ENERAC CALIBRATION PROTOCOL"
"TIME: XX:XX:XX DATE: XX/XX/XX"

followed by a series of messages.

a. Air leak check.

The instrument is checked for air leaks during span calibration.

*The air leak check is carried out only when calibrating the NO sensor, since NO span gas must always have zero oxygen.*

If a leak is detected the following messages appear on the printer:

"SENSOR CALIBRATION FAILED"
"DETECTED SYSTEM AIR LEAK"

If an air leak is discovered, first check the gas connection to the tip of the probe to make sure that it is air tight. Following this, determine if the leak is in the probe or in the instrument. You can do this by passing the probe and feeding the gas to the instrument directly. Contact EES for further assistance.
b. Sensor sensitivity check.

The output of the sensor undergoing calibration is checked against its original sensitivity that has been stored in its memory. If the sensor's sensitivity is within the acceptable limits, the following message appears on the printer:

"SENSOR CALIBRATION SUCCESSFUL"
"XX SENSOR OK"

where XX refers to the sensor being calibrated.

If the sensor's sensitivity is slightly outside acceptable limits, but the sensor is still functioning properly, the following messages appear on the printer:

"SENSOR CALIBRATION SUCCESSFUL"
"REPLACE XX SENSOR SOON OR CHECK GAS"

The purpose of the last message is to warn the operator that the sensor might soon need replacement, or that the wrong span gas value has been entered accidentally.

Be careful when calibrating the NO2 sensor with span gas. NO2 span gas concentration deteriorates with time. Don't use any cylinders that are more than 6 months old. Buy from a reputable supplier. Don't use any external desiccants or water traps.

If the sensor's sensitivity is considerably outside acceptable limits, the sensor is considered as not functioning properly and should be replaced. The following messages appear on the printer:

"SENSOR CALIBRATION FAILED"
"REPLACE XX SENSOR OR CHECK SPAN GAS"

c. Sensor selectivity check.

The Precision Control Modules of the CO, NO and SO2 sensors have long life inboard filters to remove any interfering gases that may be present in the
sample. Filter life depends on the sensor, the concentration of the gas and exposure time of the interfering gas. Typically, for the ENERAC's SEM sensors it is 200,000 PPM-hours for the CO sensor and 20,000 PPM-hours for the NO sensor to NO2 gas and 70000 PPM-hours to SO2 gas.

If the cross sensitivity of the interfering gas rises to 2% for CO or 6% for NO the following warning message will appear on the printer:

"REPLACE XX SENSOR FILTER SOON"

If the cross sensitivity of the interfering gas rises further (i.e. 5% for the CO sensor) the following message will appear on the printer:

"REPLACE XX SENSOR FILTER"

*Please keep in mind that irrespective of the inboard filter performance, the ENERAC mathematically compensates for any residual cross sensitivity, so that measurements can be taken with reasonable accuracy (but not compliance level accuracy), even if the filters need replacement.*

B. AUTO ZEROING THE INSTRUMENT.

Every time you turn the instrument on, you should wait for 2 minutes for the ENERAC to warm up (OR UNTIL THE GREEN "PROBE OK LED TURNS ON"). At the end of the warmup period the ENERAC reads the output of all sensors and sets them all to zero with the exception of the oxygen that it sets to 20.9%. (The ambient temperature is read directly). Consequently, it is very important that at the moment of "zeroing" the probe tip is at room temperature and the environment is clean from traces of carbon monoxide or other gases.

*NOTE: In practice AUTOZEROING is only needed once at the beginning of a day of measurements. The ENERAC will not have sufficient zero drift during the next 24 hours to require additional autozeroing procedures.*

*You can bypass the AUTOZERO procedure by pressing any key other than the "ENTER" key, when prompted to do so by the display.*
If the instrument has not been used for quite some time, it is a good idea to give it a longer warmup period. To do this turn the unit off at the end of its initial warmup and then turn it immediately back on.

*If you accidentally shut off the unit, while the probe is still in the stack, turn the unit back on and bypass the Autozeroing procedure by pressing any key other than the "Enter" key when the message "press enter to autozero" appears.*

C. INSTRUMENT SPAN CALIBRATION.

Ideally, you should span calibrate the instrument every time you replace a Precision Control Module. At a minimum, once every 3-4 months you should perform a span calibration of the instrument. The parameters that require a span calibration are: carbon monoxide, combustibles, nitric oxide, nitrogen dioxide and sulfur dioxide.

There is, also, a span calibration for the ambient temperature sensor.

For instruments that have the stack-velocity (S-V) option, there is an additional calibration of the very low pressure sensor and a command to adjust the Pitot tube factor.

You can carry out all span calibrations in sequence or just one only, if you wish.

You can use your own span gas, or if you need to calibrate the ENERAC in the field, you can use the convenient gas calibration kit supplied by Energy Efficiency Systems.

1. **Span calibration using the EES kit.**

   The gas calibration system supplied by EES is shown in Fig. 9. The kit comes with a gas cylinder containing a mixture of 200 PPM carbon monoxide (typically), 1.0% methane and balance nitrogen. For NO, NO2 and SO2 calibrations you must order extra gas cylinders containing the desired type of span gas. All four gas cylinders and apparatus fit inside a
carrying case for easy transportation to the field.

Follow the instructions supplied with the calibration kit for proper span calibration.

For the span calibration of the AMBIENT TEMPERATURE follow the directions in section 2 below.

2. Span calibration using your own gas.

If you wish to use your own gas to perform span calibrations you must take
certain precautions, in order to calibrate the sensors properly.

*Preferably, for greatest accuracy it is recommended that you use a span gas value close to the emission concentration you expect to measure.*

To carry out a span calibration **USING YOUR OWN GAS APPARATUS**

(Use single toxic gas mixture!)

**FIGURE 10**

follow the steps below:

1. Set up your calibration apparatus as shown in fig. 10.

Notice that you need a number of certified gas cylinders. Make sure you use the calibration accessory supplied with your instrument. The accessory ensures proper gas flow to the ENERAC.
You must not feed gas to the ENERAC under pressure and you must not starve the ENERAC's pump for gas. When feeding the gas to the ENERAC you must maintain the pressure reasonably constant. This is a requirement of all diffusion type sensors.

Connect the calibration accessory to the ENERAC probe. Make sure the rubber bulb is inserted past the square grooves located at the probe tip.

Connect the other end of the calibration accessory to the gas cylinder.

Make sure the concentration of the calibration gas is within the range of the Precision Control Module selected for each sensor. Do not under any circumstances, use gas that will over range the PCM. Preferably, do not calibrate with gas whose concentration is lower the PCM’s range’s lower boundary.

The Carbon Monoxide gas can be in the range 30-20000 PPM 2% accuracy with the balance nitrogen, preferably.

The Combustible gas can be in the range 0.07%-3.0% methane, 2% accuracy with the balance nitrogen or air.

The NO span gas can be in the range 10-3500 PPM, 2% accuracy with balance nitrogen.

The NO2 span gas should be in the range 50-500 PPM, 2% accuracy balance air, preferably.

The sulfur dioxide span gas can be in the range of 30-7000 PPM, 2% accuracy, balance nitrogen, preferably.

If you plan to calibrate all sensors, follow the order of their appearance on the display. This is desirable in order to set the compensating matrix for cross sensitivities, properly.

2. Turn the instrument on, press ENTER to autozero and wait until the following message appears on the display:
"INSERT PROBE"

3. Push the "SET" button and observe "SET" LED turn on.

4. Push the "NO/NO2" button. The following message will appear:

"CMB SPAN GAS: 0.11%"

Step #5 below demonstrates how to by pass an unwanted span calibration and proceed to the next one.

5. (If you wish to skip the Combustibles calibration push the "ENTER" button. The display will read:

"PUSH ENTER KEY!!".

Press any button, except the "ENTER" button and the unit will skip the combustibles calibration and proceed to the next one.)

6. To carry out the combustibles span calibration, use the "UP" or "DOWN" buttons until the display reads the same combustibles value as that printed on the combustibles (methane) gas cylinder label. Then press the "ENTER" button. The following message will appear on the display:

"PRESS ENTER KEY!!"

7. Open the span gas valve and set your gas bypass flow (as indicated by the small flow meter of the calibration accessory) to 200-400 cc/min Make sure the flow rate indicated is reasonably constant. Press the "ENTER" key. The following message will appear on the display:

"FEED GAS NOW and WAIT"

8. Make sure you keep the gas flow reasonably constant by monitoring the flow meter. At the end of approximately three minutes the ENERAC will record and store the combustibles sensor response and define it as the value that you set earlier on the display.
When the following message appears on the display:

"CO SPAN GAS: 200 PPM"

it means that you are finished with the combustibles span calibration and the instrument is prompting you to perform the CO calibration next. Shut off the gas!

9. To carry out the CO (carbon monoxide) span calibration follow the procedure outlined above for the combustibles calibration.

A number of important messages, that are part of the "ENERAC CALIBRATION PROTOCOL", will appear on the printer at the end of the CO calibration.

If you wish to skip the CO sensor calibration proceed as in step 5. The following message will appear on the display:

"NO SPAN GAS: 200 PPM"

prompting you to carry out this calibration.

*Please note that according to "ENERAC Calibration Protocol" this calibration also checks the performance of the CO sensor filter.*

You may carry out or by pass this calibration, as you wish.

10. The next sensor calibration in line is sulfur dioxide and the following message will appear on the display;

"SO2 SPAN GAS: 200 PPM"

If you wish to carry out any of these calibrations, proceed as outlined in steps 6, 7 and 8.

*IMPORTANT NOTE: SO2 AND NO2 gases are "sticky" gases. That means*
that they tend to adsorb partially to the surface of materials causing a slow down of the response time of the instrument. For this reason, it is a good practice when calibrating with SO2 or NO2 span gases, to begin feeding the gas at least four minutes before executing the span calibration!

11. The last sensor calibration to be carried out is nitrogen dioxide and the following message will appear on the display:

"NO2 SPAN GAS: 100 PPM"

prompting you to carry out this calibration in turn.

Please note that this span calibration also checks the performance of the NO sensor inboard filter and in addition, the performance of the SO2 sensor according to the "ENERAC Calibration Protocol".

At the end of all span gas calibrations the following message will appear on the display:

"ATEMP OFFSET +0 C"

12. The final span calibration corrects for any inaccuracy in the ambient temperature reading. This calibration allows you to make minor corrections so that the ENERAC will read the exact ambient temperature.

You can only enter the correction in degrees Celsius. Use a good thermometer to compare with the ENERAC's ambient temperature reading and correct accordingly.

At the end of the span calibration procedure the following message will appear on the display:

"WAIT TWO MINUTES!!"

The instrument is now purging any traces of remaining gas.

At the end of the two minute period it will perform an "auto zero" and it will
be ready for measurements by displaying any two stack parameters.

NOTE: IF you wish to exit the span calibration procedure at any time, other than when the message "FEED GAS AND WAIT" is displayed simply press the "SET" key and observe the "SET LED" turn off.

Whenever the message "FEED GAS NOW AND WAIT" appears, the ENERAC is inside a software loop and will not respond to any keys or communicate with external computers. SHUT THE INSTRUMENT OFF, IF YOU HAVE TO ABORT A SPAN CALIBRATION.

INCREASED ACCURACY REQUIREMENTS

1. ALLOW THE INSTRUMENT TO REACH AMBIENT TEMPERATURE BEFORE CARRYING OUT A SPAN CALIBRATION OR MEASUREMENT.

2. FOR NO, NO2 AND SO2 CALIBRATIONS, FEED THE SPAN GAS FOR A MINIMUM OF 10 MINUTES BEFORE EXECUTING THE SPAN CALIBRATION PROCEDURE.

3. DURING A MEASUREMENT MAINTAIN THE SAME FLOW RATE INTO THE INSTRUMENT (+/- 10%) AS DURING SPAN CALIBRATION BY ADJUSTING THE SAMPLE PUMP VOLTAGE, IF NECESSARY.

4. TO ACHIEVE THE BEST MATHEMATICAL COMPENSATION, USE NO2 SPAN GAS TO CALIBRATE, WHOSE CONCENTRATION IS APPROXIMATELY THE AVERAGE CONCENTRATION OF YOUR EXPECTED EMISSION.

5. CHECK THE NO FILTER INTERFERENCE REJECTION OF SO2 GAS BY FEEDING A BLEND OF KNOWN CONCENTRATIONS OF no AND SO2 GASES.
MEASURED PARAMETERS:

1. AMBIENT TEMPERATURE. IC sensor. Degrees F or C.
   Range: 0-150 degrees F
   Resolution: 1 degree F or C.
   Accuracy: 3 degrees F

2. STACK TEMPERATURE. Type K thermocouple. Degrees F or C
   Range: 0-2000 degrees F (1100 C).
   Resolution: 1 degree F. (1 C.)
   Accuracy: .5 degrees F.

3. OXYGEN. Electrochemical cell. Life 2 years.
   Range: 0-25%
   Resolution: 0.1%
   Accuracy: 0.2%

4. NITRIC OXIDE(NO). Electrochemical (SEM (TM)) cell. Life 2 years.
   PCM Ranges: 0-300 PPM.
   0-1000 PPM (300-1000)
   0-3500 PPM (1000-3500)
   Resolution: 1 PPM
   Accuracy: 2% of reading (*)

5. NITROGEN DIOXIDE(NO2). Electrochemical (SEM (TM)) cell. Life 2 years.
   Range: 0-500 PPM.
   Resolution: 1 PPM
   Accuracy: 2% of reading (*)

6. CARBON MONOXIDE. Electrochemical (SEM (TM)) cell. Life 2 years.
   PCM Ranges: 0-500 PPM.
   0-2000 PPM (500-2000)
   0-20000 PPM (2000-20000)
   Resolution: 1 PPM
Accuracy: 2% of reading (*)

7. SULFUR DIOXIDE.
   Electrochemical (SEM (TM)) cell. Life 2 years.
   PCM Ranges: 0-500 PPM.
   0-2000 PPM (500-2000)
   0-7000 PPM (2000-7000)
   Resolution: 1 PPM
   Accuracy: 2% of reading (*)

8. COMBUSTIBLES(GASES).
   Catalytic sensor. Life indefinite.
   Range: 0-6.00%
   Resolution: 0.01%
   Accuracy: 10% of reading in CH4 gas

9. TIME/DATE.
   Time in hours, minutes, seconds. Date in month, day, year format.

(*) When tested according to 40CFR60, RAA test.

COMPUTED PARAMETERS:

1. COMBUSTION EFFICIENCY. Heat loss method. Unique four loss factors computation.
   (dry gas, water vapor, gaseous combustibles, combustibles in ash)
   Range: 0-100%
   Resolution: 0.1%
   Accuracy (4 loss): 1% (above H2O condensation)
   2% (below H2O condensation)

2. CARBON DIOXIDE.
   Range: 0-40%
   Resolution: 0.1%
   Accuracy: 5% of reading.
3. EXCESS AIR. Range: 0-1000%
Resolution: 1%
Accuracy: 10% of reading

4. OXIDES OF NITROGEN. PCM Ranges: 0-800 PPM,
0-1500 PPM (800-1500)
0-4300 PPM (1500-4300)
Resolution: 1 PPM
Accuracy: 2% of reading (*)

5. EMISSIONS 1.
(CO, NO, NO2, NOX, SO2) Range: 0-2500 milligrams/cubic meter
Resolution: 2 mg/m³
Accuracy: 5% of reading

6. EMISSIONS 2.
(CO, NO, NO2, NOX, SO2) Range: 0.000-99.99 lbs./million BTU
Resolution: 0.01 lbs./MMBTU
Accuracy: 5% of reading
(Oxygen correction factor for emissions adjustable 0-20% in 1% steps plus TRUE).

7. EMISSIONS 3. Range: 0-99.99 grams/brake hp-hr
Resolution: 0.01 grms/bhp-hr
Accuracy: 10% of reading

PRINTER:

SEIKO 4", 40 char. per line thermal printer with form feed and line feed buttons and with end of paper override.

Operates in any of four print modes:

1. TEXT MODE. 25 line printout of instant. values of all measured parameters. (time req. 20 sec.)
2. PLOT MODE. Any one parameter vs. time plotted.
3 ordinate scales: full, half, quarter.
Time scale: Selectable, 1 sec/dot-1 min/dot in 1 sec/dot intervals.
APPENDIX I

Example Calculations
Example Calculations

1. Determine the mass emission flow rate (lbs/hr) of carbon monoxide from the SUE Incinerator during exhaust Sampling Run # 2.

   \[ E = (C) \times (MW) \times (FR) \times (1.55 \times 10^{-7}) \]

   Where,

   \[ E = \text{The pollutant emission rate in pounds per hour (lb/hr)} \]
   \[ C = \text{The measured pollutant concentration in parts per million by volume (ppmv). For Run # 2, the average CO concentration was 108 ppmv.} \]
   \[ MW = \text{The molecular weight of the pollutant. For CO, } MW = 28 \]
   \[ FR = \text{The flow rate of the stack gas in dry standard cubic feet per minute (DSCFM). The flow rate for Run # 2 (as calculated by EPA's HP 41 "Meth 2" Calculator Program) was 9,097 DSCFM.} \]
   \[ 1.55 \times 10^{-7} = \text{Conversion Factor } [(\text{min} \cdot \text{g-mole} \cdot \text{lb})/(\text{hr} \cdot \text{g} \cdot \text{ft}^3)] \]

   \[ E = (108)(28 \text{ g/g-mole})(9,097 \text{ ft}^3/\text{min})(1.55 \times 10^{-7} \text{ min} \cdot \text{g-mole} \cdot \text{lb}/\text{hr} \cdot \text{g} \cdot \text{ft}^3) \]

   \[ E = 4.3 \text{ lbs/hr} \]

2. Determine the VOC destruction efficiency of the SUE Incinerator during exhaust Sampling Run #1.

   \[ \text{DE} = [(CF - E_{ex})/CF] \times 100 \]

   Where,

   \[ \text{DE} = \text{Destruction Efficiency (\%)} \]
   \[ \text{CF} = \text{Calibration fluid combusted by the SUE Incinerator (lb/hr as Stoddard solvent). This includes both the VOC vapors in the inlet gas stream and the liquid waste calibration fluid burned as supplemental fuel.} \]
   \[ E_{ex} = \text{VOC emission rate in exhaust stack (lb/hr as Stoddard solvent).} \]

   Since the SUE Incinerator burned liquid waste calibration fluid, it is necessary to determine both the inlet and exhaust VOC mass flow rates in units of "lbs/hr as Stoddard solvent" instead of "lbs/hr as propane." This is done by converting the measured concentrations from "ppmv as propane" to "ppmv as Stoddard solvent" using the following equation:

   \[ \text{ppmv as Stoddard solvent} = [(\text{ppmv as propane}) \times (3)]/7.05 \]

   Where,
3 = the carbon equivalent correction factor (listed in EPA Method 25A) which converts "ppmv as propane" to "ppmv as carbon"

7.05 = response factor (determined by a contractor during previous VOC emissions testing at Kelly AFB) for converting "ppmv as carbon" to "ppmv as Stoddard solvent"

Average inlet VOC concentration = (149 ppmv as propane)(3)(1/7.05) = 63.4 ppmv as Stoddard solvent

Run 1 exhaust VOC concentration = (14.7 ppmv as propane)(3)(1/7.05) = 6.3 ppmv as Stoddard solvent

The inlet and exhaust VOC mass emission rates (in lbs/hr as Stoddard solvent) are then calculated as follows:

E = (C) x (MW) x (FR) x (1.55x10⁻⁷)

Where,

E = The pollutant emission rate (lbs/hr as Stoddard solvent)
C = The pollutant concentration (ppmv as Stoddard solvent)
MW = The molecular weight of the pollutant. For Stoddard solvent, MW = 140
FR = The flow rate of the gas stream (DSCFM). The average inlet flow rate (as calculated by EPA's HP 41 "Meth 2" Calculator Program) was 10,085 DSCFM. The Run 1 exhaust flow rate (as calculated by EPA's HP 41 "Meth 2" Calculator Program) was 9,155 DSCFM.
1.55x10⁻⁷ = Conversion Factor [(min.g-mole.lb)/(hr.g.ft³)]

E (in) = (63.4)(140 g/g-mole)(10,085 ft³/min)(1.55x10⁻⁷ min.g-mole.lb/hr.g.ft³) = 13.9 lbs/hr as Stoddard solvent

E (ex) = (6.3)(140 g/g-mole)(9,155 ft³/min)(1.55x10⁻⁷ min.g-mole.lb/hr.g.ft³) = 1.25 lbs/hr as Stoddard solvent

The average inlet VOC mass flow rate (13.9 lbs/hr as Stoddard solvent) is then added to the liquid waste Stoddard solvent combusted during exhaust Sampling Run #1 (108 lbs/hr) to obtain the approximate amount of total calibration fluid (121.9 lbs/hr) combusted during Run #1. The destruction efficiency can now be calculated as follows:

DE = [(121.9 lb/hr - 1.25 lbs/hr)/121.9 lbs/hr] x 100

DE = 99.0%