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AFOEHL REPORT 89-054EQ0146GEF

Compliance Testing of Consumat Silver Reclamation Incinerator No. 4, Offutt AFB NE

PAUL T. SCOTT, Capt, USAF, BSC

JULY 1989

Final Report

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AF Occupational and Environmental Health Laboratory (AFSC)
Human Systems Division
Brooks Air Force Base, Texas 78235-5501

NOTICES

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

This report has been reviewed and is approved for publication.

PAUL T. SCOTT, Capt, USAF,
Consultant, Air Quality Meteorologist

DENNIS R. SKALKA, Lt Col, USAF, BSC
Chief, Consultant Services Division

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James C Rock
JAMES C. ROCK, Colonel, USAF, BSC
Commander

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At the request of HQ SAC/SGPB compliance testing of Consumat Silver Reclamation Incinerator No. 4 (particulate emissions) was accomplished 26-28 Jan 89. Visible emissions were evaluated by the Nebraska Department of Environmental Control on-site observer. Results indicate the incinerator met the standard for visible emissions. The survey was to determine compliance with the emission standards as defined under Nebraska Air Pollution Control Rules and Regulations. Results indicate the incinerator met particulate standards.

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22a NAME OF RESPONSIBLE INDIVIDUAL
Paul T. Scott, Capt, USAF, BSC

22b TELEPHONE *(Include Area Code)*
(512) 536-2891

22c OFFICE SYMBOL
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I. INTRODUCTION

On 26-28 January 1989, compliance testing was accomplished on consumat silver reclamation incinerator No. 4 located in Bldg 301D, Offutt AFB NE. Testing was conducted by the Air Quality Function, Consultant Services Division of the Air Force Occupational and Environmental Health Laboratory (AFOEHL). The survey was requested by HQ SAC/SGPB to determine compliance with particulate emission standards as defined under Nebraska Air Pollution Control Rules and Regulations. Personnel involved with on-site testing are listed in Appendix A.

II. DISCUSSION

A. Background

In 1986, three silver reclamation incinerators were in operation and being used for film destruction and silver recovery. During an inspection of the incinerators, representatives of the Nebraska Department of Environmental Control determined that one or more of the units failed to meet opacity standards in accordance with Chapter 17 (Visible Emissions; Prohibited) of the Nebraska Air Pollution Control Rules and Regulations. The base was subsequently cited for failure to meet applicable regulations governing incineration emissions and operation of the incinerators was halted until source emission testing was accomplished on each unit. The state required that the incinerators meet both the standards for opacity and particulate emissions.

Because of the noncompliance status of the incinerators, HQ SAC/SGPB requested that AFOEHL conduct emissions testing of the units to determine compliance. Testing was first accomplished in September 1986. The AFOEHL source test team conducted particulate emissions testing while state personnel determined visible emissions. Emissions data were analyzed on-site with the intent of determining compliance status during testing so that contractor personnel (available during testing) could make adjustments to the incinerators if found to be out of compliance.

Test results indicated that incinerators 1 and 2 failed to meet both the visible and particulate emissions standards. Contractor personnel could not correct the operation of these two units to meet standards, therefore, the state would not allow units 1 and 2 to continue operation. After test results were known, a decision was made by appropriate base agencies to replace incinerators 1 and 2 and add a fourth incinerator.

After the new incinerators were in place, HQ SAC/SGPB again requested that AFOEHL conduct emissions testing of the silver recovery incinerators to determine compliance. The request included testing the three new incinerators as well as incinerator 3 which previously met particulate and opacity emission standards. In addition to particulates, the state requested that emission testing include hydrogen chloride (HCl) and certain heavy metals (i.e., antimony, arsenic, cadmium, lead, mercury, silver, and zinc).

Testing was again accomplished in November 1988. The AFOEHL source team conducted particulate emissions testing while state personnel determined visible emissions. Test results indicated that incinerator 4 failed to meet both visible and particulate emission standards. Consequently, the state would not allow its continued operation. Incinerators 1, 2, and 3 met both visible and particulate emissions standards and were allowed to continue operation. HQ SAC/SGPB asked that we return at our earliest convenience to retest incinerator 4.

B. Site Description

The silver reclamation incinerators are owned and operated by the 544th Target Materials Squadron. Incinerator 4 is a Model C-75 SR, Consumat Waste Disposal System manufactured by Consumat Systems, Inc. The unit is self-contained and is used to destroy classified photographic film with the ashes sent to a contractor for silver recovery. The system is completely refractory lined and has a capacity of 600 pounds per 24 hour period (lbs/24 hr) (Fig 1).

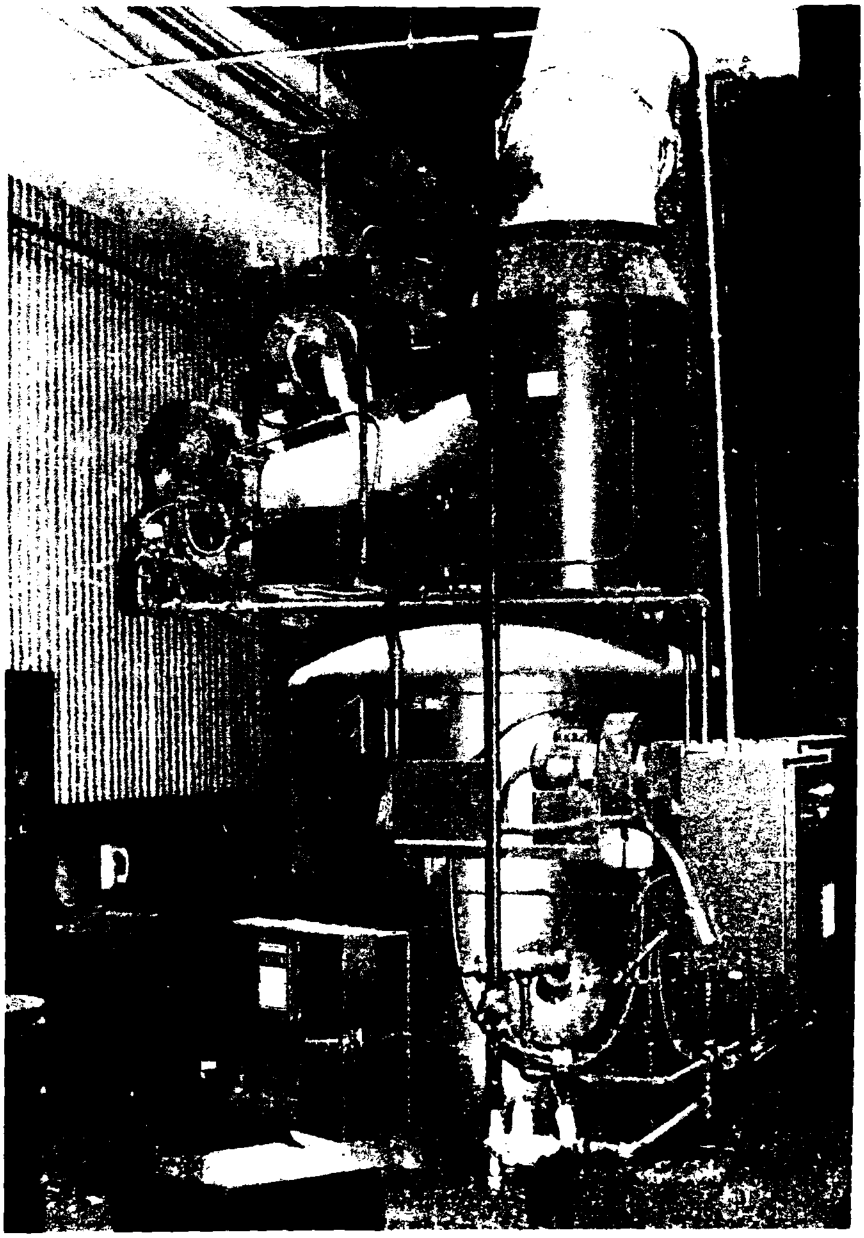

FIGURE 1. Silver Reclamation Incinerator

The incinerator is a cylindrically shaped unit consisting of three major components or assemblies: (1) the combustion chamber, (2) a transition assembly, and (3) a control box (Figs 2-4). The combustion chamber houses the loading door , ash removal port, and the two primary burners. In this area the film is volatized and reduced to ash.

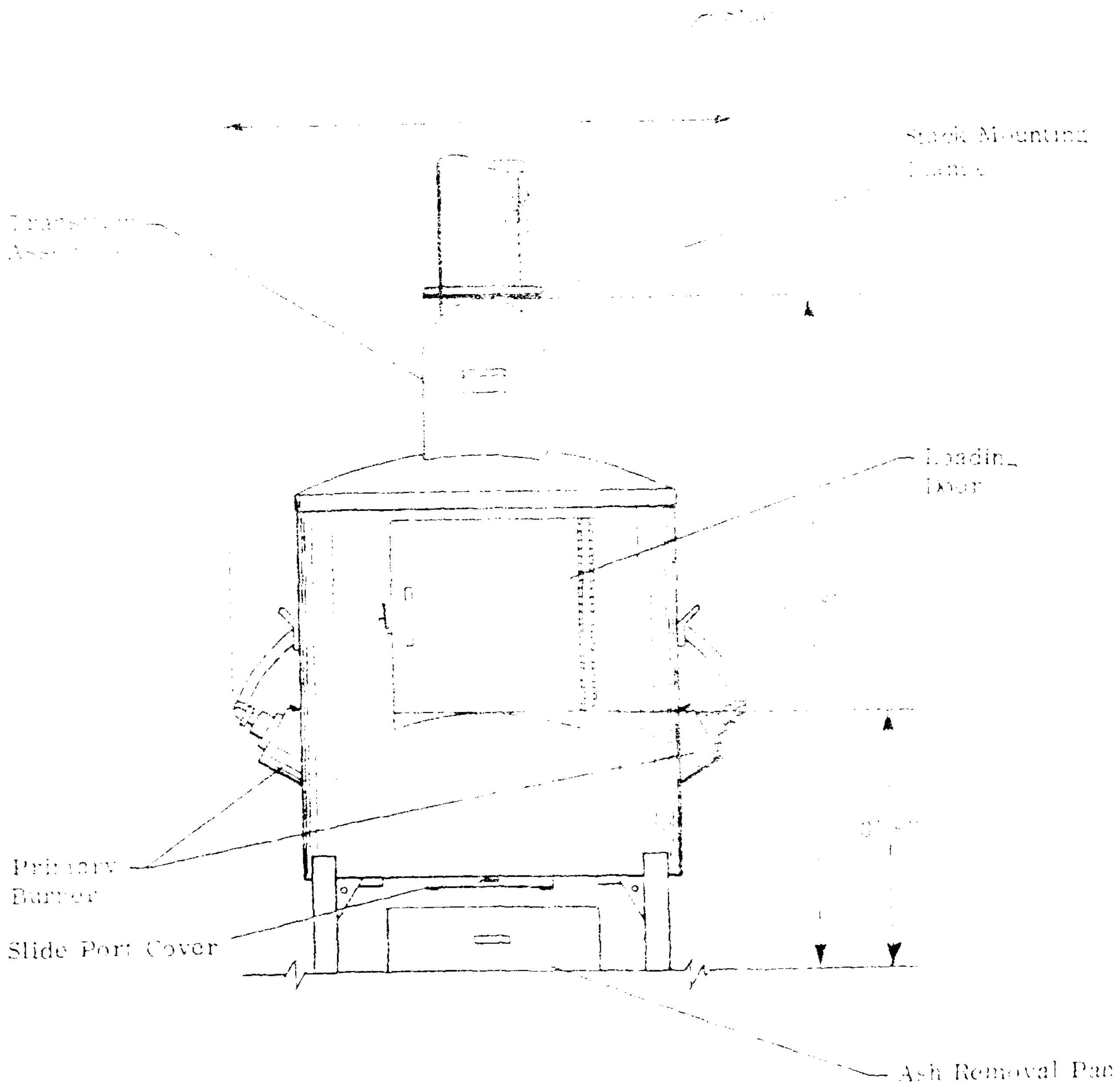

FIGURE 2. Incinerator Front View

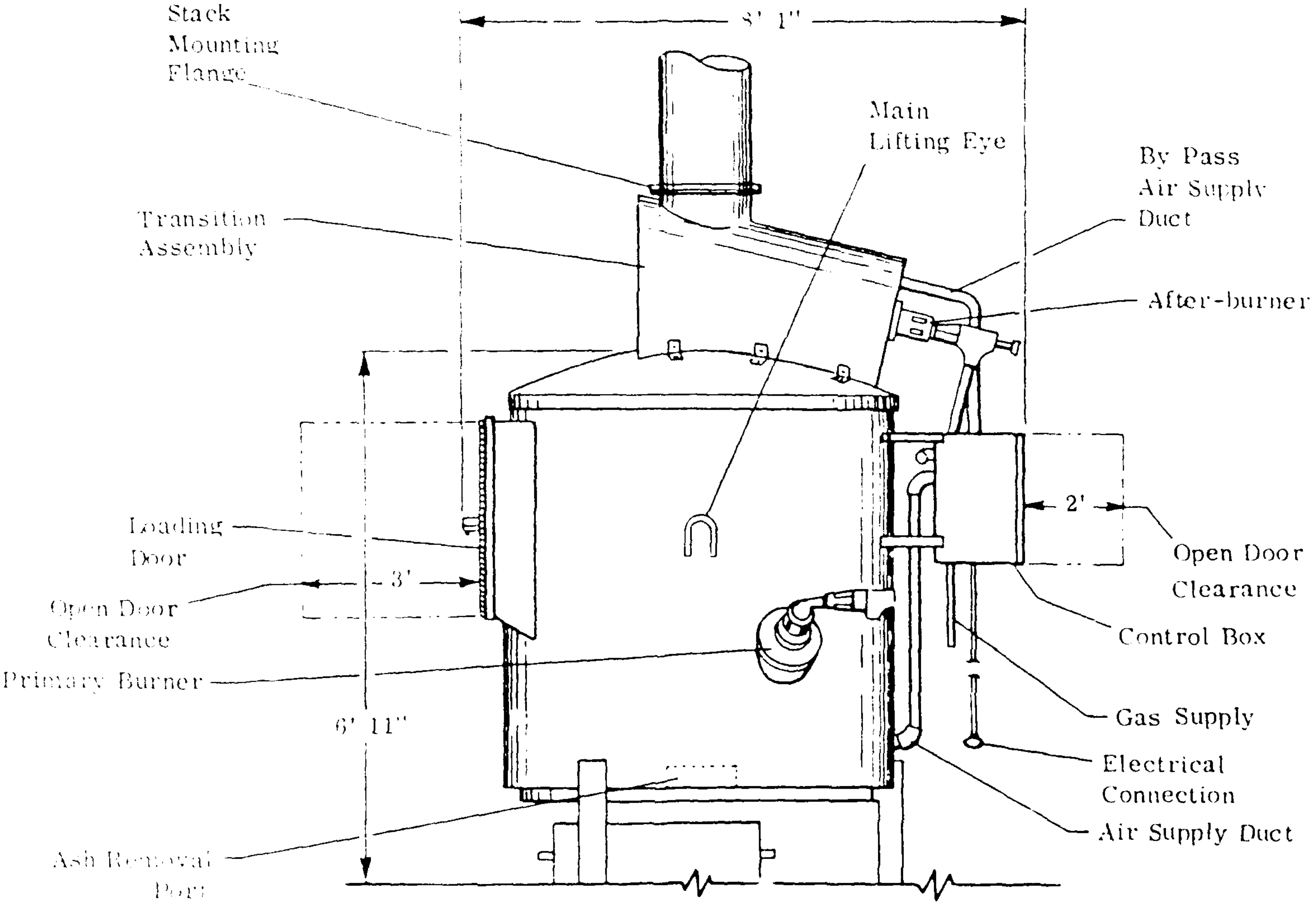

FIGURE 3. Incinerator Side View

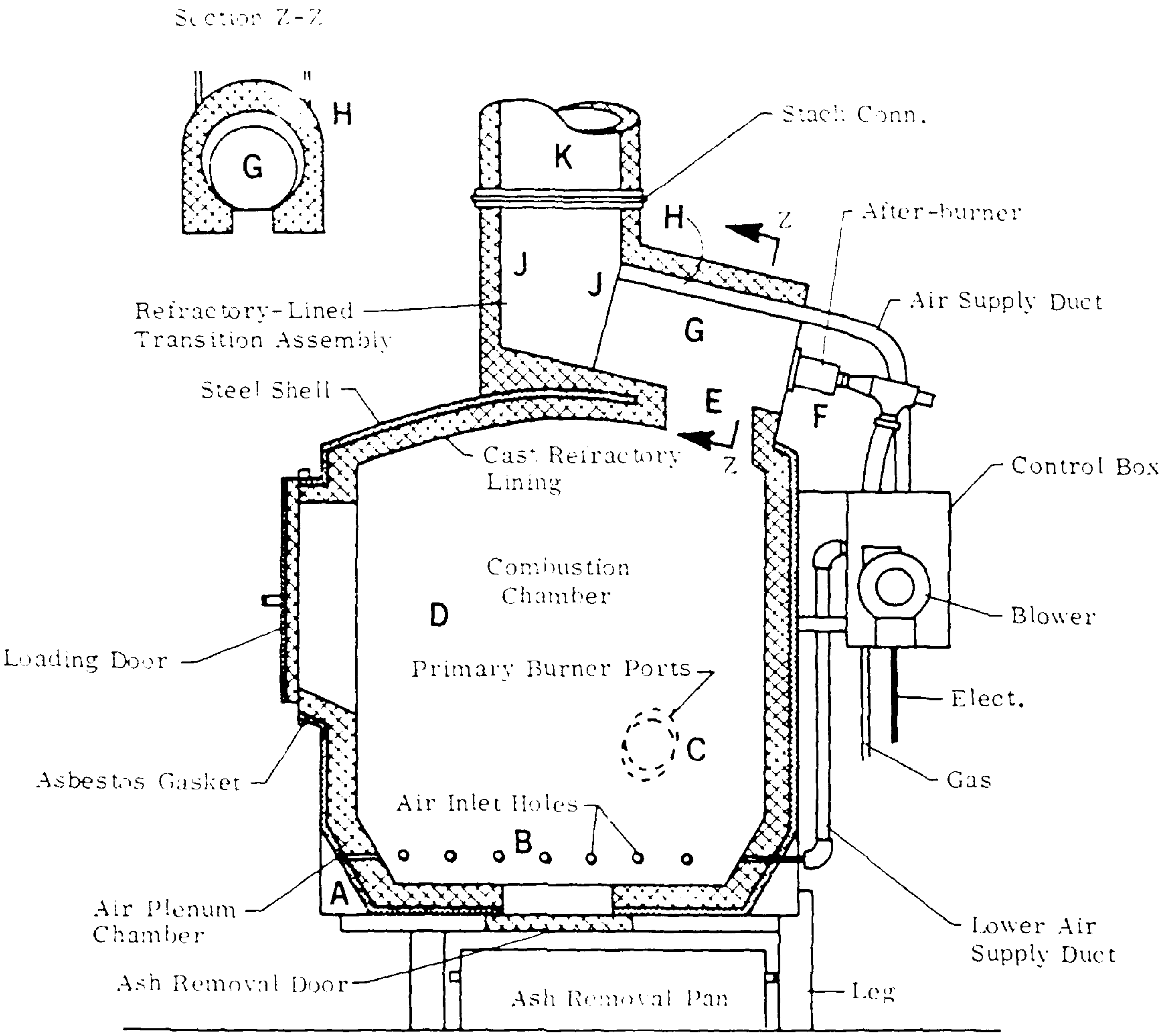

FIGURE 4. Incinerator Internal View

The transition assembly houses the after-burner and is located on top of the combustion chamber. Exhaust gases and particulate matter from the combustion chamber enter the transition assembly where combustion is completed. The intended design of the chamber is such that gas exit velocities from the chamber to the transitional assembly are so low that most particles remain in the chamber to be further reduced to ash. In the transition assembly, fine particulate matter is completely oxidized and carbon monoxide is converted to carbon dioxide to complete the combustion process. Exhaust gases from the transition assembly pass through a transitional exhaust duct section to a "free standing" stack. The transition and stack are shown in Figure 5. The stack extends vertically through the roof of the building to a height of approximately 30 feet as shown in Figure 6.

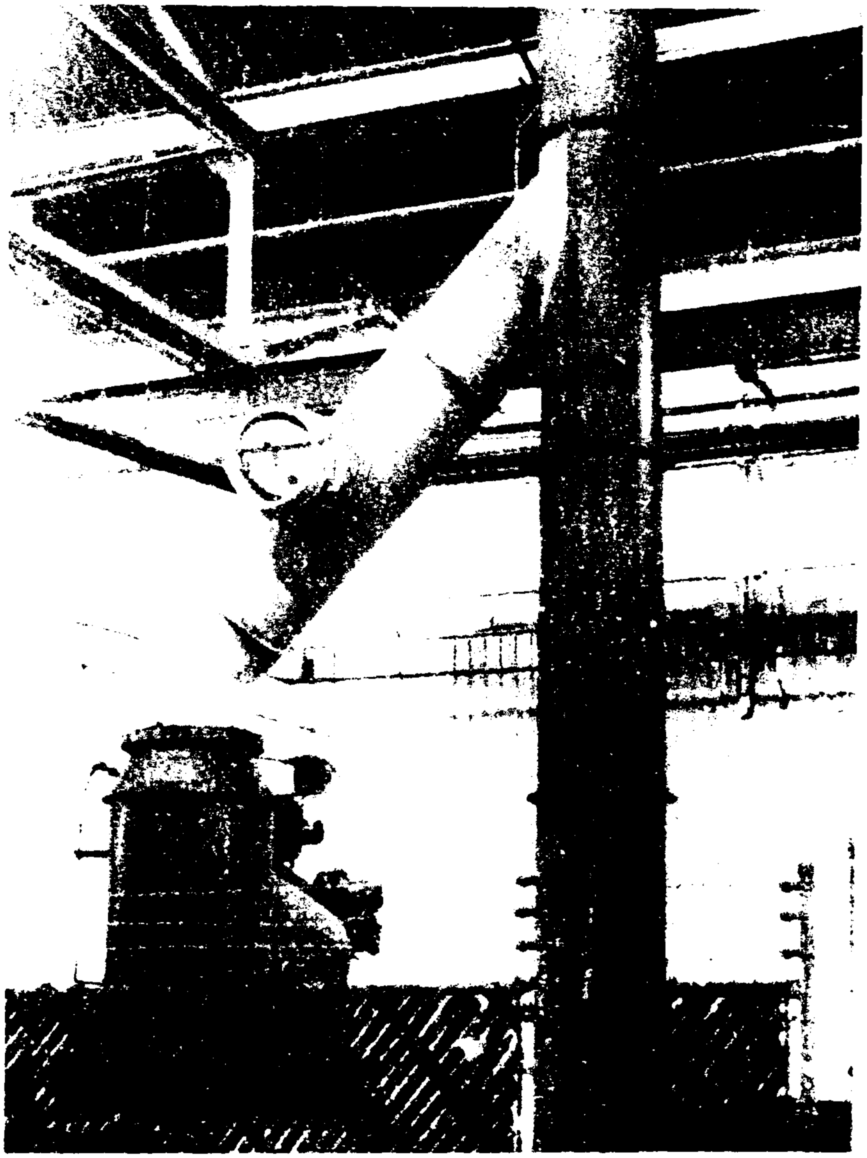

FIGURE 5. Transition and Stack

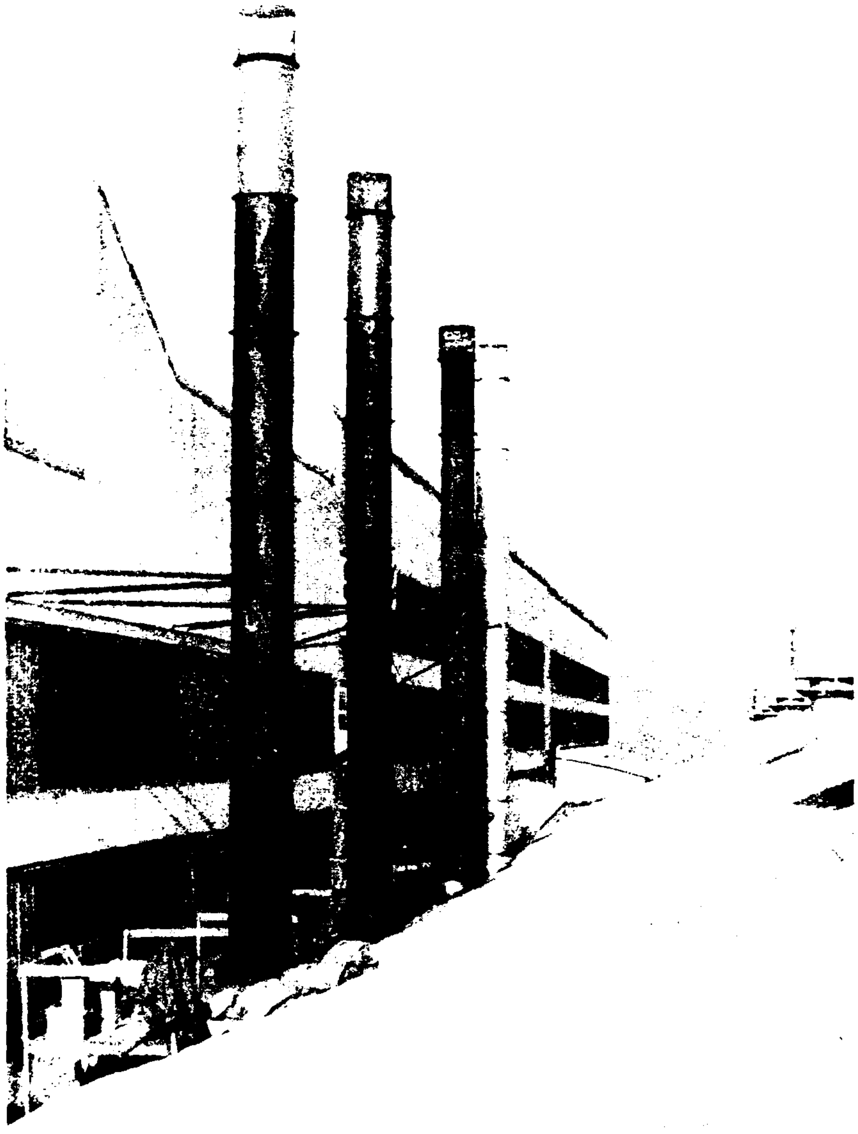

FIGURE 6. Incinerator Stacks 1-4 (Foreground to Background)

The control box houses a forced air blower and electrical circuitry. The blower provides forced air to the combustion chamber to purge the chamber, aid in burning, and cool the transition assembly and combustion chamber at the end of the operating cycle. The electrical circuitry contains those subsystems which control burner and blower cycles, pyrometer temperature monitor, air supply valves, and others.

A typical operating scenario begins when the combustion chamber is loaded with film (normally 500-600 lbs). After purging the combustion chamber with air and preheating the afterburner section, the film is ignited by the primary burners. The desirable action is to volatilize the film by partial oxidation. Most particulate material remains in the combustion chamber to be further reduced to ash. The evolved gases and entrained fine particles are vented to the transition stage. Gas velocity increases as the gases are inducted into the flame of the afterburner. Combustion air is also supplied at this point. Because of the added heat and air, the hot gases and particles begin to burn and the combustion process is completed. The complete combustion and cool down cycle takes approximately 24 hours. This cycle is shown in Table 1.

TABLE 1. INCINERATOR COMBUSTION CYCLE

Time Into Cycle (hrs)	Event
0.0	Afterburner on for preheat
	Blower on
0.5	Primary burners on to start film combustion process
1.0	Primary burners off
12.0	Afterburners off
20.0	Blower off
23.0	Ash removed from combustion chamber

C. Applicable Standards

State standards applicable to incinerators used for refuse disposal or processing of salvageable materials are defined under the Nebraska Code of Rules and Regulation, Department of Environmental Control, Title 129 - Nebraska Air Pollution Control, Rules, and Regulations, Chapters 11 and 17. These regulations are found in Appendix B.

1. Chapter 11 - Incinerators; Emission Standards

Chapter 11 prohibits the emission of particulate matter in excess of 0.2 grains of particulate matter per dry standard cubic foot of exhaust gas (gr/dscf), corrected to twelve percent (12%) carbon dioxide (CO_2), from any incinerator with a waste burning capacity less than 2,000 pounds per hour.

2. Chapter 17 - Visible Emissions; Prohibited

Chapter 17 prohibits emissions from any source which are of a shade or density equal to or darker than that designated as No. 1 on the Ringlemann chart or equivalent opacity of twenty percent (20%).

D. Sampling Methods and Procedures

The Nebraska Code of Rules and Regulations, Title 129, Chapter 21 requires that emission testing be conducted in accordance with Appendix A to Title 40, Code of Federal Regulations, Part 60 (40 CFR 60). Therefore, sample train preparation, sampling and recovery, calculations, and quality assurance were done in accordance with the methods and procedures outlined in 40 CFR 60, Appendix A. A state on-site observer evaluated visible emissions.

For testing purposes, the incinerator was operated according to normal day-to-day procedures with a charge weight of 546 lbs.

Particulate emissions testing was conducted in accordance with EPA method 5, found in 40 CFR 60, Appendix A. Testing requires three 1-hour (minimum) sample runs; the results of which are averaged for a final emission rate. Based on a request from the state, we tried to start the first sampling run as close to 30 minutes into the incinerator burn as possible. Each sample run was actually 64 minutes in length.

Sampling ports existed in the stack approximately 4 feet above the roof line which provided sampling sites 6.5 duct diameters downstream and greater than 2 duct diameters upstream from any flow disturbance. Based on the inside stack diameter, port locations, and type of sample (particulate), 16 traverse points (8 per diameter) were used to collect a representative particulate sample.

Prior to testing, cyclonic flow was determined by using the type S pitot tube and measuring the stack gas rotational angle at each traverse point. Flow conditions were considered acceptable when the arithmetic mean average of the rotational angles was 20 degrees or less. A preliminary velocity pressure traverse was also accomplished at this time.

A grab sample for Orsat analysis (measures oxygen (O_2) and CO_2 for stack gas molecular weight determination) was taken during each sample run. Orsat sampling and anaysis equipment are shown in Figures 7 and 8. Flue gas moisture content, needed for determination of flue gas molecular weight, was obtained during particulate sampling.

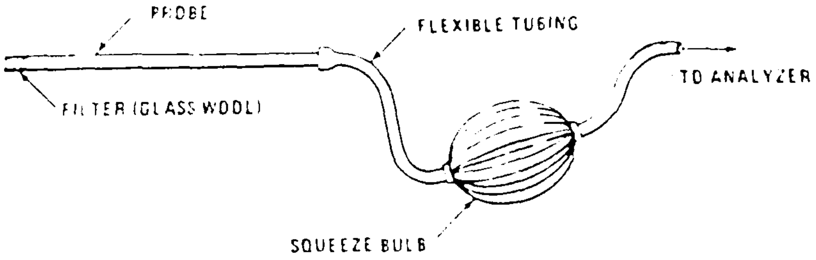

FIGURE 7. ORSAT Sampling Probe

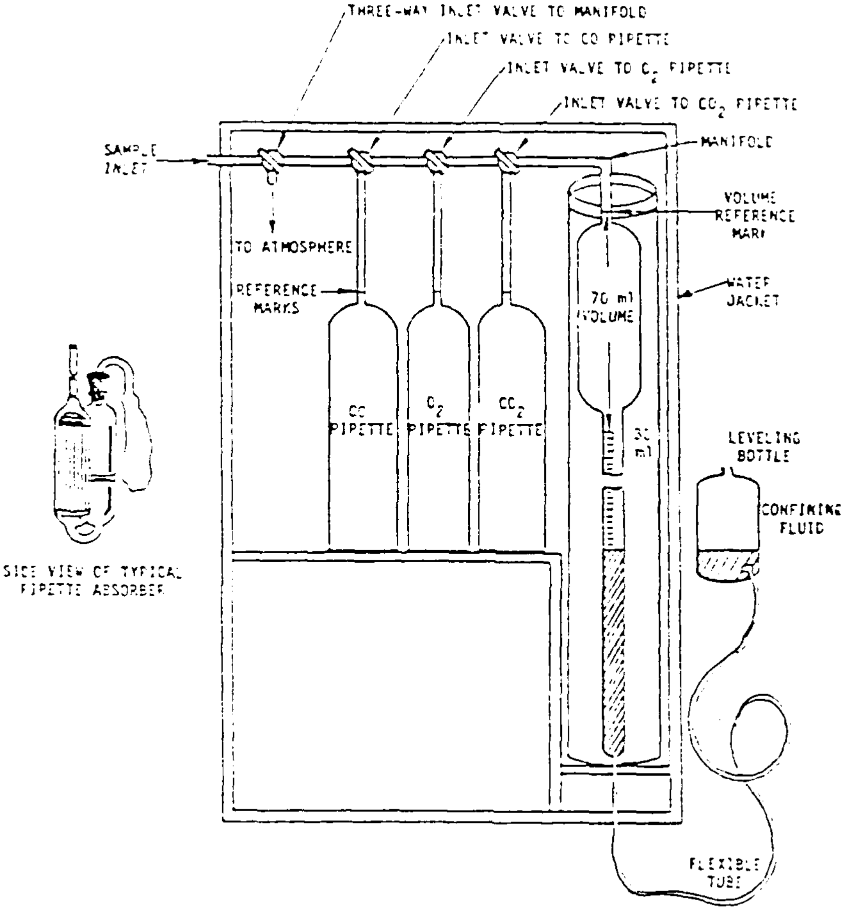

FIGURE 8. ORSAT Analyzer

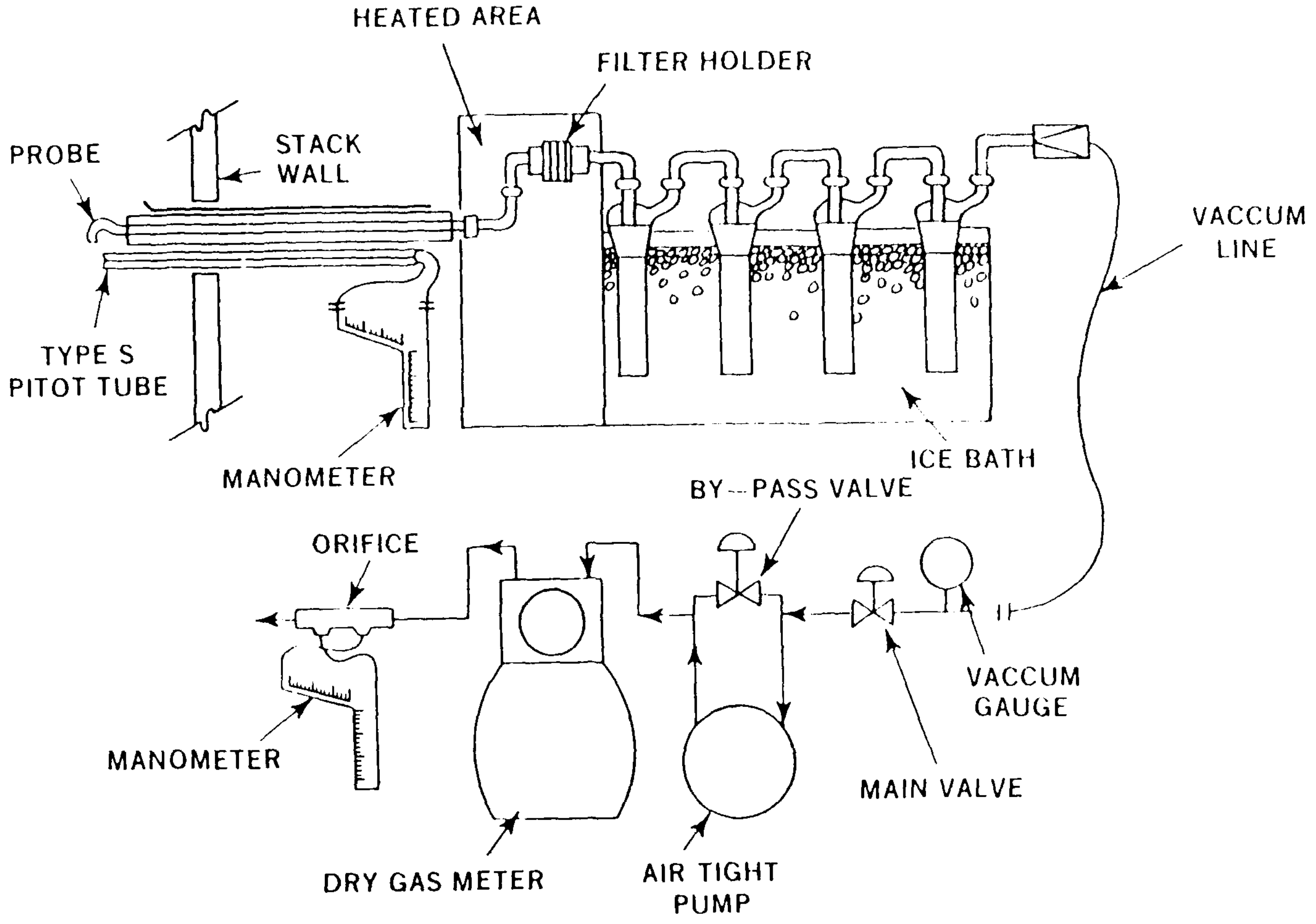

FIGURE 9. Particulate Sampling Train

Particulate samples were collected using the sampling train shown in Figure 9. The train consisted of a buttonhook probe nozzle, heated stainless steel-lined probe, heated glass filter, impingers and a pumping and metering device. The probe nozzle was sized prior to each sample run so that the gas stream could be sampled isokinetically, (i.e., the velocity at the nozzle tip was the same as the stack gas velocity at each point sampled). Flue gas velocity pressure was measured at the nozzle tip using a Type S pitot tube connected to a 10 inch inclined-vertical manometer. Type K thermocouples were used to measure flue gas as well as sampling train temperatures. The probe liner was heated to minimize moisture condensation. The heated filter was used to collect particulates. The impinger train (first, third, and fourth impingers: modified Greenburg-Smith type, second impinger: standard Greenburg-Smith design) was used as a condenser to collect stack gas moisture. The pumping and metering system was used to control and monitor the sample gas flow rate.

Particulate samples were analyzed according to the procedures specified in Method 5. Emission calculations were accomplished using the "Source Test Calculation and Check Programs for Hewlett-Packard 41 Calculators" (EPA-340/1-85-018) developed by the EPA Office of Air Quality Planning and Standards, Research Triangle Park NC. All field data and resulting emission calculations are presented in Appendixes C and D. Equipment calibration data is presented in Appendix E. A summary of test conditions and results appear in Table 2.

TABLE 2. SAMPLE RESULTS

RUN	INCINERATOR START TIME	RUN START TIME	AVG STACK TEMPERATURE (oF)	STACK FLOWRATE (dscfm)*	%CO_2	%O_2	PARTICULATE EMISSIONS (mg)	PARTICULATES cor. 12% CO_2 (gdscf)**
1	0845	1030	525	1464	2.5	15.7	109.5	0.2122
2		1221	445	1278	2.5	15.7	55.5	0.1223
3		1408	403	1302	2.5	15.7	12.0	0.0261
AVERAGES					2.5	15.7	177.0	0.1169

* dscfm: dry standard cubic feet per minute

** gdscf: grains per dry standard cubic foot

III. CONCLUSIONS/RECOMMENDATIONS

According to the state on-site observer, silver recovery incinerator 4 passed visible emissions (EPA Method 9). The average particulate emissions were 0.0241 gdscf with a CO_2 concentration of 2.5%. Correcting to 12% CO_2 gives an average particulate emission rate of 0.1169 gdscf, well below the Nebraska particulate emission standard of 0.2 gdscf.

AFOEHL will continue to provide consultative and testing services to Offutt AFB as requested.

References

1. Code of Federal Regulations. Vol 40, Parts 53-60, The Office of the Federal Register National Archives and Records Service, General Services Administration, Washington DC, July 1987.

2. Quality Assurance Handbook for Air Pollution Measurement Systems - Volume III, Stationary Source Specific Methods, U.S. Environmental Protection Agency , EPA-600/4-77-027-b, Research Triangle Park , North Carolina, December 1984.

3. Source Test Calculation and Check Programs for Hewlett-Packard 41 Calculators, U.S. Environmental Protection Agency, EPA-340/1-85-018, Research Triangle Park, North Carolina, May 1987.

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APPENDIX A
Personnel

1. AFOEHL Test Team

   Maj James A. Garrison, Chief, Air Quality Function
   Capt Paul T. Scott, Consultant, Air Quality Meteorologist
   SSgt Daniel Schillings, Environmental Quality Technician
   Sgt James J. Jarbeau Jr., Industrial Hygiene Technician

   AFOEHL/ECQ
   Brooks AFB TX 78235-5501

2. Offutt AFB on-site representative

Johnette Shockley	55 CSG/DEEV
Maynard Keith	55 CSG/DEEV AV 271-6372/3714 COM (402)294-6372/3714
SSgt Patrick McAlexander	544 TMS/TGOPWL AV 271-3434/4404 COM (402)294-3434/4404

3. State of Nebraska On-Site Representative

   David Meierhenry
   Air Quality Division
   Inspection and Compliance
   Nebraska Department of Environmental Control
   Box 94877
   Lincoln NE 68509-4877
   (402)471-2186

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APPENDIX B
State Regulations

Chapter 9 CONTROLS FOR TRANSFERRING, CONVEYING, RAILCAR AND TRUCK LOADING AT ROCK PROCESSING OPERATIONS IN CASS COUNTY

001 By [illegible] the owner or [illegible] rock processing operation [illegible] shall install [illegible] control system to reduce [illegible] conveying [illegible] rail car and truck loading by 85 percent. Compliance with this Chapter may be demonstrated by the [illegible] spray heads [illegible] is deemed [illegible] by the Director.

Chapter 10 FUEL BURNING EQUIPMENT; PARTICULATE EMISSIONS LIMITATIONS FOR EXISTING SOURCES

001 No person shall cause or allow particulate matter caused by the combustion of fuel to be emitted from any stack or chimney into the outdoor atmosphere in excess of the hourly rate set forth in the following table.

[illegible]	[illegible]
[illegible]	0.60
[illegible]	0.12

002 The allowable emission rate for equipment having intermediate heat input between 10 (10⁶) BTU and 10,000 (10⁶) BTU may be determined by the formula:

$$E = \frac{1.026}{I^{0.233}}$$

where:

E = The allowable emission rate in lb/10⁶ BTU

I = The total heat input in 10⁶ BTU/Hr.

003 For the purpose of these regulations, the heat input shall be the aggregate heat content of all fuels whose products of combustion pass through a stack or the equipment manufacturer's or designer's guaranteed maximum input, whichever is greater. The total heat input of all fuel burning units at a plant or on a premises shall be used for determining the maximum allowable amount of particulate matter which may be emitted.

Chapter 11 INCINERATORS; EMISSION STANDARDS

001 These regulations shall apply to all incinerators except [illegible] used for refuse disposal in the processing of salvageable material, except where incinerators located at residential premises containing five or less dwelling units and used exclusively for the disposal of waste originating on such premises.

002 No person shall cause or permit emissions of particulate matter to be discharged into the outdoor atmosphere:

002.01 From any incinerator with a waste burning capacity less than 2,000 pounds per hour, to exceed 0.2 grains of particulate matter per standard dry cubic foot of exhaust gas, corrected to twelve percent (12%) carbon dioxide.

002.02 From any incinerator with a waste burning capacity equal to or in excess of 2,000 pounds per hour, to exceed 0.1 grains of particulate matter per standard dry cubic foot of exhaust gas, corrected to twelve percent (12%) carbon dioxide. In correcting the grain loading to twelve percent (12%) carbon dioxide, the exhaust gases contributed by the burning of a liquid or gaseous fuel shall be excluded.

003 The burning capacity of an incinerator shall be the manufacturer's or designer's guaranteed maximum rate or such other rate as may be determined by the Director in accordance with good engineering practice.

004 Waste burned during performance testing required by Chapter 21 shall be representative of the waste normally generated by the affected facility and shall be charged at a rate equal to the burning capacity of the incinerator. Copies of any additional operational data recorded during the test shall be submitted to the Department together with the completed test report forms.

Chapter 12 HAZARDOUS AIR POLLUTANTS; EMISSION STANDARDS

001 Notwithstanding any other provisions of these regulations, the "National Emissions Standards for Hazardous Air Pollutants", published at 40 CFR Sections 61.01-61.18, 61.30-61.71, 61.110-61.112, 61.140-61.242 for beryllium, beryllium rocket motor firing, mercury, vinyl chloride, equipment leaks (fugitive emission sources) of benzene, asbestos and equipment leaks (fugitive emission sources) of hazardous volatile air pollutants, respectively, effective [illegible] as published at [illegible] Fed. Reg. [illegible] ([illegible]), is hereby adopted and incorporated into these regulations. Appendices A, B and C of 40 CFR Part 61 are also adopted and incorporated into these regulations.

Chapter 13 SULFUR COMPOUND EMISSIONS; EMISSION STANDARDS

001 No person shall allow sulfur oxides to be emitted from any existing fossil fuel burning equipment in excess of two and one-half (2.5) pounds per million BTU input, maximum 2 hour average.

002 For the purpose of these regulations, the heat input shall be the aggregate heat content of all fuels whose products of combustion pass through a stack or the equipment manufacturer's or designer's guaranteed maximum input, whichever is greater. The total heat input of all fuel burning units at a plant or on a premises shall be used for determining the maximum allowable amount of sulfur dioxide which may be emitted.

003 No person shall cause or allow sulfur oxides to be emitted from any existing equipment, other than fuel burning equipment, in excess of the following limits:

003.01 During any consecutive 12 month period, sulfur oxides in excess of the amount emitted during the 1971 calendar year.

003.02 During any 24 hour period, sulfur oxides exceeding the maximum amount emitted during any consecutive 24 hour period during the 1971 calendar year.

003.03 Nothing in sections 003.01 and 003.02 of this Chapter shall be construed to allow sources to conduct operations not in accordance with Chapters 4 and 6.

003.04 Nothing in 003.01, 003.02 or 003.03 of this Chapter shall be interpreted to allow any source to operate in violation of emergency reduction plans pursuant to Chapter 25.

003.05 If emission data for sulfur dioxide for the 1971 calendar year is not available, estimates of emissions shall be made based on materials processed or produced and appropriate emission factors developed by the U.S. Environmental Protection Agency.

Chapter 14 NITROGEN OXIDES (CALCULATED AS NITROGEN DIOXIDE); EMISSIONS STANDARDS FOR EXISTING STATIONARY SOURCES

001 Nitric Acid Manufacturing. No owner or operator of an installation producing nitric acid either as an end product or for use in intermediate steps in production of other products will exceed the following limitations on the emission of oxides of nitrogen (calculated as nitrogen dioxide):

001.01 5.5 pounds per ton of 100 percent nitric acid produced; or

001.02 A concentration of nitrogen dioxide equivalent to 400 parts per million (p.p.m.) by volume, whichever is more stringent.

Chapter 15 OPEN FIRES, PROHIBITED; EXCEPTIONS

001 No person shall cause or allow any open fires.

002 Exceptions

002.01 Fires set solely for recreational purposes or for outdoor cooking of food for human consumption on other than commercial premises and no nuisance or hazard is created.

002.02 Fires set for the purpose of training public and industrial fire fighting personnel.

002.03 Fires set in the operation of smokeless flare stacks for the combustion of waste gases, provided they meet the requirements of Chapter 17, Visible Emissions for Stationary Sources.

002.04 Fires set in an agricultural operation where no nuisance or traffic hazard is created. For the purpose of this regulation, "fires set in an *agricultural operation*" shall mean:

002.04A The burning of any trees or vegetation indigenous to the property of the owner or person in lawful possession of the land, and

002.04B The burning of any agriculturally related material potentially hazardous and where disposal by burning is recommended by the manufacturer. Such materials must have been used on the owner's property or person in legal possession of the said property.

002.05 Unless prohibited by local ordinances, fires set to destroy household refuse on residential premises containing ten or less dwelling units, by individuals residing on the premises and no nuisance or traffic hazard is created.

002.06 For the purpose of plant and wildlife and parks management, provided such burning is conducted by the Nebraska Game Commission, the United States Forest Service, or the University of Nebraska.

002.07 Unless prohibited by local ordinances or regulations, fires set with the written permission of the Director:

002.07A For the purpose of destroying dangerous materials, diseased trees, or abatement of a fire hazard.

002.07B For the purpose of land clearing for roads or other construction activity.

002.07C For the purpose of destroying wood and trees at community land disposal sites, in which case such burning must be distinctly separate from the disposal area for non-burnables.

002.08 Permits for open fires as specified in this regulation will be granted only if there is no other practical means of disposal. Any burning of materials not specified in the burning permit will result *in immediate withdrawal of the permit*.

Chapter 16 RESPONSIBILITY; DEFINED

001 It shall be prima facie evidence that the person who owns or controls property on which burning occurs has caused or permitted said open burning.

Chapter 17 VISIBLE EMISSIONS; PROHIBITED (EXCEPTIONS DUE TO BREAKDOWNS OR SCHEDULED MAINTENANCE: SEE CHAPTER 22)

001 No person shall cause or allow emissions, except steam, from any existing source, which are of a shade or density equal to or darker than that designated as No. 1 on the Ringelmann Chart or equivalent opacity of twenty percent (20%).

002 Exceptions

002.01 No person shall cause or allow emissions from any existing teepee waste wood burner which are of a shade or density equal to or darker than that designated as No. 2 on the Ringelmann Chart or equivalent opacity of forty percent (40%).

002.02 No person shall cause or allow emissions from any existing alfalfa dehydration plant dryer which are of a shade, density or opacity greater than thirty percent (30%).

002.03 This rule shall not be applied to food processing ovens in Dodge County until April 30, 1981.

003 No new sources shall comply with section 001 of this Chapter unless a New Source Performance Standard applies as specified in Chapter 6.

Chapter 18 DUST; DUTY TO PREVENT ESCAPE OF

001 Handling, Transportation, Storing. No person may cause or permit the handling, transporting or storage of any material in a manner which may allow particulate matter to become airborne in such quantities and concentrations that it remains visible in the ambient air beyond the premises where it originates.

002 Construction, Use, Repair, Demolition. No person may cause or permit a building or its appurtenances or a road, or a driveway, or an open area to be constructed, used, repaired or demolished without applying all such reasonable measures as may be required to prevent particulate matter from becoming airborne so that it remains visible beyond the premises where it originates. The Director may require such reasonable measures as may be necessary to prevent particulate matter from becoming airborne including but not limited to paving or frequent cleaning of roads, driveways and parking lots; application of dust-free surfaces; application of water; and the planting and maintenance of vegetative ground cover.

Chapter 19 COMPLIANCE; TIME SCHEDULE FOR

001 Except as otherwise noted in specific emission control regulations, compliance to these regulations shall be according to the following schedule:

001.01 All new or modified installations that required approval under the provisions of Chapter 6 shall be in compliance with all applicable emission control regulations at start-up any time after the effective date of the applicable emission control regulation. Provided, however, such installation may, at the request of the operator and under conditions approved by the Department, be operated for such specified time periods as are required to make necessary adjustments on the equipment. Compliance must be demonstrated in conformance with Chapter [illegible].

001.02 All existing installations and open burning operations subject to Chapter 4, 003 shall be in compliance with

Appendix C
Field Data

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AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE Offutt AFB, Ne	DATE 26 Jan 89	RUN NUMBER one

BUILDING NUMBER Bldg D	SOURCE NUMBER Silver Recovery Incinerator #4

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.3684	0.2871	.0813
ACETONE WASHINGS *(Probe, Front Half Filter)*	100.0906	100.0624	.0282
BACK HALF *(If needed)*	—	—	—
	Total Weight of Particulates Collected		.1095 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 *(H20)*	194.0	200.0	-6.0
IMPINGER 2 *(H20)*	204.0	200.0	4.0
IMPINGER 3 *(Dry)*	1.0	0.0	1.0
IMPINGER 4 *(Silica Gel)*	208.8	200.0	8.8
	Total Weight of Water Collected		7.8 gm

III. GASES *(Dry)*

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	2.5	2.5	2.4		2.47
VOL % O_2	15.6	15.7	15.7		15.70
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

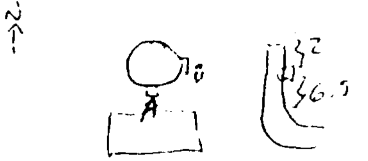
AMD FORM FEB 84 651 REPLACES OEHL 20, MAY 76, WHICH IS OBSOLETE

PARTICULATE SAMPLING DATA SHEET

bH 2.07

RUN NUMBER	ONE
DATE	27 Jan 81
PLANT	Ag Recovery Inc #4
BASE	Offutt AFB
SAMPLE BOX NUMBER	Nutech #2
METER BOX NUMBER	Nutech #1
Qw/Qm	
Co	

SCHEMATIC OF STACK CROSS SECTION



incinerator start time 0845L

static ΔP = -.22

EQUATIONS

$$^{o}R = {}^{o}F + 460$$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

Assumed H_2O = 2.0

CO_2 = 2.0

O_2 = 17.0

MW = 29.0

Pitot check good

Pre leak good at (5in Hg)

Post leak good at

AMBIENT TEMP	26 °F
STATION PRESS	29.046 in Hg
HEATER BOX TEMP	~190 °F
PROBE HEATER SETTING	~245
PROBE LENGTH	48 in
NOZZLE AREA (A)	.372 sq in
Cp	.84
DRY GAS FRACTION (Fd)	

time	TRAVERSE POINT NUMBER	SAMPLING TIME (min)	VAC STATIC ~~PRESSURE~~ (in H20)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
1030	A 1	0	-2.0	406		.10	1.41	971.750	43		43	224	37
	2	4.0	-4.0	478		.12	1.56		47		43	247	37
	3	8.0	-4.0	555		.13	1.57		51		44	245	40
	4	12.0	-4.0	568		.13	1.55		52		45	246	52
	5	16.0	-3.5	556		.14	1.69		53		46	242	43
	6	20.0	-4.0	542		.13	1.66		55		47	246	44
	7	24.0	-4.0	560		.14	1.70		57		48	250	46
	8	28.0	-4.0	555		.12	1.46	990.262	58		49	251	48
1102		32.0											
1106	B 1	0	-3.0	432		.06	0.93		54		50	250	46
	2	4.0	-3.5	482		.08	1.05		58		51	251	48
	3	8.0	-4.0	484		.10	1.32		59		52	249	49
	4	12.0	-3.5	499		.09	1.41		60		52	240	49
	5	16.0	-4.0	552		.12	1.48		61		53	249	50
	6	20.0	-4.0	578		.12	1.44		61		54	251	50
	7	24.0	-4.0	584		.12	1.44		63		54	247	51
1114	8	28.0	-4.0	578		.11	1.33	7,425	63		55	247	52
		32.0											
	$\bar{T}_s$ 525	$\bar{T}_M$ 53	$\Delta\bar{H}$ = 1.41			√[illegible] = 10.5185	TOTAL CuFT = 35.675						

[illegible]

OEHL FORM MAY 78 18

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE Offutt AFB, Ne	DATE 26 Jan 89	RUN NUMBER TWO
BUILDING NUMBER B'ldg D	SOURCE NUMBER Ag Recovery Incinerator #4	

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.3328	0.2934	.0394
ACETONE WASHINGS *(Probe, Front Half Filter.*	105.3909	105.3748	.0161
BACK HALF *(If needed)*			
	Total Weight of Particulates Collected		.0555 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 *(H_2O)*	197.0	200.0	-3.0
IMPINGER 2 *(H_2O)*	206.0	200.0	6.0
IMPINGER 3 *(Dry)*	1.0	0.0	1.0
IMPINGER 4 *(Silica Gel)*	208.0	200.0	8.0
	Total Weight of Water Collected		12.0 gm

III. GASES *(Dry)*

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	2.5	2.5	2.4		2.47
VOL % O_2	15.6	15.7	15.7		15.7
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

AMD FORM FEB 84 651 REPLACES OEHL 20, MAY 78, WHICH IS OBSOLETE

PARTICULATE SAMPLING DATA SHEET

[illegible]

RUN NUMBER
two

DATE
27 Jan [illegible]

PLANT
[illegible]

BASE
[illegible]

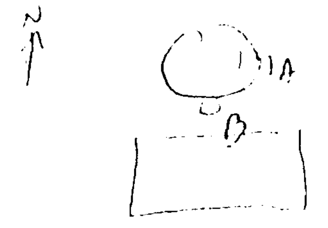
SAMPLE BOX NUMBER
[illegible] #1

METER BOX NUMBER
[illegible] # 1

Qw/Qm

Co

SCHEMATIC OF STACK CROSS SECTION



Chg wt 546 lbs

static ΔP = -.22

EQUATIONS

$$°R = °F + 460$$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

Pitot ck good
Pre leak ck good at 15 in Hg
Post leak ck good at 6 in Hg

AMBIENT TEMP
39 cold °F

STATION PRESS
29.946 in Hg

HEATER BOX TEMP
~ 190 °F

PROBE HEATER SETTING
~ 245

PROBE LENGTH
48"

NOZZLE AREA (A)
.328 sq ft

Cp
.84

DRY GAS FRACTION (Fd)

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H2O)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
A 1	0	-2.0	406		.04	0.57	1048.203	55		54	236	42
2	4	-2.5	421		.07	0.91		58		55	245	42
3	8	-3.0	439		.10	1.30		59		55	238	42
4	12	-3.0	448		.09	1.24		62		56	238	44
5	16	-3.0	478		.09	1.20		63		56	233	46
6	20	-3.0	495		.11	1.44		64		57	240	49
7	24	-3.0	475		.10	1.34		65		58	254	50
8	28	-3.5	476		.09	1.21	024.610	66		58	251	52
	32											
B 1	0	-2.5	400		.04	0.58	024.610	65		59	247	58
2	4	-2.5	415		.06	0.86		65		60	220	52
3	8	-3.0	431		.08	1.13		65		60	248	51
4	12	-3.0	431		.08	1.12		67		61	238	52
5	16	-3.0	455		.09	1.24		68		61	251	53
6	20	-3.0	452		.08	1.11		69		61	251	55
7	24	-3.0	446		.08	1.12		69		62	248	56
8	28	-3.0	441		.09	1.26	40.025	70		62	247	58
	32											
$\overline{T_m} = 61$	$\overline{T_s} = 445$	$\overline{\Delta H} = 1.1$			$\sqrt{\Delta P_s} = 8.4821$	TOT FT³ =	32.022					DM (vote)

OEHL FORM MAY 78 18

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE Offutt AFB	DATE 26 Jan 89	RUN NUMBER THREE

BUILDING NUMBER Bldg D	SOURCE NUMBER Ag^+ Recovery Incinerator #4

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.2925	0.2866	.0059
ACETONE WASHINGS (Probe, Front Half Filter)	102.2151	102.2090	.0061
BACK HALF (if needed)	—	—	—
	Total Weight of Particulates Collected		.0120 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H_2O)	195.0	200.0	−5.0
IMPINGER 2 (H_2O)	204.0	200.0	4.0
IMPINGER 3 (Dry)	1.0	0.0	1.0
IMPINGER 4 (Silica Gel)	210.3	200.0	10.3
	Total Weight of Water Collected		10.3 gm

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	2.5	2.5	2.4		2.47
VOL % O_2	15.6	15.7	15.7		15.70
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

AMD FORM FEB 84 651 REPLACES OEHL 20, MAY 78, WHICH IS OBSOLETE

PARTICULATE SAMPLING DATA SHEET

ST-2-07

RUN NUMBER
THREE

DATE
27 Jan 87

PLANT
[illegible]

BASE
[illegible]

SAMPLE BOX NUMBER
Nutech #2

METER BOX NUMBER
Nutech #1

Qw/Qm

Co

SCHEMATIC OF STACK CROSS SECTION

Static @P = -.22

EQUATIONS

$^{o}R = ^{o}F + 460$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

Pitot ck good
Pre leak ck good at 15 in Hg
Post leak ck good at 7 in Hg

AMBIENT TEMP
39 °F

STATION PRESS
29.445 in Hg

HEATER BOX TEMP
~190 °F

PROBE HEATER SETTING
~245

PROBE LENGTH
48 in

NOZZLE AREA (A)
.378 sq ft

Cp
.84

DRY GAS FRACTION (Fd)

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	√:C STATIC PRESSURE (in H2O)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
A 1	0	-3.0	394		.06	0.68	40.320	62		61	237	54
2	4	-3.0	402		.08	1.17		64		62	238	53
3	8	-4.0	390		.08	1.19		66		62	240	54
4	12	-4.5	400		.08	1.18		68		62	243	57
5	16	-4.5	420		.08	1.15		70		64	245	62
6	20	-4.5	418		.08	1.16		71		64	246	66
7	24	-5.0	418		.09	1.30		71		64	246	67
8	28	-5.0	416		.09	1.31		72		65	246	67
							56.135					
B 1	0	-3.5	371		.05	0.76		70		65	245	62
2	4	-4.5	380		.07	1.06		70		65	246	59
3	8	-5.0	387		.08	1.21		71		65	245	58
4	12	-5.0	398		.08	1.19		72		66	246	57
5	16	-5.0	409		.08	1.17		73		66	246	59
6	20	-5.0	419		.09	1.31		73		67	247	60
7	24	-5.0	416		.09	1.31		73		66	247	60
8	28	-5.0	418		.08	1.16	73.120	74		61	247	60

$\overline{Tm} = 67$ $\overline{Ts} = 403$ $\overline{\Delta H} = 1.16$ $\overline{\sqrt{Vp \cdot Ts}} = 8.2273$ $Vm\ ft^3 = 32.806$ $Tm^{(avg)}$

OEHL FORM 18

. RELIMINARY SURVEY DATA SHEET NO.

(Stack Geometry)

BASE Offutt AFB	PLANT Bldg D
DATE 25 Jan 89	SAMPLING TEAM
SOURCE TYPE AND MAKE Silver Recovery Unit	
SOURCE NUMBER Stack # 4	INSIDE STACK DIAMETER 18.25" Inches
RELATED CAPACITY	TYPE FUEL
DISTANCE FROM OUTSIDE OF NIPPLE TO INSIDE DIAMETER 8.75" Inches	
NUMBER OF TRAVERSES 2	NUMBER OF POINTS/TRAVERSE 8

LOCATION OF SAMPLING POINTS ALONG TRAVERSE

POINT	PERCENT OF DIAMETER	DISTANCE FROM INSIDE WALL *(Inches)*	TOTAL DISTANCE FROM OUTSIDE OF NIPPLE TO SAMPLING POINT *(Inches)*
1		0.6	9.3
2		1.9	10.7
3		3.5	12.3
4		5.9	14.6
5		12.4	21.1
6		14.8	23.5
7		16.4	25.1
8		17.7	26.4

reconnended nozzel 0.376" dia

Probe length 48 - steel liner

4 min per point

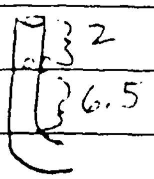
assm $\%H_2O \approx 2.6$

$\%O_2 \approx 17.0$

$\%CO_2 \approx 2.0$

MW ≈ 29.0

FPS ≈ 21.0



OEHL FORM APR 78 15

PRELIMINARY SURVEY DATA SHEET NO. 2

(Velocity and Temperature Traverse)

BASE Offutt AFB

DATE 26 Jun 89

BOILER NUMBER Incinerator #4

INSIDE STACK DIAMETER 18.25 in Inches

STATION PRESSURE 29.446 In Hg

STACK STATIC PRESSURE -.22 In H20

SAMPLING TEAM OEHL/ECQ

TRAVERSE POINT NUMBER	VELOCITY HEAD, V_p IN H20	$\sqrt{V_p}$	STACK TEMPERATURE (°F)
1	.09	5	435
2	.11	5	450
3	.12	5	496
4	.12	2	500
5	.13	2	490
6	.12	2	487
7	.12	6	485
8	.11	6	485
		FPS = 3[illegible]	
		F 47	
		θ .407	
	AVERAGE		

OEHL FORM APR 78 16

Appendix D
Emission Results

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```
          XROM "METH 5"
RUN NUMBER
          1.0000     RUN
METER BOX Y
          1.0770     RUN
DELTA H
          1.4100     RUN
BAR PRESS ?
          29.8400    RUN
METER VOL
          35.[illegible]     RUN
MTR TEMP F?
          55.0000    RUN
STATIC H2O IN ?
          -.0200     RUN
STACK TEMP.
          505.0000   RUN
ML WATER ?
          7.8000     RUN




IMP. % H2O = 0.9

% H2O=0.9


% CO2
          1.4700     RUN
% OXYGEN?
          15.7000    RUN
% CO ?
          0.0000     RUN

Mwd =29.07
Mw WET=28.[illegible]


SQRT PITO
          10.5105    RUN
TIME MIN ?
          64.0000    RUN
NOZZLE DIA ?
          .3708      RUN
STK DIA INCH ?
          18.2500    RUN

* VOL MTR STD = 35.[illegible]
  STK PRES ABS = 29.83
  VOL H2O GAS = 0.37
  % MOISTURE = 0.94
  MOL DRY GAS = 0.991
  % NITROGEN = 82.83
  MOL WT DRY = 29.02
  MOL WT WET = 28.92
  VELOCITY FPS = 25.07
  STACK AREA = 1.82
  STACK ACFM = 2 [illegible]
* STACK DSCFM = 1 [illegible]
  % ISOKINETIC = [illegible]


END OF FIELD DATA
```

```
          XROM "METH 5"
RUN NUMBER
          2.0000     RUN
METER BOX Y
          1.0770     RUN
DELTA H
          1.1100     RUN
BAR PRESS ?
          29.8400    RUN
METER VOL ?
          31.1100    RUN
MTR TEMP F?
          61.0000    RUN
STATIC H2O IN ?
          -.0200     RUN
STACK TEMP.
          445.0000   RUN
ML WATER ?
          11.0000    RUN




IMP. % H2O = 1.8

% H2O=1.8


% CO2
          1.4700     RUN
% OXYGEN?
          15.7000    RUN
% CO ?
          0.0000     RUN

Mwd =29.02
Mw WET=28.84


SQRT PITO ?
          8.4001     RUN
TIME MIN ?
          64.0000    RUN
NOZZLE DIA ?
          .3708      RUN
STK DIA INCH ?
          18.2500    RUN

* VOL MTR STD = 34.612
  STK PRES ABS = 29.83
  VOL H2O GAS = 0.52
  % MOISTURE = 1.87
  MOL DRY GAS = 0.984
  % NITROGEN = 82.83
  MOL WT DRY = 29.02
  MOL WT WET = 28.84
  VELOCITY FPS = 21.05
  STACK AREA = 1.82
  STACK ACFM = 2 294.
* STACK DSCFM = 1 271.
  % ISOKINETIC = 87.6


END OF FIELD DATA
```

```
          XROM "METH 5"
RUN NUMBER
          3.0000     RUN
METER BOX Y
          1.0770     RUN
DELTA H
          1.1400     RUN
BAR PRESS ?
          29.8400    RUN
METER VOL ?
          31.5000    RUN
MTR TEMP F?
          67.0000    RUN
STATIC H2O IN ?
          -.0200     RUN
STACK TEMP.
          460.0000   RUN
ML WATER ?
          10.0000    RUN




IMP. % H2O = 1.4

% H2O=1.4


% CO2
          1.4700     RUN
% OXYGEN?
          15.7000    RUN
% CO ?
          0.0000     RUN

Mwd =29
Mw WET=28.[illegible]


SQRT PITO ?
          8.3077     RUN
TIME MIN ?
          64.0000    RUN
NOZZLE DIA ?
          .3708      RUN
STK DIA INCH ?
          18.2500    RUN

* VOL MTR STD = 34.466
  STK PRES ABS = 29.87
  VOL H2O GAS = 0.48
  % MOISTURE = 1.39
  MOL DRY GAS = 0.986
  % NITROGEN = 82.83
  MOL WT DRY = 29.02
  MOL WT WET = 28.87
  VELOCITY FPS = 20.4[illegible]
  STACK AREA = 1.82
  STACK ACFM = 2 234.
* STACK DSCFM = 1 312.
  % ISOKINETIC = [illegible]


END OF FIELD DATA
```

Uncorrected Emission Data from Mass Flow

```
XROM "MASSFLO"

RUN NUMBER
            1.00    RUN

VOL MTR STD ?
          38.527    RUN
STACK DSCFM ?
        1,464.00    RUN
FRONT 1/2 MG ?
          109.50    RUN
BACK 1/2 MG ?
            0.00    RUN


F  GR/DSCF = 0.04
F  MG/MMM = 100.37
F  LB/HR = 0.55
F  KG/HR = 0.25
```

```
XROM "MASSFLO"

RUN NUMBER
            2.00    RUN

VOL MTR STD ?
          34.025    RUN
STACK DSCFM ?
        1,278.00    RUN
FRONT 1/2 MG ?
           55.50    RUN
BACK 1/2 MG ?
            0.00    RUN


F  GR/DSCF = 0.03
F  MG/MMM = 57.60
F  LB/HR = 0.28
F  KG/HR = 0.13
```

```
XROM "MASSFLO"

RUN NUMBER
            3.00    RUN

VOL MTR STD ?
           34.46    RUN
STACK DSCFM ?
        1,302.00    RUN
FRONT 1/2 MG ?
           12.00    RUN
BACK 1/2 MG ?
            0.00    RUN


F  GR/DSCF = 0.01
F  MG/MMM = 12.30
F  LB/HR = 0.06
F  KG/HR = 0.03
```

Emission Data corrected to 12% CO_2

```
XROM "MASSFLO"

RUN NUMBER
          1.0000    RUN

VOL MTR STD ?
         38.5270    RUN
STACK DSCFM ?
      1,464.0000    RUN
FRONT 1/2 MG ?
        529.7400    RUN
BACK 1/2 MG ?
          0.0000    RUN


F  GR/DSCF = 0.2122
F  MG/MMM = 485.5619
F  LB/HR = 2.6627
F  KG/HR = 1.2078
```

```
XROM "MASSFLO"

RUN NUMBER
          2.0000    RUN

VOL MTR STD ?
         34.0250    RUN
STACK DSCFM ?
      1,278.0000    RUN
FRONT 1/2 MG ?
        269.7300    RUN
BACK 1/2 MG ?
          0.0000    RUN


F  GR/DSCF = 0.1223
F  MG/MMM = 279.9484
F  LB/HR = 1.3401
F  KG/HR = 0.6079
```

```
XROM "MASSFLO"

RUN NUMBER
          3.0000    RUN

VOL MTR STD ?
         34.4600    RUN
STACK DSCFM ?
      1,302.0000    RUN
FRONT 1/2 MG ?
         58.3200    RUN
BACK 1/2 MG ?
          0.0000    RUN


F  GR/DSCF = 0.0261
F  MG/MMM = 59.7652
F  LB/HR = 0.2915
F  KG/HR = 0.1322
```

Appendix E
Calibration Data

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NOZZLE CALIBRATION DATA FORM

Date [illegible] Jan [illegible] Calibrated by [illegible]

Nozzle identification number	Nozzle Diameter[a]			ΔD,[b] mm (in.)	D_{avg}[c]
	D_1, mm (in.)	D_2, mm (in.)	D_3, mm (in.)		
3/8" (.375)	.37[illegible]	.378	.377	.001	.378

where:

[a] $D_{1,2,3}$, = three different nozzles diameters, mm (in.); each diameter must be within (0.025 mm) 0.001 in.

[b] ΔD = maximum difference between any two diameters, mm (in.), $\Delta D \leq$ (0.10 mm) 0.004 in.

[c] D_{avg} = average of D_1, D_2, and D_3.

POSTTEST DRY GAS METER CALIBRATION DATA FORM (English units) Pre

Test number ________ Date 22 Feb 89 Meter box number one Nutech Plant Post Offutt/Griffiss

Barometric pressure, P_b = 29.740 in. Hg Dry gas meter number standard Pretest Y 1.077

Orifice manometer setting, (ΔH), in. H_2O	Gas volume		Temperature				Time (θ), min	Vacuum setting, in. Hg	Y_i	Y_i
	Wet test meter (V_w), ft^3	Dry gas meter (V_d), ft^3	Wet test meter (t_w), °F	Dry gas meter						$\frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w + 460)}$
				Inlet (t_{d_i}), °F	Outlet (t_{d_o}), °F	Average[a] (t_d), °F				
2.5	10	9.280	77 77 537R	81 86 543.5	71 75 533.0	538.25	12.33	8.0	1.074	$\frac{(10)(29.74)(538.25)}{(9.280)(29.74 + \frac{2.5}{13.6})(537)}$
2.5	10	9.306	77 77 537R	86 89 547.5	75 77 536.5	542.00	12.31	8.0	1.078	$\frac{(10)(29.74)(542)}{(9.306)(29.923)(537)}$
2.5	10	9.343	77 77 537R	84 93 551.0	79 83 541.0	546.00	12.32	8.0	1.082	$\frac{(10)(29.74)(546)}{(9.343)(29.922)(537)}$
									Y = 1.078	

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d

(1.077 ± .0539) ⇒ 1.0231 ↔ 1.1309

where

V_w = Gas volume passing through the wet test meter, ft^3.

V_d = Gas volume passing through the dry gas meter, ft^3.

t_w = Temperature of the gas in the wet test meter, °F.

t_{d_i} = Temperature of the inlet gas of the dry gas meter, °F.

t_{d_o} = Temperature of the outlet gas of the dry gas meter, °F.

t_d = Average temperature of the gas in the dry gas meter, obtained by the average of t_{d_i} and t_{d_o}, °F.

ΔH = Pressure differential across orifice, in. H_2O.

Y_i = Ratio of accuracy of wet test meter to dry gas meter for each run.

Y = Average ratio of accuracy of wet test meter to dry gas meter for all three runs; tolerance = pretest Y ±0.05Y.

P_b = Barometric pressure, in. Hg.

θ = Time of calibration run, min.

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 12 Jul 88 Meter box number 2010 NUTECH

Barometric pressure, P_b = 29.119 in. Hg Calibrated by Fagin & Scott

Orifice manometer setting (ΔH), in. H_2O	Gas volume		Temperature				Time (θ), min	Y_i	$\Delta H@_i$ in. H_2O
	Wet test meter (V_w), ft³	Dry gas meter (V_d), ft³	Wet test meter (t_w), °F/R	Dry gas meter					
				Inlet (t_{d_i}), °F/R	Outlet (t_{d_o}), °F/R	Avg[a] (t_d), °F/R			
0.5	5	4.668	78 79 538	76 83 539.5	75 78 536.5	538	13.1	1.070	2.010
1.0	5	4.670	78 78 538	84 89 546.5	78 81 539.5	543	9.3	1.078	2.008
1.5	10	9.390	78 78 538	90 96 553	82 86 544	548.5	15.5	1.082	2.070
2.0	10	9.455	79 80 539.5	96 101 558.5	87 90 548.5	553.5	13.5	1.070	2.087
3.0	10	9.470	80 81 540.5	101 106 563.5	90 93 551.5	557.5	11.1	1.031	2.109
4.0	10.1	9.590	81 81 541	106 109 567.5	94 96 555	561.3	9.8	1.082	2.138
							Avg	1.077	2.070

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6})(t_w + 460)}$	$\Delta H@_i = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\theta}{V_w}\right]^2$
0.5	0.0368	$Y_1 = \frac{(5)(29.119)(538)}{(4.668)(29.119 + .5/13.6)(538)}$	$H@_1 = \frac{(.0317)(.5)}{(29.119)(538)}\left[\frac{(538)(13.1)}{5}\right]^2$
1.0	0.0737	$Y_2 = \frac{(5)(29.119)(543)}{(4.67)(29.119 + 1/13.6)(538)}$	$H@_2 = \frac{(.0317)(1)}{(29.119)(543)}\left[\frac{(538)(9.3)}{5}\right]^2$
1.5	0.110	$Y_3 = \frac{(10)(29.119)(548.5)}{(9.39)(29.119 + 1.5/13.6)(538)}$	$H@_3 = \frac{(.0317)(1.5)}{(29.119)(548.5)}\left[\frac{(538)(15.5)}{10}\right]^2$
2.0	0.147	$Y_4 = \frac{(10)(29.119)(553.5)}{(9.455)(29.119 + 2/13.6)(539.5)}$	$H@_4 = \frac{(.0317)(2.0)}{(29.119)(552.5)}\left[\frac{(539.5)(13.5)}{10}\right]^2$
3.0	0.221	$Y_5 = \frac{(10)(29.119)(557.5)}{(9.47)(29.119 + 3/13.6)(540.5)}$	$H@_5 = \frac{(.0317)(3)}{(29.119)(557.5)}\left[\frac{(540.5)(11.1)}{10}\right]^2$
4.0	0.294	$Y_6 = \frac{(10.1)(29.119)(561.3)}{(9.59)(29.119 + 4/13.6)(541)}$	$H@_6 = \frac{(.0317)(4)}{(29.119)(561.3)}\left[\frac{(541)(9.8)}{10.1}\right]^2$

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[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

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