VALENTINE, FISHER & TOMLINSON

Consulting Engineers

520 LLOYD BUILDING - SEATTLE, WASHINGTON 98101

Phone MA 3-0717

AP-42 Section 9.2.3
Reference 3
Report Sect. ____
Reference ____

MESSAGE | **REPLY**

MESSAGE

TO: MR. Jim Southerland
EPA, Air Quality Office
411 West Chapel Hill St.
Durham, North Carolina 27701

DATE: 5/13/71

Jim —

Two copies of emission reports we prepared for orchard heater clients are enclosed for your information. You may copy the reports but please return them. Also, please keep the names confidential. Summary of results & sample data for the other reports are also included. All samples were collected with ARCO team.

SIGNED: Wes

REPLY

DATE: 5/17/71

Wes —

The info. on orchard heaters will prove to be very useful to us in the evaluation of emissions in many areas. Thank you again for sending us the reports. They are returned, as you requested.

Jim

SIGNED

FORM AVAILABLE FROM GRAYARC CO., INC.
882 THIRD AVE., B'KLYN., N. Y. 11232

PERSON ADDRESSED RETURN THIS COPY TO SENDER

PART I

SUMMARY OF RESULTS

ORCHARD HEATER EFFLUENT EVALUATION

1. CLIENT Spot Heaters (return stack oil bath fired)
2. SAMPLE TAKEN AT Yakima, Washington
3. TYPE OF OPERATION oil bath fired orchard heater
4. LOCATION OF PORT 5.3 diameters upstream and 2.1 diameters downstream of stack inlet and outlet
5. FUEL BURNED AT RATE 10 lb/hr of 7.13 lb/gal fuel oil
6. POLLUTANT(S) SAMPLED Particulates, carbon dioxide, oxygen and carbon monoxide
7. TIME SAMPLE TAKEN:
   DATE 1/8/70 BEGIN 11:10 AM END 11:34 AM
8. STACK FLOW RATE 552 scfm @ 70° F., 1 atm. press., and dry
9. WATER VAPOR IN STACK GAS (DRY-WET BULB) 2% by volume
10. % ISOKINETIC SAMPLING FROM THE TRAIN* 98%
11. STANDARDIZED DRY GAS METER VOLUME (70° F. and 1 atmosphere pressure) 11.30 scf
12. LABORATORY DATA - TOTAL PARTICULATE 10.1 mg
13. PARTICULATE CONCENTRATION IN SAMPLING TRAIN 0.895 mg/scf
14. PARTICULATE MASS RATE 0.495 gm/min
15. EXCESS AIR AT SAMPLING PORT 17.9 times (theoretical)
16. CARBON DIOXIDE CALCULATED AT HEATER OUTLET 5.4%
17. EFFICIENCY OF COMBUSTION 50%

*i.e. Ratio of velocity within nozzle to that of stack velocity x 100.

PART II

SUMMARY OF SAMPLE DATA

CLIENT Spot Heaters (return stack oil bath fired)

DATE 1/3/72 RUN NO. 4

1. SAMPLING NOZZLE DIAMETER 1/2"
2. SAMPLING TIME 24 min.
3. SAMPLE VOLUME @ METER CONDITIONS 11.39 ft.^{3}
4. AVERAGE METER TEMPERATURE 56° F.
5. AVERAGE ORIFICE PRESSURE DROP 0.58" water
6. BAROMETRIC PRESSURE 28.90" Hg

VELOCITY TRAVERSE DURING SAMPLING

7. STACK AREA 1.575 ft.^{2}
8. AVERAGE STACK PRESSURE atmospheric
9. AVERAGE STACK TEMPERATURE 193° F.
10. AVERAGE $\sqrt{\text{VELOCITY HEAD}}$ 0.1365

STACK MOISTURE CONTENT

11. % MOISTURE BY DRY-WET BULB AND PSYCHROMETRIC CHART 2% by volume

ORSAT ANALYSIS

12. CARBON DIOXIDE, % BY VOLUME ON DRY BASIS 0.30 (3000 ppm by Vol.)
13. CARBON MONOXIDE, % BY VOLUME ON DRY BASIS 0.35 (3500 ppm by Vol.)
14. OXYGEN, % BY VOLUME ON DRY BASIS 19.70 (197,000 ppm by Vol.)
15. NITROGEN, % BY VOLUME ON DRY BASIS 79.65 (796,500 ppm by Vol.)
16. MOLECULAR WEIGHT OF STACK GASES (DRY) 28.82 lb/lb mole

PART I

SUMMARY OF RESULTS

ORCHARD HEATER EFFLUENT EVALUATION

1. CLIENT Spot Heaters (27" stack Model)
2. SAMPLE TAKEN AT Yakima, Washington
3. TYPE OF OPERATION Nozzle fired oil orchard heater
4. LOCATION OF PORT 5.3 diameters upstream and 2.1 diameters downstream of stack inlet and outlet
5. FUEL BURNED AT RATE 5.79 lb/hr. of 7.13 lb/gal fuel oil
6. POLLUTANT(S) SAMPLED Particulates, carbon dioxide, oxygen, and carbon monoxide
7. TIME SAMPLE TAKEN:
   DATE 1/6/70 BEGIN 4:04 PM END 4:48 PM
8. STACK FLOW RATE 453 scfm @ 70° F., 1 atm. press. and dry
9. WATER VAPOR IN STACK GAS (DRY-WET BULB) 3% by volume
10. % ISOKINETIC SAMPLING FROM THE TRAIN* 108%
11. STANDARDIZED DRY GAS METER VOLUME (70° F. and 1 atmosphere pressure) 18.00 scf
12. LABORATORY DATA - TOTAL PARTICULATE 2.5 mg
13. PARTICULATE CONCENTRATION IN SAMPLING TRAIN 0.168 mg/scf
14. PARTICULATE MASS RATE 0.076 gm/min.
15. EXCESS AIR AT SAMPLING PORT 25.3 times (theoretical)
16. CARBON DIOXIDE CALCULATED AT HEATER OUTLET 8.9%
17. EFFICIENCY OF COMBUSTION 60%

*i.e. Ratio of velocity within nozzle to that of stack velocity x 100.

PART II

SUMMARY OF SAMPLE DATA

CLIENT Spot Heaters (27" stack model)

DATE 1/6/70 RUN NO. 2

1. SAMPLING NOZZLE DIAMETER 1/2"
2. SAMPLING TIME 44 min.
3. SAMPLE VOLUME @ METER CONDITIONS 17.05 $ft.^3$
4. AVERAGE METER TEMPERATURE 40° F.
5. AVERAGE ORIFICE PRESSURE DROP 0.21" Hg
6. BAROMETRIC PRESSURE 29.40" Hg

VELOCITY TRAVERSE DURING SAMPLING

7. STACK AREA 1.575 $ft.^2$
8. AVERAGE STACK PRESSURE atmospheric
9. AVERAGE STACK TEMPERATURE 210° F.
10. AVERAGE $\sqrt{\text{VELOCITY HEAD}}$ 0.0973

STACK MOISTURE CONTENT

11. % MOISTURE BY DRY-WET BULB AND PSYCHROMETRIC CHART 3%

ORSAT ANALYSIS

12. CARBON DIOXIDE, % BY VOLUME ON DRY BASIS 0.35 (3500 ppm by Vol.)
13. CARBON MONOXIDE, % BY VOLUME ON DRY BASIS 0.30 (3000 ppm by Vol.)
14. OXYGEN, % BY VOLUME ON DRY BASIS 20.35 (203,500 ppm by Vol.)
15. NITROGEN, % BY VOLUME ON DRY BASIS 79.60 (796,000 ppm by Vol.)
16. MOLECULAR WEIGHT OF STACK GASES (DRY) 28.93 lb/lb mole

PART I

SUMMARY OF RESULTS

ORCHARD HEATER EFFLUENT EVALUATION

1. CLIENT Braders Heaters, Inc.
2. SAMPLE TAKEN AT Yakima, Washington
3. TYPE OF OPERATION Nozzle fired oil orchard heater
4. LOCATION OF PORT 5.3 diameters upstream and 2.1 diameters downstream of stack inlet and outlet
5. FUEL BURNED AT RATE 8.7 lb/hr of 7.13 lb/gal fuel oil
6. POLLUTANT(S) SAMPLED Particulates, carbon dioxide, oxygen, and carbon monoxide
7. TIME SAMPLE TAKEN:
   DATE 1/7/70 BEGIN 8:43 AM END 9:25 AM
8. STACK FLOW RATE 467 scfm @ 70° F., 1 atm. press., dry
9. WATER VAPOR IN STACK GAS (DRY-WET BULB) 4% by volume
10. % ISOKINETIC SAMPLING FROM THE TRAIN* 87.5%
11. STANDARDIZED DRY GAS METER VOLUME 14.62 scf
    (70° F. and 1 atmosphere pressure)
12. LABORATORY DATA - TOTAL PARTICULATE 1.0 mg
13. PARTICULATE CONCENTRATION IN SAMPLING TRAIN 0.0683 mg/scf
14. PARTICULATE MASS RATE 0.033 gm/min
15. EXCESS AIR AT SAMPLING PORT 25.0 times (theoretical) (17.4 times)
16. CARBON DIOXIDE CALCULATED AT HEATER OUTLET 12.5% (11.0%)
17. EFFICIENCY OF COMBUSTION 75.0% (70%)

*i.e. Ratio of velocity within nozzle to that of stack velocity x 100.

PART II

SUMMARY OF SAMPLE DATA

CLIENT Braders Heaters, Inc.

DATE 1/7/70 RUN NO. 1

1. SAMPLING NOZZLE DIAMETER 1/2"
2. SAMPLING TIME 42 minutes
3. SAMPLE VOLUME @ METER CONDITIONS 14.17 ft.^{3}
4. AVERAGE METER TEMPERATURE 44° F.
5. AVERAGE ORIFICE PRESSURE DROP 0.27" water
6. BAROMETRIC PRESSURE 29.27" Hg

VELOCITY TRAVERSE DURING SAMPLING

7. STACK AREA 1.575 ft.^{2}
8. AVERAGE STACK PRESSURE atmospheric
9. AVERAGE STACK TEMPERATURE 174° F.
10. AVERAGE $\sqrt{\text{VELOCITY HEAD}}$ 0.0984

STACK MOISTURE CONTENT

11. % MOISTURE BY DRY-WET BULB AND PSYCHROMETRIC CHART 4.0% by volume

ORSAT ANALYSIS

12. CARBON DIOXIDE, % BY VOLUME ON DRY BASIS 0.30
13. CARBON MONOXIDE, % BY VOLUME ON DRY BASIS 0.20
14. OXYGEN, % BY VOLUME ON DRY BASIS 20.00
15. NITROGEN, % BY VOLUME ON DRY BASIS 79.50
16. MOLECULAR WEIGHT OF STACK GASES (DRY) 28.79 lb/lb mole

PART I

SUMMARY OF RESULTS

ORCHARD HEATER EFFLUENT EVALUATION

1. CLIENT Flodin, Inc., P.O. Box 418, Sunnyside, Washington 98944
2. SAMPLE TAKEN AT Yakima, Washington
3. TYPE OF OPERATION Nozzle fired oil orchard heater
4. LOCATION OF PORT 5.3 diameters upstream and 2.1 diameters downstream from inlet and outlet of stack extension
5. FUEL BURNED AT RATE 5.23 lb/hr. of 7.31 lb/gal oil
6. POLLUTANT(S) SAMPLED Particulates, carbon dioxide, oxygen, carbon monoxide
7. TIME SAMPLE TAKEN:

   DATE 1/9/70 BEGIN 9:28 AM END 11:11 AM
8. STACK FLOW RATE 437 scfm @ 70° F., 1 atm. press. and dry
9. WATER VAPOR IN STACK GAS (DRY-WET BULB) 4% by volume
10. % ISOKINETIC SAMPLING FROM THE TRAIN* 91.5%
11. STANDARDIZED DRY GAS METER VOLUME (70° F. and 1 atmosphere pressure) 14.61 scf
12. LABORATORY DATA - TOTAL PARTICULATE 2.2 mg
13. PARTICULATE CONCENTRATION IN SAMPLING TRAIN 0.151 mg/scf
14. PARTICULATE MASS RATE 0.066 gm/min
15. EXCESS AIR AT SAMPLING PORT 27 times (theoretical)
16. CARBON DIOXIDE CALCULATED AT HEATER OUTLET 12%
17. EFFICIENCY OF COMBUSTION 75%

*i.e. Ratio of velocity within nozzle to that of stack velocity x 100.

PART II

SUMMARY OF SAMPLE DATA

CLIENT Flodin, Inc., P.O. Box 418, Sunnyside, Washington 98944

DATE 1/10/70 RUN NO. 1

1. SAMPLING NOZZLE DIAMETER 1/2"
2. SAMPLING TIME 42 min.
3. SAMPLE VOLUME @ METER CONDITIONS 14.92 cf
4. AVERAGE METER TEMPERATURE 57° F.
5. AVERAGE ORIFICE PRESSURE DROP 0.25" water
6. BAROMETRIC PRESSURE 28.55" Hg

VELOCITY TRAVERSE DURING SAMPLING

7. STACK AREA 1.575 $ft.^2$
8. AVERAGE STACK PRESSURE atmospheric
9. AVERAGE STACK TEMPERATURE 147° F.
10. AVERAGE $\sqrt{\text{VELOCITY HEAD}}$ 0.089

STACK MOISTURE CONTENT

11. % MOISTURE BY DRY-WET BULB AND PSYCHROMETRIC CHART 3.8% by volume

ORSAT ANALYSIS

12. CARBON DIOXIDE, % BY VOLUME ON DRY BASIS 0.5%
13. CARBON MONOXIDE, % BY VOLUME ON DRY BASIS 0.6%
14. OXYGEN, % BY VOLUME ON DRY BASIS 20.0%
15. NITROGEN, % BY VOLUME ON DRY BASIS 78.9%
16. MOLECULAR WEIGHT OF STACK GASES (DRY) 28.99 lb/lb mole

PART I

SUMMARY OF RESULTS

ORCHARD HEATER EFFLUENT EVALUATION

1. CLIENT Spot Heaters (nozzle fired return stack model)
2. SAMPLE TAKEN AT Yakima, Washington
3. TYPE OF OPERATION Nozzle fired oil orchard heater
4. LOCATION OF PORT 5.3 diameters upstream and 2.1 diameters downstream of stack inlet and outlet
5. FUEL BURNED AT RATE 6.24 lb/hr of 7.13 lb/gal. fuel oil
6. POLLUTANT(S) SAMPLED Particulates, carbon dioxide, oxygen, carbon monoxide
7. TIME SAMPLE TAKEN:
   DATE 1/7/70 BEGIN 11:15 AM END 11:57 AM
8. STACK FLOW RATE 448 scfm @ 70° F., 1 atm. press., and dry
9. WATER VAPOR IN STACK GAS (DRY-WET BULB) 4% by volume
10. % ISOKINETIC SAMPLING FROM THE TRAIN* 83.5%
11. STANDARDIZED DRY GAS METER VOLUME 13.45 scf
    (70° F. and 1 atmosphere pressure)
12. LABORATORY DATA - TOTAL PARTICULATE 1.3 mg
13. PARTICULATE CONCENTRATION IN SAMPLING TRAIN 0.0965 mg/scf
14. PARTICULATE MASS RATE 0.043 gm/min
15. EXCESS AIR AT SAMPLING PORT 23.3 times (theoretical)
16. CARBON DIOXIDE CALCULATED AT HEATER OUTLET 15.2%
17. EFFICIENCY OF COMBUSTION 90%

*i.e. Ratio of velocity within nozzle to that of stack velocity x 100.

PART II

SUMMARY OF SAMPLE DATA

CLIENT Spot Heaters (nozzle fired return stack model)

DATE 1/7/70 RUN NO. 3

1. SAMPLING NOZZLE DIAMETER 1/2"
2. SAMPLING TIME 42 min.
3. SAMPLE VOLUME @ METER CONDITIONS 13.04 cu.ft.
4. AVERAGE METER TEMPERATURE 42° F.
5. AVERAGE ORIFICE PRESSURE DROP 0.28" water
6. BAROMETRIC PRESSURE 29.20" Hg

VELOCITY TRAVERSE DURING SAMPLING

7. STACK AREA 1.575 ft.^{2}
8. AVERAGE STACK PRESSURE Atmospheric
9. AVERAGE STACK TEMPERATURE 172° F.
10. AVERAGE $\sqrt{\text{VELOCITY HEAD}}$ 0.0967

STACK MOISTURE CONTENT

11. % MOISTURE BY DRY-WET BULB AND PSYCHROMETRIC CHART 4% by volume

ORSAT ANALYSIS

12. CARBON DIOXIDE, % BY VOLUME ON DRY BASIS 0.65 (6500 ppm by Vol.)
13. CARBON MONOXIDE, % BY VOLUME ON DRY BASIS 0.25 (2500 ppm by Vol.)
14. OXYGEN, % BY VOLUME ON DRY BASIS 19.30 (193,000 ppm by Vol.)
15. NITROGEN, % BY VOLUME ON DRY BASIS 79.80 (798,000 ppm by Vol.)
16. MOLECULAR WEIGHT OF STACK GASES (DRY) 28.85 lb/lb, mole

ATMOSPHERIC EMISSION EVALUATION

MASCO JUNIOR

OIL-FIRED ORCHARD HEATER

Manhasset Specialty Co.
Yakima, Washington

PREPARED BY

VALENTINE, FISHER & TOMLINSON
Consulting Engineers
520 Lloyd Building
Seattle, Washington 98101
(206) 623-0717

February 8, 1971

VALENTINE, FISHER & TOMLINSON
CONSULTING ENGINEERS
A.S.H.R.A.E., A.A.A.S., S.A.M.E., I.E.S.
820 LLOYD BUILDING • MAIN 3-0717
SEATTLE, WASHINGTON 98101

WM. M. VALENTINE, M.E.
ARTHUR K. FISHER, M.E.
GEORGE D. TOMLINSON, E.E.

ASSOCIATES:
WAYNE A. HANSON, M.E.
P. "CHIC" CICCHETTI
DOUGLAS W. PASCOE, E.E.
PHILIP W. WOODRUFF
DENNIS W. FINLAYSON
HENRY L. ROYCE, ILLUM.
THOMAS G. JOHNS, M.E.
WILLIAM T. McDONALD
DEAN A. HANNIG

PURPOSE

The purpose of this report is to determine the concentration of particulate matter emitted from the MASCO Junior Orchard Heater manufactured by Manhasset Specialty Company of Yakima, Washington.

SUMMARY

The stack gas sample was found to have a weight rate emission of 0.131 gm/min. 0.78 gpm of #2 Diesel oil at 125 psi was burned during the evaluation.

PROCEDURE

A 17" diameter stack extension was erected above the heater to enable combustion to cease and establish straight line flow at the point of sampling. The "MASCO Junior" heater was placed about 3 inches below the inlet to the stack extension.

The "MASCO Junior" heater was 21 inches high including the cap and 9 inches in diameter. The oil was fed into the heater by a nozzle operating at 125 psi and passing 0.78 gallons per hour.

The particulate sample (solids and condensible hydrocarbons) was collected with a stack gas sampling train and procedures designed by the National Air Pollution Control Administration (NAPCA). The train is designed to maintain the velocity of the gas entering the nozzle equal to the velocity of the stack gas around the nozzle. Percent isokinetic is defined as 100 times the ratio of the velocity of the gas entering the nozzle to the gas around the nozzle. The NAPCA train will collect samples within ±10% isokinetic to insure that all particles approaching the nozzle will be collected

A NAPCA nomograph was used to establish the sampling train flow rate. A 0.50 inch diameter nozzle was selected and the nomograph used to establish a train fl rate of 0.5 cubic feet per minute or greater depending upon the sampling locatio The sample was collected on January 26, 1971 at 99+% isokinetic.

The true stack velocity was calculated from the velocity readings taken during sampling. The sample was collected through a button-hook nozzle, glass-lined probe (integral with the pitot tube and the combination referred to as a pitobe) The solid particulates from the stack gas were collected on a heated glass fiber filter mat in the first section of the sample box. A 250° F. temperature was maintained in the sample box to prevent water condensation on the filter and filter plugging. An ice bath following the filter contained a bubbler with 100 ml of deionized distilled water, an impinger with 100 ml of the same water, a dry bubbler, and a bubbler containing a weighed amount of silica gel respectively. The impinger and bubblers were used to collect any particulate carry-over through the filter and to cool the 250°F. gases for condensation of water and condensible hydrocarbons.

Anaylsis for stack gas carbon dioxide concentration was performed with a Bacharac "Fryrite" absorption instrument and "Unico" detector tube adsorption instrument. The accuracy of the combination instruments was set at ± 0.1%. Carbon Monoxide was measured by detector tube because of the very low concentration. Oxygen was assumed to be the difference between 100% - assumed % nitrogen - % carbon dioxid % carbon monoxide. The gas samples were used to determine the molecular weight of the gas.

CLEAN-UP AND ANALYSIS

Clean-up was performed by first carefully removing the filter and placing it in a container marked "Run X, Container A." Reagent acetone and brushes were used to clean the nozzle, glass probe and cyclone. The acetone wash was placed in a container marked "Run X, Container B.". The volume of water in the impinger and bubblers was measured to the nearest 0.1 milliliters. The original volume of 200 milliliters was subtracted and the difference plus the water weight added to the silica gel was considered as the amount of water collected during the run. The water from the impinger and the water rinse of the impinger, bubblers and connectors were placed in one container marked "Run X, Container C." An acetone rinse of the impinger, bubblers and all connectors was performed and placed in a container marked "Run X, Container D." The silica gel was weighed within the bubbler before and after the run.

Analysis of the samples in each container was performed according to the following "Specification" or equivalent procedures:

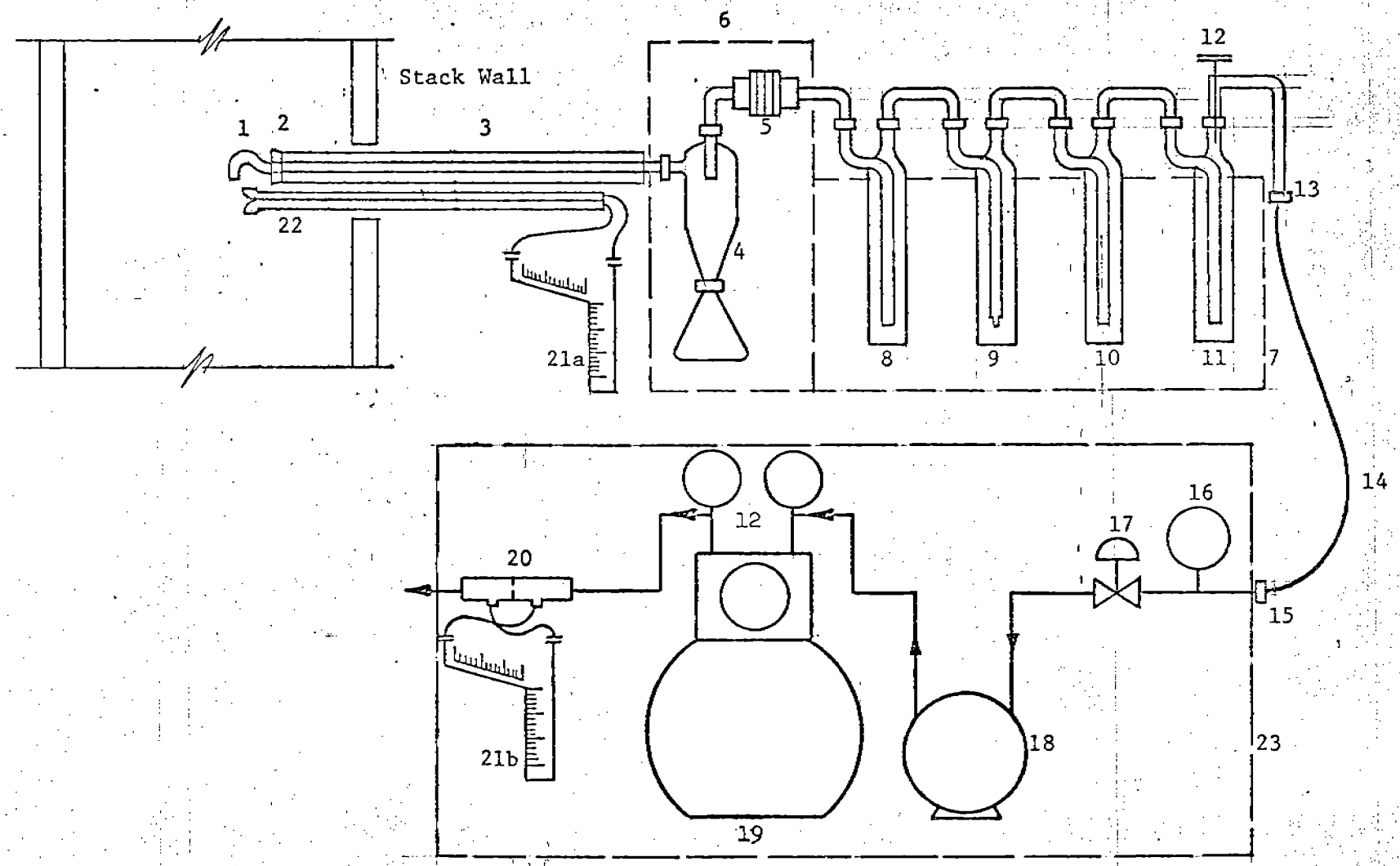
Run X, Container A - Transfer the filter and any loose particulate from the sample container to a tared glass weighing dish and desiccate for 24 hours in a desiccator or constant humidity chamber containing a saturated solution of calcium chloride or its equivalent. Weigh to a constant weight and report the results to the nearest 0.1 milligram.

Run X, Container B - Measure the volume to the nearest 0.1 milliliter. Transfer acetone washings from container into a tared beaker and evaporate to dryness at ambient temperature and pressure. Desiccate for 24 hours and weigh to a constant weight. Report the result to the nearest 0.1 milligram.

Run X, Container C - Measure the volume to the nearest 0.1 milliliter. Extract organic particulate from the water solution with three 25 milliliter portions of chloroform and three 25 milliliter portions of ethyl ether. Combine the ether and chloroform extracts and transfer to a tared beaker. Evaporate until no solvent remains at about 70°F. This can be accomplished by blowing air that has been filtered through activated charcoal over the sample. Desiccate for 24 hours and weigh to a constant weight. Report the results to the nearest 0.1 milligram. After the extraction, evaporate the remaining water to dryness and report the results to the nearest 0.1 milligram.

Run X, Container D - Measure the volume to the nearest 0.1 milliliter. Transfer the acetone washings to a tared beaker and evaporate to dryness at ambient temperature and pressure. Desiccate for 24 hours and weigh to a constant weight. Report the results to the nearest 0.1 milligram.

Blanks were taken on the acetone, ether, chloroform, and deionized water and subtracted from the respective sample volumes. The filter paper used was a Mine Safety Appliance 1106 BH, heat treated glass fiber mat.



VALENTINE, FISHER & TOMLINSON STACK GAS SAMPLING TRAIN

SAMPLING TRAIN COMPONENTS

1. Sampling nozzle - button hook to prevent moisture from draining back into stack and to allow insertion through 2-1/2" port.

2. Quick connect for changing to different size nozzles.

3. Stainless steel probe with glass interliner wrapped with heating wire to maintain a 250° F. temperature for retarding condensation.

4. Sampling cyclone to catch large particles and reduce loading on filter.

5. Filter holder with glass fiber media.

6. Sample box - heated and maintained @ 250° F.

7. Impinger ice bath used for condensing out water and gaseous and particulate collection in bubblers and impinger.

8. Bubbler.

9. Impinger.

10. Bubbler.

11. Bubbler.

12. Thermometer.

13. Quick connect for sample box to umbilical cord.

14. Umbilical cord contains:
    a. Vacuum line from last impinger to meter box.
    b. Pitot tube lines.
    c. Electrical supply lines from meter box to sample box.

15. Quick connect from umbilical cord to meter box.

16. Vacuum gauge to indicate pressure build-up across filter.

17. Flow Control Valve.

18. Vacuum pump.

19. Dry gas meter.

20. Orifice meter to determine flow rate of gases through sampling train.

21. Manometer to record deflection for:
    a. Stack gas velocity.
    b. Sampling train flow rate.

22. "S" type pitot tube to measure stack gas velocity.

23. Meter box.

VALENTINE, FISHER & TOMLINSON ⊙ CONSULTING ENGINEERS

COMPUTATION & DESIGNING SHEET

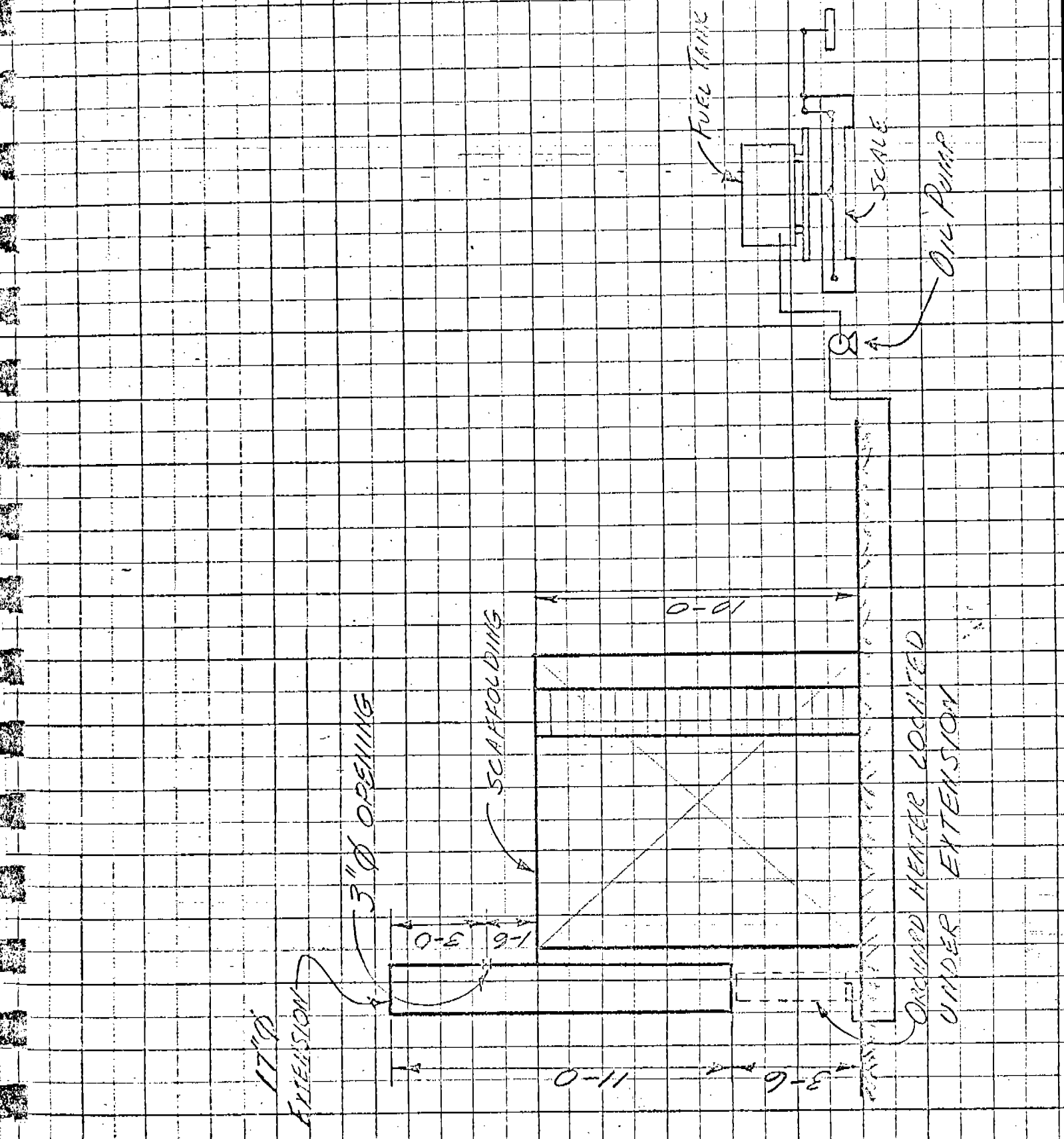
JOB NAME Ground Heater Exhaust Extension

DATE 1/17/80

PREPARED BY W.D. Simpson

PAGE 1 OF 1

SUBJECT Extension, Scaffolding, & Fuel Working Set-up



PART I

SUMMARY OF RESULTS

PROCESS EFFLUENT EVALUATION

1. CLIENT Manhasset Specialty Company
2. SAMPLE TAKEN AT Yakima, Washington
3. TYPE OF PROCESS Oil-Fired Orchard Heater - MASCO Junior
4. LOCATION OF PORT 5.3 Ø's prior and 2.1 Ø's after the sampling port consisted of straight unobstructed duct.
5. PROCESS RATE 0.78 gph = 0.10 lb/min of #2 fuel oil.
6. POLLUTANT(S) SAMPLED Particulates (Including condensible hydrocarbons)
7. TIME SAMPLE TAKEN:

   DATE 1-28-71 BEGIN 12:02 END 13:02
8. STACK FLOW RATE 532 scfm @ 60°F. 1 Atmosphere Pressure, Dry
9. WATER VAPOR IN STACK GAS (DRY-WET BULB) 2%
10. % ISOKINETIC SAMPLING FROM THE TRAIN* 100%
11. STANDARDIZED DRY GAS METER VOLUME 27.52 scf
    (60 °F. and 1 atmosphere pressure, dry)
12. LABORATORY DATA - TOTAL PARTICULATE 6.8 mg
13. PARTICULATE CONCENTRATION 0.004 grains/cubic foot
14. POLLUTANT MASS RATE 0.131 gm/minute
15.
16.
17.

*i.e. Ratio of velocity within nozzle to that of stack velocity x 100.

PART II

SUMMARY OF SAMPLE DATA

CLIENT Manhasset Specialty Company

DATE January 28, 1971 RUN NO. 1

1. SAMPLING NOZZLE DIAMETER 1/2 inch
2. SAMPLING TIME 60 Minutes
3. SAMPLE VOLUME @ METER CONDITIONS 29.40 acf
4. AVERAGE METER TEMPERATURE 83°F.
5. AVERAGE OFIFICE PRESSURE DROP 0.50" Water = 0.04" Hg.
6. BAROMETRIC PRESSURE 29.21" Hg.
7. CORRECTED METER PRESSURE 29.25" Hg.

VELOCITY TRAVERSE DURING SAMPLING

8. STACK AREA 1.576 FT^2
9. AVERAGE STACK PRESSURE 29.21" Hg.
10. AVERAGE STACK TEMPERATURE 153°F.
11. AVERAGE CORRECTED VELOCITY 6.81 fps

STACK MOISTURE CONTENT

12. % MOISTURE BY DRY-WET BULB AND PSYCHROMETRIC CHART 2%
13. % MOISTURE FROM TRAIN AND SILICA GEL = 0.05

GAS ANALYSIS

14. CARBON DIOXIDE %, BY VOLUME ON DRY BASIS 0.3
15. CARBON MONOXIDE, % BY VOLUME ON DRY BASIS 0.002% - 20 ppm
16. OXYGEN, % BY VOLUME ON DRY BASIS 20.7
17. NITROGEN, % BY VOLUME ON DRY BASIS 79.0
18. MOLECULAR WEIGHT OF STACK GASES (DRY) 28.87
19. AUXILIARY FUEL

VALENTINE, FISHER & TOMLINSON ◎ CONSULTING ENGINEERS

COMPUTATION & DESIGNING SHEET

JOB NAME MASCO JUNIOR ATMOSPHERIC EMISSION EVAL. DATE 2/1/71

PREPARED BY W.D. SAXMEN PAGE 1 OF 1

SUBJECT COMPUTER PRINTOUT OF EVALUATION CALCULATIONS

29.40	S	VOL_m	0.011	S	VH	2.7244263	A0	K_a
29.25	S	P_m	610	S	T_s			
520	S	T_{STD}	2.5903667	A0		0.85	S	C_p
543	S	T_m				6.8085732	A0	V_o
			0.010	S	VH	1.5762504	S	A_s
27.5242266	A0	VOL_{STD}	610	S	T_s			
			2.4698178	A0		643.9209720	A0	Q_o
0.05	S	VOL_w						
			0.012	S		520	S	T_{STD}
0.1813200	A0	M	620	S		613	S	T_s
			2.7276363	A0		29.21	S	P_{SN}
0.9981868	A0	MF						
28.87	S	W_D	0.015	S		532.3009352	A0	Q_{os}
			610	S				
28.8502905	A0	W_w	3.0248966	A0		613	S	T_s
						520	S	T_{STD}
1.0017265	A0	C_D	0.014	S		29.21	S	P_{SN}
29.21	S	P_{SN}	610	S		60	S	T
			2.9223278	A0		0.0013635	S	A_n
1.0120803	A0	C_s						
			0.011	S		6.7831707	A0	V_n
			620	S				
			2.6115129	A0		99.6269042	A0	I
						6.8	S	P_T
						0.0038046	A0	C_o
						12	S	N
						0.0038046	A0	C
						0.0173579	A0	PMR
						0.0173579		
						0.1321585		
						0.1313415	A0	PMR

(gm/sec

MASCO JUNIOR LABORATORY & TOTAL PARTICULATE RESULTS

I. LABORATORY RESULTS

CONTAINER	SAMPLE WEIGHTS	BLANK
A	0.1948 gm Final	
B	194 ml .0029 gm	150 ml .0010 gm
C	385 ml	380 ml
(Extraction)	0.0031 gm	.0024 gm
(Water Evap.)	0.0016 gm	.0005 gm
D	126 ml .0041 gm	

Blanks are as follows:

1. Acetone - 1.0 mg/150 ml = 0.67 mg/100 ml
2. Ether & Chloroform Extract = 2.4 mg (Constant as same quantity or ether & chloroform was used).
3. Water Evaporation = 0.5 mg/380 ml = 0.13 mg/100 ml.

II. TOTAL PARTICULATE

0.3 mg on filter
1.6 mg from cleaning nozzle, probe and cyclone (2.9 - 0.67 x 1.94)
0.5 mg from extraction (3.1 - 2.4)
1.1 mg from water evaporation (1.6 - 0.13 x 3.85)
3.3 mg from impinger acetone rinse (4.1 - 0.67 x 1.26)
6.8 mg Total Particulate

VALENTINE, FISHER & TOMLINSON
SEATTLE, WASHINGTON

CLIENT: Mannasset Specialty Co.
LOCATION: Yakima, Washington
DATE: January 28, 1971
OPERATOR/S: W.D. Snowden
RUN NO.: #1 - Light off @ 11:10
EQUIPMENT: VF&T - PHS Design
FILTER NO.: 4 - 0.1935 gm

PARTICULATE FIELD DATA

VERY IMPORTANT: FILL IN ALL BLANKS

AMBIENT TEMP.: 56 °F
BAR. PRESSURE: 29.21 "Hg
ASSUMED MOISTURE: 4.0
HEATER BOX SETTING: 300
PROBE NOZZLE DIA.: 1/2 In
PROBE LENGTH: 3 Ft. 0 In
PROBE HEATER SETTING: 85%

CLOCK TIME	DRY GAS METER (CUBIC FEET)	DRY GAS TEMP. (°F) INLET	DRY GAS TEMP. (°F) OUTLET	PUMP VACUUM ("Hg Ga.)	BOX TEMP. (°F)	IMPINGER TEMP. (°F)	POINT	PITOT Δ P ("H_2O)	ORIFICE Δ H ("H_2O) DESIRED	ORIFICE Δ H ("H_2O) ACTUAL	STACK PRESS ("Hg)	STACK TEMP. (°F)	OPACITY
12:02	472.97	59	59	2.5	250	50	1	0.011	0.44	✓	Atm	150	0
12:12	477.55	65	63	3.0	"	55	2	0.010	0.42	✓	"	150	0
12:22	481.61	75	70	3.5	"	56	3	0.012	0.46	✓	"	163	0
12:32	486.28	85	78	4.0	"	60	4	0.015	0.66	✓	"	150	0
12:42	490.90	95	90	5.0	"	62	5	0.014	0.56	✓	"	150	0
12:52	497.11	105	98	5.0	"	65	6	0.011	0.45	✓	"	160	0
13:02	502.27	110	104	5.0	"	68							
60 min													
TOTAL	29.46	11	61						2.94			920	
AVERAGE		83	543°F						0.498			153	

0.04" Hg = 29.25" Hg

613°R

REMARKS: New heater when cut off @ 11:10 AM
Heater shut-down @ 13:40

V.F.T./AP1.B

PART IV

VALENTINE, FISHER & TOMLINSON
VELOCITY TRAVERSE DATA SHEET

CLIENT Manhasset Specialty Company

DATE 1-28-71 TIME 12:02-13:02 RUN NO. 1

SAMPLING PORT LOCATION 5.3 D's after inlet & 2.1 D's before outlet

STACK AREA, FT.^{2} 1.576 FT^2

REFERENCE POINT Stack Wall

OPERATOR W.D. Snowden

TYPE PITOT TUBE USED "S" w/ Cp = 0.85

BAROMETRIC PRESSURE 29.21 "Hg

STATION	DIST. FROM REF. PT.	VH ("H_2O)	STACK TEMP(°F)	T_S (°R)	STACK PRESS. ("Hg)	VH x T_S	$\sqrt{VH \times T_S}$
1	3/4	0.011	150	610	ATM		
2	3 3/8	0.015	150	610	"		
3	6 3/4	0.012	160	620	"		
4	11 1/4	0.015	150	610	"		
5	13 5/8	0.014	150	610	"		
6	15 1/4	0.011	160	620	"		
AVERAGES							

*"P" type pitot tube velocity read from velocity tables at stack temperature and vel. head values using the following equation (Ref. Western Precipitation Bulletin WP50):

$$V = 2.9\sqrt{(VH \times T_S)}\ \text{avg.}$$

T_S = Absolute Stack Temperature, °R
VH = Velocity Head, in.H_2O
V = Point Velocity (fps)

Velocity correction for; "S" type pitot tube = 0.855 x "P" type, gas density = $\sqrt{(28.95\ \text{lb/lb mole})_{air}/\text{Mol. Wt. Stack Gas}}$, Stack Pressure Correction = $\sqrt{29.92\text{"Hg./Stack Pressure.}}$

VFT/AP2A

PART VII

VALENTINE, FISHER & TOMLINSON

ORSAT DATA AND CALCULATION SHEET

CLIENT Hanifasset Specialty Company

Sampling point location @ Velocity Readings Port

Date 1-28-71 Time 12:02 - 13:30 Run No. 1

		Analysis 1 *	Analysis 2 **	Analysis 3	Avg	x = mole.wt	wt/mole (dry)
CO_2	% vol (dry)	0.3	0.3	0.3	0.3	44/100	0.13
CO	% vol (dry)		20ppm		0.0	28/100	+ 0.00
O_2	% vol (dry)				20.7	32/100	+ 6.62
N_2	% vol (dry)				79.0	28/100	+22.12
					M = Avg molecular wt of dry stack gas=		28.87

* Bacharach Fyrite Reading

** Detector Tube Readings

Date _____ Time _____ Run No. _____

Sampling point location _____

		Analysis 4	Analysis 5	Analysis 6	Avg	x = mole wt	wt/mole (dry)
CO_2	% vol (dry)					44/100	
CO	% vol (dry)					28/100	+
O_2	% vol (dry)					32/100	+
N_2	% vol (dry)					28/100	+
					M = Avg molecular wt of dry stack gas =		

PART VI

STACK MOISTURE CONTENT DATA AND CALCULATIONS

CLIENT Monsanto Specialty Co.

LOCATION Yakima Washington

DATE 1-28-71

			RUN NO.		
H_2O CONDENSED IN IMPINGERS	Final	189.0 ml.	-11.0		
	Initial	200.6			
	Diff.	-11.0 ml.			
H_2O ABSORBED BY SILICA GEL	Final	707.9 gm.	+12.1		
	Initial	695.8			
	Diff.	12.1 gm.			
TOTAL H_2O COLLECTED; ml			1.1		
VOL. OF H_2O VAPOR @ 60 F. AND 1 ATM. = 0.0465 x TOTAL H_2O			0.05		
MOISTURE IN STACK GAS, %					
MOLE FRACTION OF DRY GAS					
MOLECULAR WT. OF STACK GAS					

$$\% \text{ MOISTURE IN STACK GAS} = \frac{100 \times \text{VOL. } H_2O \text{ VAPOR}}{\text{VOL. DRY GAS} + \text{VOL. WET GAS}}$$

$$\text{MOLE FRACTION OF DRY GAS} = \frac{100 - \% \text{ MOISTURE IN STACK GAS}}{100}$$

MOLECULAR WT. OF STACK GAS = AVG. DRY MOL. WT. OF GAS x MOLE FRACTION + 18 x (1-MOLE FRACTION)

VALENTINE, FISHER & TOMLINSON ◎ CONSULTING ENGINEERS

COMPUTATION & DESIGNING SHEET

JOB NAME "MASCO Junior" Emission Evaluation DATE 2/2/71

PREPARED BY W.D. Snowden PAGE ____ OF ____

SUBJECT Efficiency of Combustion Calculation

Burning Rate = 0.78 gph × 7.7 LB/gal = 6.0 LB/HR

= 0.100 LB fuel oil/min

Sct Air Reqd = (185 FT³/LB)(0.100 LB/min) = 18.5 scfm

∴ Times Excess Air = 532/18.5 = 28.8

% CO_2 @ Port = (0.3 ± 0.1) × 28.8 = 8.6 % ± 2.9

Efficiency of Combustion = $\frac{8.6 \pm 2.9}{16} \times 100$

= 54% ± 18%

= 72%

High point of range selected as little or no filter discoloration or weight gain was found indicating higher efficiency. Range of accuracy was set @ ± 0.1% CO_2 because detector tubes and Bacharach "Fyrite" were used to determine the CO_2 value.

ATMOSPHERIC EMISSION EVALUATION

MASCO JUNIOR

OIL-FIRED ORCHARD HEATER

Manhasset Specialty Co.
Yakima, Washington

PREPARED BY

VALENTINE, FISHER & TOMLINSON
Consulting Engineers
520 Lloyd Building
Seattle, Washington 98101
(206) 623-0717

February 8, 1971

VALENTINE, FISHER & TOMLINSON
CONSULTING ENGINEERS
A.S.H.R.A.E., A.A.A.E., S.A.M.E., I.E.S.
520 LLOYD BUILDING • MAIN 3-0717
SEATTLE, WASHINGTON 98101

WM. M. VALENTINE, M.E.
ARTHUR K. FISHER, M.E.
GEORGE D. TOMLINSON, E.E.

ASSOCIATES:
WAYNE A. HANSON, M.E.
P. "CHIC" CICCHETTI
DOUGLAS W. PASCOE, E.E.
PHILIP W. WOODRUFF
DENNIS W. FINLAYSON
HENRY L. ROYCE, ILLUM.
THOMAS G. JOHNS, M.E.
WILLIAM T. McDONALD
DEAN A. HANNIG

PURPOSE

The purpose of this report is to determine the concentration of particulate matter emitted from the MASCO Junior Orchard Heater manufactured by Manhasset Specialty Company of Yakima, Washington.

SUMMARY

The stack gas sample was found to have a weight rate emission of 0.131 gm/min. 0.78 gpm of #2 Diesel oil at 125 psi was burned during the evaluation.

PROCEDURE

A 17" diameter stack extension was erected above the heater to enable combustion to cease and establish straight line flow at the point of sampling. The "MASCO Junior" heater was placed about 3 inches below the inlet to the stack extension.

The "MASCO Junior" heater was 21 inches high including the cap and 9 inches in diameter. The oil was fed into the heater by a nozzle operating at 125 psi and passing 0.78 gallons per hour.

The particulate sample (solids and condensible hydrocarbons) was collected with a stack gas sampling train and procedures designed by the National Air Pollution Control Administration (NAPCA). The train is designed to maintain the velocity of the gas entering the nozzle equal to the velocity of the stack gas around the nozzle. Percent isokinetic is defined as 100 times the ratio of the velocity of the gas entering the nozzle to the gas around the nozzle. The NAPCA train will collect samples within ±10% isokinetic to insure that all particles approaching the nozzle will be collected

A NAPCA nomograph was used to establish the sampling train flow rate. A 0.50 inch diameter nozzle was selected and the nomograph used to establish a train fl rate of 0.5 cubic feet per minute or greater depending upon the sampling locatio The sample was collected on January 26, 1971 at 99+% isokinetic.

The true stack velocity was calculated from the velocity readings taken during sampling. The sample was collected through a button-hook nozzle, glass-lined probe (integral with the pitot tube and the combination referred to as a pitobe). The solid particulates from the stack gas were collected on a heated glass fiber filter mat in the first section of the sample box. A 250° F. temperature was maintained in the sample box to prevent water condensation on the filter and filter plugging. An ice bath following the filter contained a bubbler with 100 ml of deionized distilled water, an impinger with 100 ml of the same water, a dry bubbler, and a bubbler containing a weighed amount of silica gel respectively. The impinger and bubblers were used to collect any particulate carry-over through the filter and to cool the 250°F. gases for condensation of water and condensible hydrocarbons.

Anaylsis for stack gas carbon dioxide concentration was performed with a Bacharac "Fryrite" absorption instrument and "Unico" detector tube adsorption instrument. The accuracy of the combination instruments was set at ± 0.1%. Carbon Monoxide was measured by detector tube because of the very low concentration. Oxygen was assumed to be the difference between 100% - assumed % nitrogen - % carbon dioxide % carbon monoxide. The gas samples were used to determine the molecular weight of the gas.

CLEAN-UP AND ANALYSIS

Clean-up was performed by first carefully removing the filter and placing it in a container marked "Run X, Container A." Reagent acetone and brushes were used to clean the nozzle, glass probe and cyclone. The acetone wash was placed in a container marked "Run X, Container B.". The volume of water in the impinger and bubblers was measured to the nearest 0.1 milliliters. The original volume of 200 milliliters was subtracted and the difference plus the water weight added to the silica gel was considered as the amount of water collected during the run. The water from the impinger and the water rinse of the impinger, bubblers and connectors were placed in one container marked "Run X, Container C." An acetone rinse of the impinger, bubblers and all connectors was performed and placed in a container marked "Run X, Container D." The silica gel was weighed within the bubbler before and after the run.

Analysis of the samples in each container was performed according to the following "Specification" or equivalent procedures:

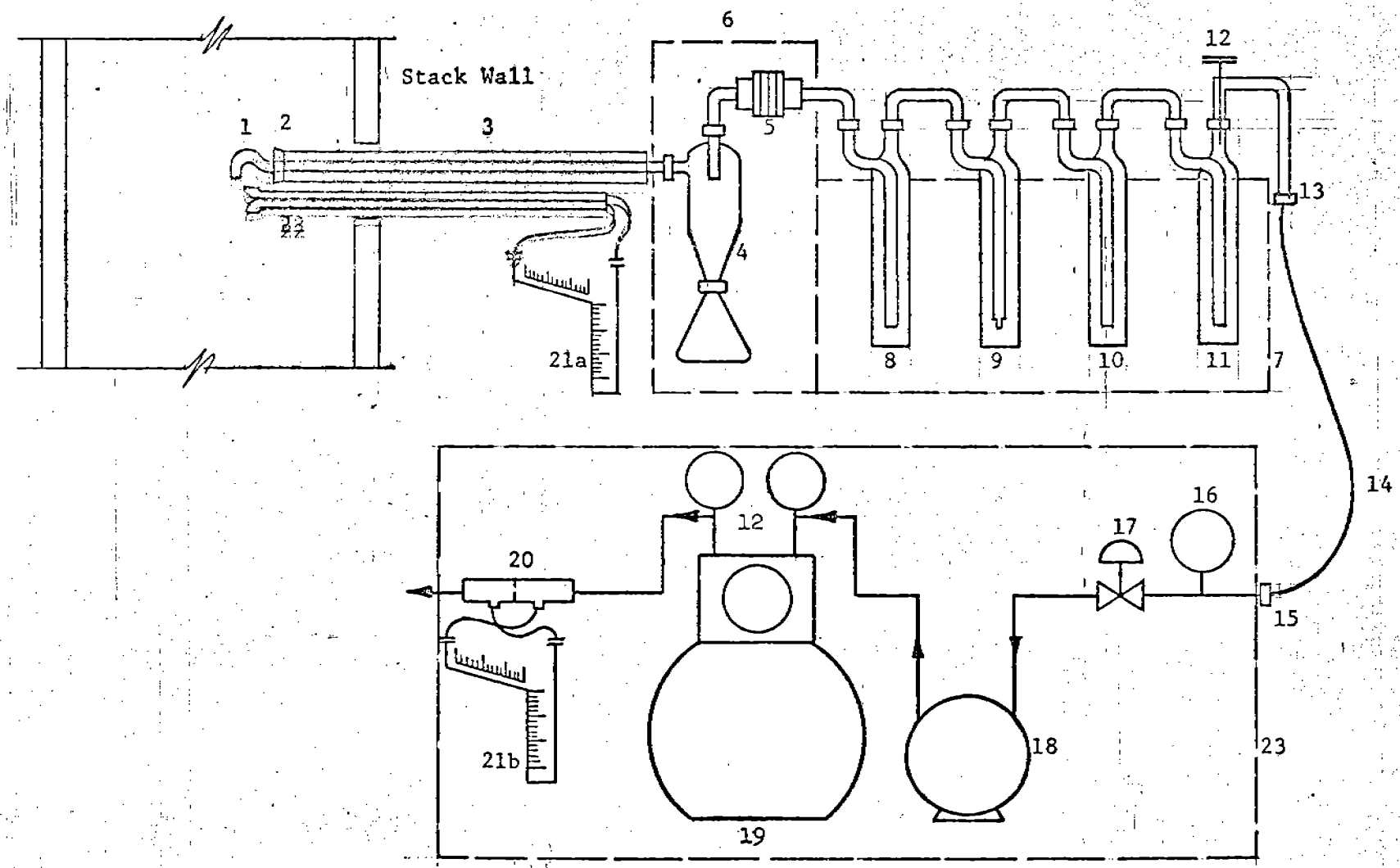
Run X, Container A - Transfer the filter and any loose particulate from the sample container to a tared glass weighing dish and desiccate for 24 hours in a desiccator or constant humidity chamber containing a saturated solution of calcium chloride or its equivalent. Weigh to a constant weight and report the results to the nearest 0.1 milligram.

Run X, Container B - Measure the volume to the nearest 0.1 milliliter. Transfer acetone washings from container into a tared beaker and evaporate to dryness at ambient temperature and pressure. Desiccate for 24 hours and weigh to a constant weight. Report the result to the nearest 0.1 milligram.

Run X, Container C - Measure the volume to the nearest 0.1 milliliter. Extract organic particulate from the water solution with three 25 milliliter portions of chloroform and three 25 milliliter portions of ethyl ether. Combine the ether and chloroform extracts and transfer to a tared beaker. Evaporate until no solvent remains at about 70°F. This can be accomplished by blowing air that has been filtered through activated charcoal over the sample. Desiccate for 24 hours and weigh to a constant weight. Report the results to the nearest 0.1 milligram. After the extraction, evaporate the remaining water to dryness and report the results to the nearest 0.1 milligram.

Run X, Container D - Measure the volume to the nearest 0.1 milliliter. Transfer the acetone washings to a tared beaker and evaporate to dryness at ambient temperature and pressure. Desiccate for 24 hours and weigh to a constant weight. Report the results to the nearest 0.1 milligram.

Blanks were taken on the acetone, ether, chloroform, and deionized water and subtracted from the respective sample volumes. The filter paper used was a Mine Safety Appliance 1106 BH, heat treated glass fiber mat.



VALENTINE, FISHER & TOMLINSON · STACK GAS SAMPLING TRAIN

SAMPLING TRAIN COMPONENTS

1. Sampling nozzle - button hook to prevent moisture from draining back into stack and to allow insertion through 2-1/2" port.
2. Quick connect for changing to different size nozzles.
3. Stainless steel probe with glass interliner wrapped with heating wire to maintain a 250° F. temperature for retarding condensation.
4. Sampling cyclone to catch large particles and reduce loading on filter.
5. Filter holder with glass fiber media.
6. Sample box - heated and maintained @ 250° F.
7. Impinger ice bath used for condensing out water and gaseous and particulate collection in bubblers and impinger.
8. Bubbler.
9. Impinger.
10. Bubbler.
11. Bubbler.
12. Thermometer.
13. Quick connect for sample box to umbilical cord.
14. Umbilical cord contains:
    a. Vacuum line from last impinger to meter box.
    b. Pitot tube lines.
    c. Electrical supply lines from meter box to sample box.
15. Quick connect from umbilical cord to meter box.
16. Vacuum gauge to indicate pressure build-up across filter.
17. Flow Control Valve.
18. Vacuum pump.
19. Dry gas meter.
20. Orifice meter to determine flow rate of gases through sampling train.
21. Manometer to record deflection for:
    a. Stack gas velocity.
    b. Sampling train flow rate.
22. "S" type pitot tube to measure stack gas velocity.
23. Meter box.

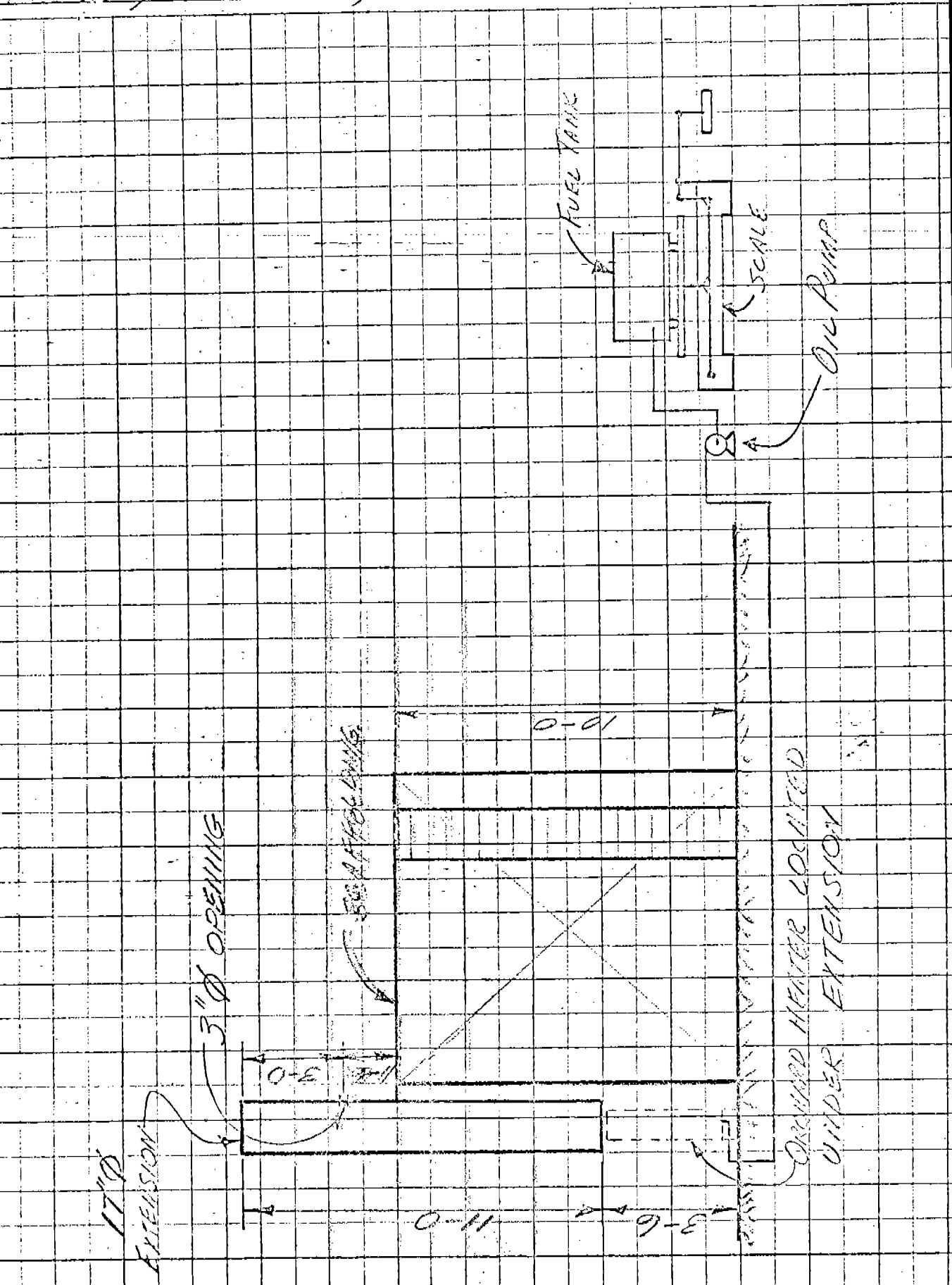
VALENTINE, FISHER & TOMLINSON ⊙ CONSULTING ENGINEERS

COMPUTATION & DESIGNING SHEET

JOB NAME Oxford Heated Effluent Extension DATE 1/17/70

PREPARED BY W.D. Shannon PAGE 1 OF 1

SUBJECT Section, Sequence, & Fuel Weighing Set-up



PART I

SUMMARY OF RESULTS

PROCESS EFFLUENT EVALUATION

1. CLIENT Manhasset Specialty Company
2. SAMPLE TAKEN AT Yakima, Washington
3. TYPE OF PROCESS Oil-Fired Orchard Heater - MASCO Junior
4. LOCATION OF PORT 5.3 Ø's prior and 2.1 Ø's after the sampling port consisted of straight unobstructed duct.
5. PROCESS RATE 0.78 gph = 0.10 lb/min of #2 fuel oil.
6. POLLUTANT(S) SAMPLED Particulates (Including condensible hydrocarbons)
7. TIME SAMPLE TAKEN:

   DATE 1-28-71 BEGIN 12:02 END 13:02
8. STACK FLOW RATE 532 scfm @ 60°F. 1 Atmosphere Pressure, Dry
9. WATER VAPOR IN STACK GAS (DRY-WET BULB) 2%
10. % ISOKINETIC SAMPLING FROM THE ~~CHAIN~~* 100%
11. STANDARDIZED DRY GAS METER VOLUME 27.52 scf
    (60 °F. and 1 atmosphere pressure, dry)
12. LABORATORY DATA - TOTAL ~~PARTICULATE~~ 6.8 mg
13. PARTICULATE CONCENTRATION 0.004 grains/cubic foot
14. POLLUTANT MASS RATE 0.131 gm/minute
15.
16.
17.

*i.e. Ratio of velocity within nozzle to that of stack velocity x 100.

PART II

SUMMARY OF SAMPLE DATA

CLIENT Manhasset Specialty Company

DATE January 28, 1971 RUN NO. 1

1. SAMPLING NOZZLE DIAMETER 1/2 inch
2. SAMPLING TIME 60 Minutes
3. SAMPLE VOLUME @ METER CONDITIONS 29.40 acf
4. AVERAGE METER TEMPERATURE 83°F.
5. AVERAGE OFIFICE PRESSURE DROP 0.50" Water = 0.04" Hg.
6. BAROMETRIC PRESSURE 29.21" Hg.
7. CORRECTED METER PRESSURE 29.25" Hg.

VELOCITY TRAVERSE DURING SAMPLING

8. STACK AREA 1.576 FT^2
9. AVERAGE STACK PRESSURE 29.21" Hg.
10. AVERAGE STACK TEMPERATURE 153°F.
11. AVERAGE CORRECTED VELOCITY 6.81 fps

STACK MOISTURE CONTENT

12. % MOISTURE BY DRY-WET BULB AND PSYCHROMETRIC CHART 2%
13. % MOISTURE FROM TRAIN AND SILICA GEL = 0.05

GAS ANALYSIS

14. CARBON DIOXIDE %, BY VOLUME ON DRY BASIS 0.3
15. CARBON MONOXIDE, % BY VOLUME ON DRY BASIS 0.002% - 20 ppm
16. OXYGEN, % BY VOLUME ON DRY BASIS 20.7
17. NITROGEN, % BY VOLUME ON DRY BASIS 79.0
18. MOLECULAR WEIGHT OF STACK GASES (DRY) 28.87
19. AUXILIARY FUEL

VALENTINE, FISHER & TOMLINSON ● CONSULTING ENGINEERS

COMPUTATION & DESIGNING SHEET

JOB NAME MASCO Junior Atmospheric Emission Eval. DATE 2/1/71

PREPARED BY W. D. Snowden PAGE 1 OF 1

SUBJECT Computer Printout of Evaluation Calculations

29.40	S	VOL_m	0.011	S	VH	2.7244263	A0	K_a
29.25	S	P_m	610	S	T_s			
520	S	T_{STD}	2.5903667	A0		0.85	S	C_p
543	S	T_m				6.8085732	A0	V_o
			0.010	S	VH	1.5762504	S	A_s
27.5242266	A0	VOL_{STD}	610	S	T_s			
			2.4698178	A0		643.9209720	A0	Q_o
0.05	S	VOL_w						
			0.012	S		520	S	T_{STD}
0.1813200	A0	M	620	S		613	S	T_s
			2.7276363	A0		29.21	S	P_{SN}
0.9981668	A0	MF						
28.87	S	W_D	0.015	S		532.3009352	A0	Q_{os}
			610	S				
28.8502905	A0	W_w	3.0248966	A0		613	S	T_s
						520	S	T_{STD}
1.0017265	A0	C_D	0.014	S		29.21	S	P_{SN}
29.21	S	P_{SN}	610	S		60	S	T
			2.9223278	A0		0.0013635	S	A_n
1.0120803	A0	C_s						
			0.011	S		6.7831707	A0	V_n
			620	S				
			2.6115129	A0		99.6269042	A0	I
						6.8	S	P_T
						0.0038046	A0	C_o
						12	S	N
						0.0038046	A0	C
						0.0173579	A0	PMR
						0.0173579		
						0.1321585		
						0.1313415	A0	PMR

(gm/

MASCO JUNIOR LABORATORY & TOTAL PARTICULATE RESULTS

I. LABORATORY RESULTS

CONTAINER	SAMPLE WEIGHTS	BLANK
A	0.1948 gm Final	
B	194 ml .0029 gm	150 ml .0010 gm
C	385 ml	380 ml
(Extraction)	0.0031 gm	.0024 gm
(Water Evap.)	0.0016 gm	.0005 gm
D	126 ml .0041 gm	

Blanks are as follows:

1. Acetone - 1.0 mg/150 ml = 0.67 mg/100 ml
2. Ether & Chloroform Extract = 2.4 mg (Constant as same quantity or ether & chloroform was used).
3. Water Evaporation = 0.5 mg/380 ml = 0.13 mg/100 ml.

II. TOTAL PARTICULATE

0.3 mg on filter
1.6 mg from cleaning nozzle, probe and cyclone (2.9 - 0.67 x 1.94)
0.5 mg from extraction (3.1 - 2.4)
1.1 mg from water evaporation (1.6 - 0.13 x 3.85)
3.3 mg from impinger acetone rinse (4.1 - 0.67 x 1.26)
6.8 mg Total Particulate

VALENTINE, FISHER & TOMLINSON
SEATTLE, WASHINGTON

CLIENT: Mashasset Specialt Co.
LOCATION: Yakima, Washington
DATE: January 28, 1971
OPERATOR/S: W.D. Snowden
RUN NO.: #1 - Light off @ 11:10
EQUIPMENT: VF&T - PHS Design
FILTER NO.: 4 - 0.1935 gm

PARTICULATE FIELD DATA

VERY IMPORTANT: FILL IN ALL BLANKS

AMBIENT TEMP.: 56 °F
BAR. PRESSURE: 29.21 "
ASSUMED MOISTURE: 4.0
HEATER BOX SETTING: 300
PROBE NOZZLE DIA.: 1/2 In
PROBE LENGTH: 3 Ft. 0 In
PROBE HEATER SETTING: 85%

CLOCK TIME	DRY GAS METER (CUBIC FEET)	DRY GAS TEMP. (°F) INLET	DRY GAS TEMP. (°F) OUTLET	PUMP VACUUM ("Hg Ga.)	BOX TEMP. (°F)	IMPINGER TEMP. (°F)	POINT	PITOT Δ P ("H_2O)	ORIFICE Δ H ("H_2O) DESIRED	ORIFICE Δ H ("H_2O) ACTUAL	STACK PRESS. ("Hg)	STACK TEMP. (°F)	OPACITY
12:02	472.37	59	59	2.5	250	50	1	0.011	0.44	✓	Atm	150	0
12:12	477.55	65	63	3.0	"	55	2	0.010	0.42	✓	"	150	0
12:22	481.61	75	70	3.5	"	56	3	0.012	0.46	✓	"	160	0
12:32	486.28	85	78	4.0	"	60	4	0.015	0.66	✓	"	150	0
12:42	490.90	95	90	5.0	"	62	5	0.014	0.56	✓	"	150	0
12:52	497.11	105	98	5.0	"	65	6	0.011	0.45	✓	"	160	0
13:02	502.27	110	104	5.0	"	68							
60 MIN													
TOTAL	29.40	11	61						2.99			920	
AVERAGE		83	543°F						0.498			153	

0.04" Hg = 29.25" Hg

613°R

REMARKS: New heater when cit off @ 11:10 AM
Heater shut-down @ 13:40

V.F.T./AP13

PART IV

VALENTINE, FISHER & TOMLINSON
VELOCITY TRAVERSE DATA SHEET

CLIENT Manhasset Specialty Company

DATE 1-28-71 TIME 12:02-13:02 RUN NO. 1

SAMPLING PORT LOCATION 5.30's after inlet & 2.10's before outlet

STACK AREA, FT.^{2} 1.576 FT^2

REFERENCE POINT Stack Wall

OPERATOR W.D. Snowden

TYPE PITOT TUBE USED "S" w/ Cp = 0.85

BAROMETRIC PRESSURE 29.21 "Hg

STATION	DIST. FROM REF. PT.	VH ("H_2O)	STACK TEMP(°F)	T_S (°R)	STACK PRESS. ("Hg)	VH x T_S	$\sqrt{VH \times T_S}$
1	3/4	0.011	150	610	ATM		
2	3 3/8	0.010	150	610	"		
3	4 3/4	0.012	160	620	"		
4	11 1/8	0.015	150	610	"		
5	13 5/8	0.014	150	610	"		
6	15 1/4	0.011	160	620	"		
AVERAGES							

*"P" type pitot tube velocity read from velocity tables at stack temperature and vel. head values using the following equation (Ref. Western Precipitation Bulletin WP50):

$$V = 2.9\sqrt{(VH \times T_S)_{avg.}}$$

T_S = Absolute Stack Temperature, °R
VH = Velocity Head, in.H_2O
V = Point Velocity (fps)

Velocity correction for; "S" type pitot tube = 0.855 x "P" type, gas density = $\sqrt{(28.95 \text{ lb/lb mole})_{air}/\text{Mol. Wt. Stack Gas}}$, Stack Pressure Correction = $\sqrt{29.92\text{"Hg.}/\text{Stack Pressure.}}$

VFT/AP2A

PART VII

VALENTINE, FISHER & TOMLINSON
ORSAT DATA AND CALCULATION SHEET

CLIENT Hammermill Specialty Company

Sampling point location @ Velocity Reading Port

Date 1-28-71 Time 12:02 - 13:30 Run No. 1

		Analysis 1 *	Analysis 2 **	Analysis 3	Avg	x = mole.wt	wt/mole (dry)
CO_2	% vol (dry)	0.3	0.3	0.3	0.3	44/100	0.13
CO	% vol (dry)		20ppm		0.0	28/100	+ 0.00
O_2	% vol (dry)				20.7	32/100	+ 6.62
N_2	% vol (dry)				79.0	28/100	+22.12
					M = Avg molecular wt of dry stack gas=		28.87

* Bacharach Fyrite Reading
** Detector Tube Readings

Date _____ Time _____ Run No. _____

Sampling point location _____

		Analysis 4	Analysis 5	Analysis 6	Avg	x = mole wt	wt/mole (dry)
CO_2	% vol (dry)					44/100	
CO	% vol (dry)					28/100	+
O_2	% vol (dry)					32/100	+
N_2	% vol (dry)					28/100	+
					M = Avg molecular wt of dry stack gas =		

VFT/AP4

PART VI

STACK MOISTURE CONTENT DATA AND CALCULATIONS

CLIENT Hooker Specialty Co.

LOCATION Yakima Washington

DATE 1-28-71

			RUN NO.		
			1		
H_2O CONDENSED IN IMPINGERS	Final	189.0 ml.			
	Initial	250.6	-11.0		
	Diff.	-11.0 ml.			
H_2O ABSORBED BY SILICA GEL	Final	707.9 gm.			
	Initial	696.8	+12.1		
	Diff.	12.1 gm.			
TOTAL H_2O COLLECTED; ml			1.1		
VOL. OF H_2O VAPOR @ 60 F. AND 1 ATM. = 0.0485 x TOTAL H_2O			0.05		
MOISTURE IN STACK GAS, %					
MOLE FRACTION OF DRY GAS					
MOLECULAR WT. OF STACK GAS					

$$\% \text{ MOISTURE IN STACK GAS} = \frac{100 \times \text{VOL. } H_2O \text{ VAPOR}}{\text{VOL. DRY GAS + VOL. WET GAS}}$$

$$\text{MOLE FRACTION OF DRY GAS} = \frac{100 - \% \text{ MOISTURE IN STACK GAS}}{100}$$

MOLECULAR WT. OF STACK GAS = AVG. DRY MOL. WT. OF GAS x MOLE FRACTION + 18 x (1-MOLE FRACTION)

VALENTINE, FISHER & TOMLINSON ⊙ CONSULTING ENGINEERS

COMPUTATION & DESIGNING SHEET

JOB NAME "MASCO JUNIOR" EMISSION EVALUATION DATE 2/2/71

PREPARED BY W.P. SNODGEN PAGE ____ OF ____

SUBJECT EFFICIENCY OF COMBUSTION CALCULATION

BURNING RATE = 0.78 gph × 7.7 LB/gal = 6.0 LB/HR

= 0.100 LB FUEL OIL/MIN

SCF AIR REQ'D = (185 FT³/LB)(0.100 LB/MIN) = 18.5 SCFM

∴ TIMES EXCESS AIR = 532/18.5 = 28.8

% CO_2 @ PORT = (0.3 ± 0.1) × 28.8 = 8.6 % ± 2.9

EFFICIENCY OF COMBUSTION = $\frac{8.6 \pm 2.9}{16} \times 100$

= 54 % ± 18 %

= 72% ←

HIGH POINT OF RANGE SELECTED AS LITTLE OR NO FILTER DISCOLORATION OR WEIGHT GAIN WAS FOUND INDICATING HIGHER EFFICIENCY. RANGE OF ACCURACY WAS SET @ ± 0.1% CO_2 BECAUSE DETECTOR TUBES AND BACHARACH "FYRITE" WERE USED TO DETERMINE THE CO_2 VALUE.

PART I

SUMMARY OF RESULTS

ORCHARD HEATER EFFLUENT EVALUATION

1. CLIENT Spot Heaters (nozzle fired return stack model)
2. SAMPLE TAKEN AT Yakima, Washington
3. TYPE OF OPERATION Nozzle fired oil orchard heater
4. LOCATION OF PORT 5.3 diameters upstream and 2.1 diameters downstream of stack inlet and outlet
5. FUEL BURNED AT RATE 6.24 lb/hr of 7.13 lb/gal. fuel oil
6. POLLUTANT(S) SAMPLED Particulates, carbon dioxide, oxygen, carbon monoxide
7. TIME SAMPLE TAKEN:

   DATE 1/7/70 BEGIN 11:15 AM END 11:57 AM
8. STACK FLOW RATE 448 acfm @ 70° F., 1 atm. press., and dry
9. WATER VAPOR IN STACK GAS (DRY-WET BULB) 4% by volume
10. % ISOKINETIC SAMPLING FROM THE TRAIN* 83.5%
11. STANDARDIZED DRY GAS METER VOLUME 13.45 scf
    (70° F. and 1 atmosphere pressure)
12. LABORATORY DATA - TOTAL PARTICULATE 1.3 mg
13. PARTICULATE CONCENTRATION IN SAMPLING TRAIN 0.0965 mg/scf
14. PARTICULATE MASS RATE 0.043 gm/min
15. EXCESS AIR AT SAMPLING PORT 23.3 times (theoretical)
16. CARBON DIOXIDE CALCULATED AT HEATER OUTLET 15.2%
17. EFFICIENCY OF COMBUSTION 90%

*i.e. Ratio of velocity within nozzle to that of stack velocity x 100.

PART II

SUMMARY OF SAMPLE DATA

CLIENT Spot Heaters (nozzle fired return stack model)

DATE 1/7/70 RUN NO. - 3

1. SAMPLING NOZZLE DIAMETER 1/2"
2. SAMPLING TIME 42 min.
3. SAMPLE VOLUME @ METER CONDITIONS 13.04 cu.ft.
4. AVERAGE METER TEMPERATURE 42° F.
5. AVERAGE ORIFICE PRESSURE DROP 0.28" water
6. BAROMETRIC PRESSURE 29.20" Hg

VELOCITY TRAVERSE DURING SAMPLING

7. STACK AREA 1.575 $ft.^2$
8. AVERAGE STACK PRESSURE atmospheric
9. AVERAGE STACK TEMPERATURE 172° F.
10. AVERAGE $\sqrt{\text{VELOCITY HEAD}}$ 0.0967

STACK MOISTURE CONTENT

11. % MOISTURE BY DRY-WET BULB AND PSYCHROMETRIC CHART 4% by volume

ORSAT ANALYSIS

12. CARBON DIOXIDE, % BY VOLUME ON DRY BASIS 0.65 (6500 ppm by Vol.)
13. CARBON MONOXIDE, % BY VOLUME ON DRY BASIS 0.25 (2500 ppm by Vol.)
14. OXYGEN, % BY VOLUME ON DRY BASIS 19.30 (193,000 ppm by Vol.)
15. NITROGEN, % BY VOLUME ON DRY BASIS 79.80 (798,000 ppm by Vol.)
16. MOLECULAR WEIGHT OF STACK GASES (DRY) 28.85 lb/lb, mole

PART I

SUMMARY OF RESULTS

ORCHARD HEATER EFFLUENT EVALUATION

1. CLIENT Flodin, Inc., P.O. Box 418, Sunnyside, Washington 98944
2. SAMPLE TAKEN AT Yakima, Washington
3. TYPE OF OPERATION Nozzle fired oil orchard heater
4. LOCATION OF PORT 5.3 diameters upstream and 2.1 diameters downstream from inlet and outlet of stack extension
5. FUEL BURNED AT RATE 5.23 lb/hr. of 7.31 lb/gal oil
6. POLLUTANT(S) SAMPLED Particulates, carbon dioxide, oxygen, carbon monoxide
7. TIME SAMPLE TAKEN:

   DATE 1/9/70 BEGIN 9:28 AM END 11:11 AM
8. STACK FLOW RATE 437 scfm @ 70° F., 1 atm. press. and dry
9. WATER VAPOR IN STACK GAS (DRY-WET BULB) 4% by volume
10. % ISOKINETIC SAMPLING FROM THE TRAIN* 91.5%
11. STANDARDIZED DRY GAS METER VOLUME (70° F. and 1 atmosphere pressure) 14.61 scf
12. LABORATORY DATA - TOTAL PARTICULATE 2.2 mg
13. PARTICULATE CONCENTRATION IN SAMPLING TRAIN 0.151 mg/scf
14. PARTICULATE MASS RATE 0.066 gm/min
15. EXCESS AIR AT SAMPLING PORT 27 times (theoretical)
16. CARBON DIOXIDE CALCULATED AT HEATER OUTLET 12%
17. EFFICIENCY OF COMBUSTION 75%

*i.e. Ratio of velocity within nozzle to that of stack velocity x 100.

PART II

SUMMARY OF SAMPLE DATA

CLIENT Flodin, Inc., P.O. Box 418, Sunnyside, Washington 98944

DATE 1/10/70 RUN NO. 1

1. SAMPLING NOZZLE DIAMETER 1/2"
2. SAMPLING TIME 42 min.
3. SAMPLE VOLUME @ METER CONDITIONS 14.92 cf
4. AVERAGE METER TEMPERATURE 57° F.
5. AVERAGE ORIFICE PRESSURE DROP 0.25" water
6. BAROMETRIC PRESSURE 28.55" Hg

VELOCITY TRAVERSE DURING SAMPLING

7. STACK AREA 1.575 $ft.^2$
8. AVERAGE STACK PRESSURE atmospheric
9. AVERAGE STACK TEMPERATURE 147° F.
10. AVERAGE $\sqrt{\text{VELOCITY HEAD}}$ 0.089

STACK MOISTURE CONTENT

11. % MOISTURE BY DRY-WET BULB AND PSYCHROMETRIC CHART 3.8% by volume

ORSAT ANALYSIS

12. CARBON DIOXIDE, % BY VOLUME ON DRY BASIS 0.5%
13. CARBON MONOXIDE, % BY VOLUME ON DRY BASIS 0.6%
14. OXYGEN, % BY VOLUME ON DRY BASIS 20.0%
15. NITROGEN, % BY VOLUME ON DRY BASIS 78.9%
16. MOLECULAR WEIGHT OF STACK GASES (DRY) 28.99 lb/lb mole

PART I

SUMMARY OF RESULTS

ORCHARD HEATER EFFLUENT EVALUATION

1. CLIENT Braders Heaters, Inc.
2. SAMPLE TAKEN AT Yakima, Washington
3. TYPE OF OPERATION Nozzle fired oil orchard heater
4. LOCATION OF PORT 5.3 diameters upstream and 2.1 diameters downstream of stack inlet and outlet
5. FUEL BURNED AT RATE 8.7 lb/hr of 7.13 lb/gal fuel oil
6. POLLUTANT(S) SAMPLED Particulates, carbon dioxide, oxygen, and carbon monoxide
7. TIME SAMPLE TAKEN:
   DATE 1/7/70 BEGIN 8:43 AM END 9:25 AM
8. STACK FLOW RATE 467 scfm @ 70° F., 1 atm. press., dry
9. WATER VAPOR IN STACK GAS (DRY-WET BULB) 4% by volume
10. % ISOKINETIC SAMPLING FROM THE TRAIN* 87.5%
11. STANDARDIZED DRY GAS METER VOLUME 14.62 scf (70° F. and 1 atmosphere pressure)
12. LABORATORY DATA - TOTAL PARTICULATE 1.0 mg
13. PARTICULATE CONCENTRATION IN SAMPLING TRAIN 0.0683 mg/scf
14. PARTICULATE MASS RATE 0.033 gm/min
15. EXCESS AIR AT SAMPLING PORT 25.0 times (theoretical) (17.4 times)
16. CARBON DIOXIDE CALCULATED AT HEATER OUTLET 12.5% (11.0%)
17. EFFICIENCY OF COMBUSTION 75.0% (70%)

*i.e. Ratio of velocity within nozzle to that of stack velocity x 100.

PART II

SUMMARY OF SAMPLE DATA

CLIENT Braders Heaters, Inc.

DATE 1/7/70 RUN NO. 1

1. SAMPLING NOZZLE DIAMETER 1/2"
2. SAMPLING TIME 42 minutes
3. SAMPLE VOLUME @ METER CONDITIONS 14.17 $ft.^3$
4. AVERAGE METER TEMPERATURE 44° F.
5. AVERAGE ORIFICE PRESSURE DROP 0.27" water
6. BAROMETRIC PRESSURE 29.27" Hg

VELOCITY TRAVERSE DURING SAMPLING

7. STACK AREA 1.575 $ft.^2$
8. AVERAGE STACK PRESSURE atmospheric
9. AVERAGE STACK TEMPERATURE 174° F.
10. AVERAGE $\sqrt{\text{VELOCITY HEAD}}$ 0.0984

STACK MOISTURE CONTENT

11. % MOISTURE BY DRY-WET BULB AND PSYCHROMETRIC CHART 4.0% by volume

ORSAT ANALYSIS

12. CARBON DIOXIDE, % BY VOLUME ON DRY BASIS 0.30
13. CARBON MONOXIDE, % BY VOLUME ON DRY BASIS 0.20
14. OXYGEN, % BY VOLUME ON DRY BASIS 20.00
15. NITROGEN, % BY VOLUME ON DRY BASIS 79.50
16. MOLECULAR WEIGHT OF STACK GASES (DRY) 28.79 lb/lb mole

PART I

SUMMARY OF RESULTS

ORCHARD HEATER EFFLUENT EVALUATION

1. CLIENT Spot Heaters (return stack oil bath fired)
2. SAMPLE TAKEN AT Yakima, Washington
3. TYPE OF OPERATION oil bath fired orchard heater
4. LOCATION OF PORT 5.3 diameters upstream and 2.1 diameters downstream of stack inlet and outlet
5. FUEL BURNED AT RATE 10 lb/hr of 7.13 lb/gal fuel oil
6. POLLUTANT(S) SAMPLED Particulates, carbon dioxide, oxygen and carbon monoxide
7. TIME SAMPLE TAKEN:
   DATE 1/8/70 BEGIN 11:10 AM END 11:34 AM
8. STACK FLOW RATE 552 acfm @ 70° F., 1 atm. press., and dry
9. WATER VAPOR IN STACK GAS (DRY-WET BULB) 2% by volume
10. % ISOKINETIC SAMPLING FROM THE TRAIN* 98%
11. STANDARDIZED DRY GAS METER VOLUME 11.30 scf
    (70° F. and 1 atmosphere pressure)
12. LABORATORY DATA - TOTAL PARTICULATE 10.1 mg
13. PARTICULATE CONCENTRATION IN SAMPLING TRAIN 0.895 mg/scf
14. PARTICULATE MASS RATE 0.495 gm/min
15. EXCESS AIR AT SAMPLING PORT 17.9 times (theoretical)
16. CARBON DIOXIDE CALCULATED AT HEATER OUTLET 5.4%
17. EFFICIENCY OF COMBUSTION 50%

*i.e. Ratio of velocity within nozzle to that of stack velocity x 100.

PART II

SUMMARY OF SAMPLE DATA

CLIENT Spot Heaters (return stack oil bath fired)

DATE 1/3/70 RUN NO. - 4

1. SAMPLING NOZZLE DIAMETER 1/2"
2. SAMPLING TIME 24 min.
3. SAMPLE VOLUME @ METER CONDITIONS 11.39 $ft.^3$
4. AVERAGE METER TEMPERATURE 56° F.
5. AVERAGE ORIFICE PRESSURE DROP 0.58" water
6. BAROMETRIC PRESSURE 28.90" Hg

VELOCITY TRAVERSE DURING SAMPLING

7. STACK AREA 1.575 $ft.^2$
8. AVERAGE STACK PRESSURE atmospheric
9. AVERAGE STACK TEMPERATURE 193° F.
10. AVERAGE $\sqrt{\text{VELOCITY HEAD}}$ 0.1365

STACK MOISTURE CONTENT

11. % MOISTURE BY DRY-WET BULB AND PSYCHROMETRIC CHART 2% by volume

ORSAT ANALYSIS

12. CARBON DIOXIDE, % BY VOLUME ON DRY BASIS 0.30 (3000 ppm by Vol.)
13. CARBON MONOXIDE, % BY VOLUME ON DRY BASIS 0.35 (3500 ppm by Vol.)
14. OXYGEN, % BY VOLUME ON DRY BASIS 19.70 (197,000 ppm by Vol.)
15. NITROGEN, % BY VOLUME ON DRY BASIS 79.65 (796,500 ppm by Vol.)
16. MOLECULAR WEIGHT OF STACK GASES (DRY) 28.82 lb/lb mole

PART I

SUMMARY OF RESULTS

ORCHARD HEATER EFFLUENT EVALUATION

1. CLIENT Spot Heaters (27" stack Model)
2. SAMPLE TAKEN AT Yakima, Washington
3. TYPE OF OPERATION Nozzle fired oil orchard heater
4. LOCATION OF PORT 5.3 diameters upstream and 2.1 diameters downstream of stack inlet and outlet
5. FUEL BURNED AT RATE 5.79 lb/hr. of 7.13 lb/gal fuel oil
6. POLLUTANT(S) SAMPLED Particulates, carbon dioxide, oxygen, and carbon monoxid
7. TIME SAMPLE TAKEN:
   DATE 1/6/70 BEGIN 4:04 PM END 4:48 PM
8. STACK FLOW RATE 453 scfm @ 70° F., 1 atm. press. and dry
9. WATER VAPOR IN STACK GAS (DRY-WET BULB) 3% by volume
10. % ISOKINETIC SAMPLING FROM THE TRAIN* 108%
11. STANDARDIZED DRY GAS METER VOLUME (70° F. and 1 atmosphere pressure) 18.00 scf
12. LABORATORY DATA - TOTAL PARTICULATE 2.5 mg
13. PARTICULATE CONCENTRATION IN SAMPLING TRAIN 0.168 mg/scf
14. PARTICULATE MASS RATE 0.076 gm/min.
15. EXCESS AIR AT SAMPLING PORT 25.3 times (theoretical)
16. CARBON DIOXIDE CALCULATED AT HEATER OUTLET 8.9%
17. EFFICIENCY OF COMBUSTION 60%

*i.e. Ratio of velocity within nozzle to that of stack velocity x 100.

PART II

SUMMARY OF SAMPLE DATA

CLIENT Spot Heaters (27" stack model)

DATE 1/6/70 RUN NO. 2

1. SAMPLING NOZZLE DIAMETER 1/2"
2. SAMPLING TIME 44 min.
3. SAMPLE VOLUME @ METER CONDITIONS 17.05 $ft.^3$
4. AVERAGE METER TEMPERATURE 40° F.
5. AVERAGE ORIFICE PRESSURE DROP 0.21" Hg
6. BAROMETRIC PRESSURE 29.40" Hg

VELOCITY TRAVERSE DURING SAMPLING

7. STACK AREA 1.575 $ft.^2$
8. AVERAGE STACK PRESSURE atmospheric
9. AVERAGE STACK TEMPERATURE 210° F.
10. AVERAGE $\sqrt{\text{VELOCITY HEAD}}$ 0.0973

STACK MOISTURE CONTENT

11. % MOISTURE BY DRY-WET BULB AND PSYCHROMETRIC CHART 3%

ORSAT ANALYSIS

12. CARBON DIOXIDE, % BY VOLUME ON DRY BASIS 0.35 (3500 ppm by Vol.)
13. CARBON MONOXIDE, % BY VOLUME ON DRY BASIS 0.30 (3000 ppm by Vol.)
14. OXYGEN, % BY VOLUME ON DRY BASIS 20.35 (203,500 ppm by Vol.)
15. NITROGEN, % BY VOLUME ON DRY BASIS 79.60 (796,000 ppm by Vol.)
16. MOLECULAR WEIGHT OF STACK GASES (DRY) 28.93 lb/lb mole

ORCHARD HEATER
EFFLUENT EVALUATION

FOR

ORCHARD RITE
6505 Apple View
Yakima, Washington

Prepared by

VALENTINE, FISHER & TOMLINSON
Consulting Engineers
520 Lloyd Building
Seattle, Washington 98101

January 1970

PURPOSE

The purpose of this report is to determine the weight per time (grams/min) of particulates emitted in the effluent of an orchard heater manufactured by Orchard Rite of Yakima, Washington.

SUMMARY

The heater was sampled the second week of January, 1970, in Yakima, Washington, to closely approximate orchard heating conditions of 20 - 30° F. and a wind of 0 - 5 miles per hour. As noted in the "Summary of Results", the heater emitted 0.009 grams of particulate per minute calculated at 70° F., 29.92" Hg of pressure, and dry.

PROCEDURE

A stack extension was erected above the heater to enable combustion to cease and establish straight line flow at the point of sampling. The heater sampled was 12" in diameter overall with an outlet of 5-3/4" in diameter at the top, 12" diameter at the bottom, and was 13" high. The oil was fed by nozzle into the combustion chamber at a rate determined by weighing the fuel tank before and after the sample was taken, (see attached sketch) and recorded at 7.5 lb/hr with a density of 7.13 lb/gal.

The particulate sample was collected with a sampling train designed by the National Air Pollution Control Administration and illustrated in the enclosed schematic. The train is designed to get the velocity of the gas entering the nozzle equal to the velocity of the stack gas around the nozzle. Percent Isokinetic is defined as 100 times ratio of the velocity of the gas in the nozzle to the gas surrounding the nozzle. 100 is a perfect isokinetic sample and insures that all particles approaching the nozzle will be collected.

The gas analysis for carbon dioxide, oxygen, and carbon monoxide was made with an Orsat Analyzer at 60° F. The Orsat sample was collected in an evacuated bag arrangement from a representative sample of stack gas. The gases sampled were used to determine the molecular weight of the gas and the carbon dioxide value was used to determine the efficiency of combustion. Theoretically, 185 standard cubic feet of air is required to burn one pound of fuel oil which results in a 16% by volume of carbon dioxide (Ref. "North American Combustion Handbook", North American Mfg. Co., Cleveland, Ohio). The combustion efficiency is assumed to be 100% if the calculated value of carbon dioxide is 16% by volume.

PART I

SUMMARY OF RESULTS

ORCHARD HEATER EFFLUENT EVALUATION

1. CLIENT Orchard Rite
2. SAMPLE TAKEN AT Yakima, Washington
3. TYPE OF OPERATION Nozzle fired oil orchard heater
4. LOCATION OF PORT 5.3 diameters upstream and 2.1 diameters downstream of stack inlet and outlet
5. FUEL BURNED AT RATE 7.5 lb/hr of 7.13 lb/gal fuel oil
6. POLLUTANT(S) SAMPLED Particulates, carbon dioxide, oxygen and carbon monoxide
7. TIME SAMPLE TAKEN:

   DATE 1/7/70 BEGIN 3:22 PM END 4:04 PM
8. STACK FLOW RATE 482 scfm @ 70° F., 1 atm. press., and dry
9. WATER VAPOR IN STACK GAS (DRY-WET BULB) 2% by volume
10. % ISOKINETIC SAMPLING FROM THE TRAIN* 84.8%
11. STANDARDIZED DRY GAS METER VOLUME 15.74 scf
    (70° F. and 1 atmosphere pressure)
12. LABORATORY DATA - TOTAL PARTICULATE 0.3 mg
13. PARTICULATE CONCENTRATION IN SAMPLING TRAIN 0.019 mg/scf
14. PARTICULATE MASS RATE 0.009 gm/min
15. EXCESS AIR AT SAMPLING PORT 19.9 times (theoretical)
16. CARBON DIOXIDE CALCULATED AT HEATER OUTLET 15.8%
17. EFFICIENCY OF COMBUSTION 99%

*i.e. Ratio of velocity within nozzle to that of stack velocity x 100.

PART II

SUMMARY OF SAMPLE DATA

CLIENT Orchard Rite

DATE 1/7/70 RUN NO. 1

1. SAMPLING NOZZLE DIAMETER 1/2"
2. SAMPLING TIME 42 min.
3. SAMPLE VOLUME @ METER CONDITIONS 15.67 ft.^{3}
4. AVERAGE METER TEMPERATURE 54° F.
5. AVERAGE ORIFICE PRESSURE DROP 0.23" Hg
6. BAROMETRIC PRESSURE 29.13" Hg

VELOCITY TRAVERSE DURING SAMPLING

7. STACK AREA 1.575 ft.^{2}
8. AVERAGE STACK PRESSURE atmospheric
9. AVERAGE STACK TEMPERATURE 193° F.
10. AVERAGE $\sqrt{\text{VELOCITY HEAD}}$ 0.104

STACK MOISTURE CONTENT

11. % MOISTURE BY DRY-WET BULB AND PSYCHROMETRIC CHART 2% by volume

ORSAT ANALYSIS

12. CARBON DIOXIDE, % BY VOLUME ON DRY BASIS 0.90
13. CARBON MONOXIDE, % BY VOLUME ON DRY BASIS 0.15
14. OXYGEN, % BY VOLUME ON DRY BASIS 19.50
15. NITROGEN, % BY VOLUME ON DRY BASIS 79.45
16. MOLECULAR WEIGHT OF STACK GASES (DRY) 28.91 lb/lb. mole

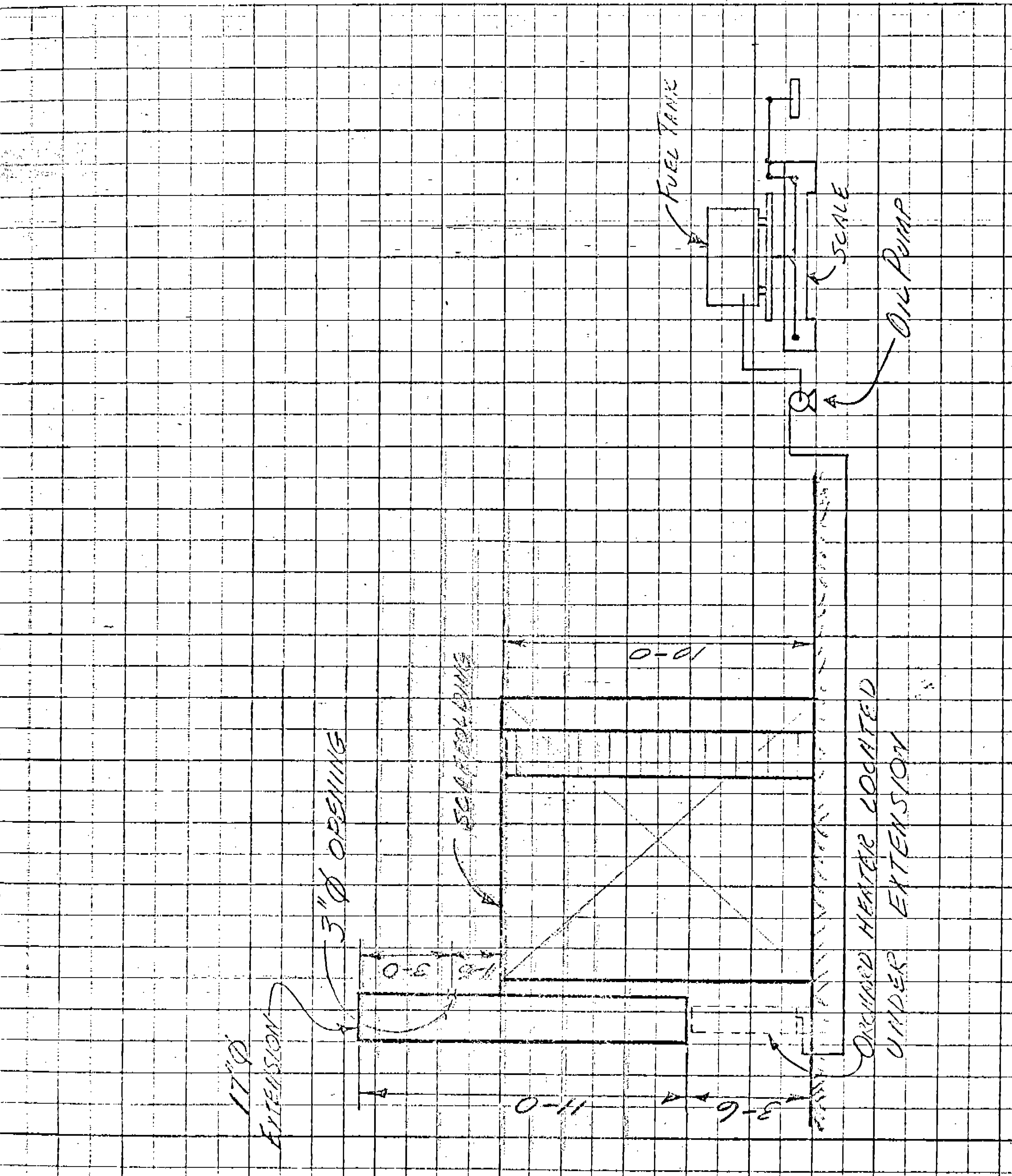
VALENTINE, FISHER & TOMLINSON · CONSULTING ENGINEERS

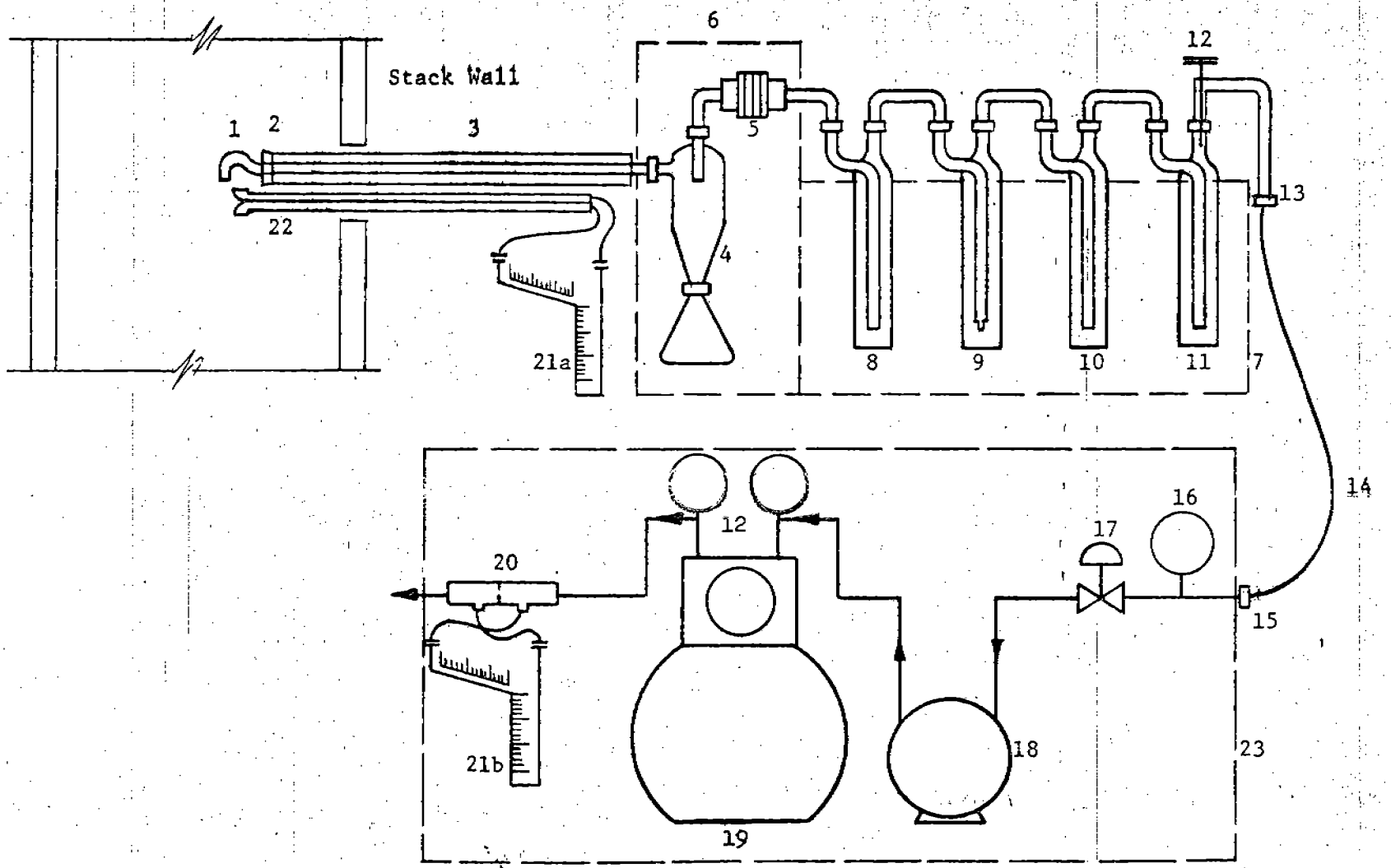
COMPUTATION & DESIGNING SHEET

JOB NAME: Orchard Heater Emission Evaluation DATE: 1/17/70

PREPARED BY: [illegible] PAGE 1 OF 1

SUBJECT: Emission, Scaffolding, & Fuel Weighing Set-up





VALENTINE, FISHER & TOMLINSON STACK GAS SAMPLING TRAIN

SAMPLING TRAIN COMPONENTS

1. Sampling nozzle - button hook to prevent moisture from draining back into stack and to allow insertion through 2-1/2" port.
2. Quick connect for changing to different size nozzles.
3. Stainless steel probe with glass interliner wrapped with heating wire to maintain a 250° F. temperature for retarding condensation.
4. Sampling cyclone to catch large particles and reduce loading on filter.
5. Filter holder with glass fiber media.
6. Sample box - heated and maintained @ 250° F.
7. Impinger ice bath used for condensing out water and gaseous and particulate collection in bubblers and impinger.
8. Bubbler.
9. Impinger.
10. Bubbler.
11. Bubbler.
12. Thermometer.
13. Quick connect for sample box to umbilical cord.
14. Umbilical cord contains:
    a. Vacuum line from last impinger to meter box.
    b. Pitot tube lines.
    c. Electrical supply lines from meter box to sample box.
15. Quick connect from umbilical cord to meter box.
16. Vacuum gauge to indicate pressure build-up across filter.
17. Flow Control Valve.
18. Vacuum pump.
19. Dry gas meter.
20. Orifice meter to determine flow rate of gases through sampling train.
21. Manometer to record deflection for:
    a. Stack gas velocity.
    b. Sampling train flow rate.
22. "S" type pitot tube to measure stack gas velocity.
23. Meter box.

PART IV

VALENTINE, FISHER & TOMLINSON
VELOCITY TRAVERSE DATA SHEET

CLIENT ORCHARD RITE

DATE 1/7/70 TIME 3:15PM RUN NO. 1

SAMPLING PORT LOCATION 5.3 DIAMETERS UPSTREAM AND 2.1 DIAMETERS DOWNSTREAM OF STACK INLET AND OUTLET.

STACK AREA, IN.^{2} 17"Ø = 1.575 FT^2

OPERATOR W.D. SNOWDEN

TYPE PITOT TUBE USED "S"

BAROMETRIC PRESSURE 29.13 IN Hg

DRY BULB TEMPERATURE, °F 198

WET BULB TEMPERATURE, °F 95 : 27% MOISTURE BY PSYCHROMETRIC CHART

DWG. OF STACK CROSS SECT

STATION	DIST. FROM REF. PT.	VEL. H_D. IN H_2O	$\sqrt{\text{VEL. } H_D}$.	STACK TEMP. °F	STACK PRESS. IN Hg	VEL.* "P" TYPE (fps)	CORR.** VEL (fps
1	0.75	0.005	0.072	198	ATM		
2	2.50	0.012	0.110	180			
3	5.00	0.015	0.122		"		
4	12.00	0.016	0.126	200			
5	19.50	0.011	0.105		"		
6	16.25	0.008	0.090	194	"		
TOTALS			0.625	772			
AVERAGES		0.011 †	0.104	193	ATM	7.76	6.73

*"P" type pitot tube velocity read from velocity tables at stack temperature and vel. head values using the following equation (Ref. Western Precipitation Bulletin WP50): $V = 2.9 \sqrt{T_s \times VH}$

T_s = Absolute stack temperature, °R
VH = velocity head, in H_2O
V = Point velocity (fps)

** Velocity, corrected for; using "S" type pitot tube (0.855 x "P" type = corr.vel.) gas density, composition, and static pressure within the stack.

† Average Vel. H_D = (Average $\sqrt{VH}$)^2

VALENTINE, FISHER & TOMLINSON

PARTICULATE FIELD DATA

CLIENT. Okanogan Rite

Location Yakima, Washington

Date 4/7/20

Operator W. D. Saunders

Run No. 1

Equipment VF&T #1

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

FUEL USED FROM 3:22 PM TO 4:04 PM WAS 5.25 LB

Ambient Temp °F 35

Bar. Press. "Hg 29.13

Assumed Moisture % 2

Heater Box Setting, °F 350

Probe Tip Dia., In. 1/2

Probe Length 6-0

Probe Heater Setting 85

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
1	15:22	617.70	0.005	0.12	"	48	46	1.5	250	34	AMB	198
2	15:29	619.80	0.012	0.30	"	43	46	2.5		34	"	195
3	15:36	622.03	0.015	0.40	"			3.5	290	35	"	
4	15:43	624.34	0.016	0.44	"	54	55	3.4		36	"	203
5	15:50	626.35	0.011	0.30	"	58	56	2.5	280	36	"	
6	15:57	630.75	0.008	0.22	"	60	60	2.0		37	"	199
	16:04	633.37										
	-15:22	-617.70										
TOTALS	42 min	15.67		1.78		268	263					772
AVGS				0.23		54	53					193
							54					

Comments:

PART VII

VALENTINE, FISHER & TOMLINSON
ORSAT DATA AND CALCULATION SHEET

CLIENT Overhead Rite

Sampling point location Stack Exhaust Above Heater

Date 1/7/70 Time 4:30PM Run No. 1

		Analysis 1	Analysis 2	Analysis 3	Avg	x = mole.wt	wt/mole (dry)
CO_2	% vol (dry)	1.0	0.8		0.90	44/100	0.40
CO	% vol (dry)	0.2	0.1		0.15	28/100	+0.04
O_2	% vol (dry)	19.4	19.6		19.5	32/100	+6.25
N_2	% vol (dry)	79.4	79.5		79.45	28/100	+22.22
					M = Avg molecular wt of dry stack gas=		28.91

MOLECULAR WT. OF AIR EQUALS 29.0 SO NO CORRECTION IN DENSITY IS REQUIRED AND CAN ASSUME STACK GASES TO BE AIR

Date _____ Time _____ Run No. _____

Sampling point location _____

		Analysis 4	Analysis 5	Analysis 6	Avg	x = mole wt	wt/mole (dry)
CO_2	% vol (dry)					44/100	
CO	% vol (dry)					28/100	+
O_2	% vol (dry)					32/100	+
N_2	% vol (dry)					28/100	+
					M = Avg molecular wt of dry stack gas =		

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COMPUTATION & DESIGNING SHEET

JOB NAME: ORCHARD RITE — DATE: 1/19/70
PREPARED BY: W.D. SNOWDEN — PAGE 1 OF 2
SUBJECT: ORCHARD HEATER CALCULATIONS

STACK MEASUREMENTS:

$AVG.\ V_{o\ \text{"P" TYPE}} = 2.9\sqrt{(460+193)(0.011)} = 7.76\ fps$ (REF. WP 50)

CORRECTIONS FOR
a. "S" TYPE PITOT BEING USED = 0.855
b. BAROMETRIC PRESSURE CORRECTION = 1.014
c. NONE FOR STACK PRESSURE AND GAS DENSITY

$\therefore V_{CORR} = V_o = (7.76\ fps)(0.855)(1.014) = 6.73\ fps$ ← V_o

% ISOKINETIC: RELATES VELOCITY OF GASES ENTERING THE NOZZLE TO THE VELOCITY OF THE GASES IN THE STACK WITH 100 BEING PERFECT.

METER PRESSURE CORRECTION FOR ORIFICE BEING AFTER.

$P_m = 29.13 + (0.23\ in\ H_2O)\frac{1''\ Hg}{13''\ H_2O} = 29.15''\ Hg$ = METER PRESSURE

$Vol_s = 15.67\ cf\left(\frac{460+70}{460+54}\right)\left(\frac{29.15}{29.92}\right) = 15.74\ scf$

$Vol_n = 15.74\ scf\left(\frac{460+193}{460+70}\right)\left(\frac{29.13}{29.92}\right)(1.02) = 19.26\ ft^3$ @ STACK (% MOISTURE)

$Q_n = 19.26\ ft^3 / 42\ min = 0.458\ cfm$

$V_n = 0.458\ cfm / 0.00134\ ft^2 = 342\ fpm = 5.70\ fps$

$\therefore \%\ Isokinetic = \frac{V_n}{V_o} = \frac{5.70\ fps}{6.73\ fps} \times 100 = 84.8\%$ ← % ISO

~ WITHIN 15% ∴ ACCEPTABLE SAMPLES.

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COMPUTATION & DESIGNING SHEET

JOB NAME: Orchard Rite
DATE: 1/19/70
PAGE 2 OF 2
PREPARED BY: W.D. [illegible]
SUBJECT: Orchard Heater Effluent Calculations

MASS RATE:

0.2 mg collected on filter

0.1 mg collected in acetone wash

0.0 mg " in impinger wash

0.3 mg total particulate collected

$C_T = 0.3 mg / 15.74 scf = 0.019 mg/scf$

$Q_0 = (6.73 fps)(1.575 ft^2) = 10.6 ft^3/sec = 636 cfm$

$(Q_0)_s = (636 cfm)\left(\frac{460+70}{460+193}\right)\left(\frac{29.13}{29.92}\right)(0.98) = \underline{482 scfm}$

∴ Pollutant Mass Rate = (0.019 mg/scf)(482 scfm)(0.001 gm/mg)

PMR = 0.009 gm/min ←

EFFICIENCY OF COMBUSTION

Burning Rate = 5.50 lb / 42 min = 0.131 lb/min

∴ Amt. stoichio air req'd = (185 scf/lb)(0.131 lb/min) = 24.2 scfm

Times excess air = 482 scfm / 24.2 scfm = 19.9 times

∴ % CO_2 @ heater = (19.9)(1.0 ± 0.2) = 19.9 ± 4.0 % CO_2

Cannot be greater than 16%. Due to small

amt. of CO & particulates and high amt. of CO_2, will use 15.9 % CO_2 @ heater outlet

∴ Efficiency of Combustion = $\frac{15.9}{16}$ (x 100) = 99 %