Background Report Reference

AP-42 Section Number: 9.6.1

Background Chapter: 4

Reference Number: 4

Title: Whey Dryer Emission Test at Northland Food Cooperative, Shawano, Wisconsin, April 9-10, 1986

Badger Laboratories and Engineering Co., Inc.

April 1986

AP-42 Section 9.6.1
Reference
Report Sect. 4
Reference 1

CHEMISTS ENGINEERS
BADGER LABORATORIES & ENGINEERI
1110 S. ONEIDA STREET • APPLETON, WISCONSIN 54915 • [414] 739
TOLL FREE PHONE IN WISCONSIN 1-800-242-3556

NORTHLAND FOOD CO-OP

WHEY DRYER EMISSION TEST

at

NORTHLAND FOOD COOPERATIVE
116 N. Main Street
Shawano, WI 54166

April 9 - 10, 1986

WHEY DRYER

Lactose Production

APRIL '86

Prepared By:

BADGER LABORATORIES & ENGINEERING CO., INC.
1110 S. Oneida Street
Appleton, WI 54915

April 30, 1986

Stephen C. Taylor
Chief Chemist

CORRESPONDENCE/MEMORANDUM — STATE OF WISCONSIN

DATE: February 27, 1987 FILE REF: 4530-3

TO: Files

FROM: Joseph G. Brehm - AM/3 JGB

SUBJECT: Review of Stack Test Performed at Northland Food Cooperative, Shawano

I. SOURCE

Northland Food Cooperative
116 North Main Street
Shawano, WI 54166

Facility Contact: Mr. Dick Marquardt, (715) 524-2191

FID #459040010, Stack #S13, Process #P30, Whey Dryer

Test Date: April 9, 1986

II. SOURCE DESCRIPTION

The source tested was a Rogers whey dryer which is a two stage process. In the first stage, whey concentrate is sprayed under pressure into a hot air chamber, the primary dryer. The partially dehydrated powder then passes to a secondary dryer for final drying. The end product is pure sugar with a moisture content of about 4%, which is used as an animal feed supplement and also in the food industry. The dryers are fired with natural gas, or can use propane as a standby fuel. Whey powder production rate averaged 5,549 lbs/hr for the test.

Emissions from this process are controlled by two cyclones. No data was available on the types of cyclones or their operating parameters.

III. SAMPLING OPERATION

A. Purpose of Test

The purpose of the test was to demonstrate compliance with the applicable emission limit. The source was issued a Notice of Noncompliance on December 13, 1985 because of whey fallout on the surrounding area.

B. Sampling Firm

Badger Laboratories & Engineering Co., Inc.
1110 South Oneida Street
Appleton, WI 54915

Crew Chief: Sander E. Sundberg, PhD., (414) 739-9213

C. The test method used was EPA Method Five as stated in the Federal Register, Volume 42, #160, August 18, 1977. The test was done through four ports in the rectangular steel stack (28" X 32"). The ports were located approximately 10 1/2 feet downstream from the last disturbance and about 2 feet from the stack exit. Twenty-four points were sampled, six per port, for three minutes per point for Run #1. The rest of the runs were sampled for 2 1/2 minutes per point. Five such runs were done (see discussion section for explanation).

D. Test Witness

Mr. Larry Weix of the Lake Michigan District office was the Department's representative at the test.

IV. SUMMARY OF RESULTS

The results listed are those as reported by Badger Laboratories. The Department's results are listed for comparison. Only the first three runs are averaged.

Run Number	Emission Rate (lb/hr)	Emission Concentration (lb/1000 lb gas, W.B.) Badger	DNR	Isokinetic Ratio (%)
1	5.3119	0.0540	0.0528	98.0
2	6.6208	0.0669	0.0656	98.5
3	4.7507	0.0480	0.0470	98.4
Ave.	5.5611	0.0563	0.0551	98.3

V. APPLICABLE EMISSION LIMIT

The emission limit that probably applies is 0.2 pounds per thousand pounds of gas as stated in Section NR 154.11(3)(b)1.m., Wisconsin Administrative Code. Section NR 154.11(3)(a)1.1., which is based on process weight rate, may also apply depending on the source location and/or when it was constructed. If applicable, this limit would be 6.76 pounds per hour.

VI. DISCUSSION OF RESULTS

The emission concentration of 0.0563 pounds per thousand pounds gas is under the limit of 0.2 lb/1000#gas. The isokinetic ratio of 98.3% is within the limits of 90% - 110% that the Department uses to judge the validity of stack tests. I checked all the field and laboratory data and found it to be complete and accurate. I then ran this data through the Department's computer program and my results had good agreement with those contained in the report.

TO: Files - February 27, 1987

According to the report "the whey dryer emission did not look normal to Mr. Marquardt and the production was stopped after the second test." A cyclone was found to be plugged. After remedying the problem, testing resumed with three more complete runs. The two extra runs were done in case the plugged cyclone had caused the results of the first two runs to be abnormally high. The results for the first two runs were higher, but so was production so there was no reason to discard the first two runs. The results for runs #4 and #5 are copied in the addendums to this review.

The report contained all necessary calibration data for the test equipment, but little information on the process itself. The process information was obtained from previous inspection reports. There was no witnessing form available from the test.

JB:pl/8069R

cc: Dan Schramm - LMD
Joe Perez - AM/3
U.S. EPA Region V

WHEY DRYER EMISSION TEST

I. Introduction and Summary

Badger Laboratories & Engineering Co., Inc. was retained by Northland Foods of Shawano, WI to determine the concentration of particulate matter in the exhaust from a whey dryer. The purpose of the test was to show compliance with State of Wisconsin particulate limitations.

Emission tests were conducted April 9 & 10, 1986 by Sander E. Sundberg, PhD and Bruce Lamers. Larry Weix of the Wisconsin Department of Natural Resources visited the test site. The ambient temperature during the test was 45 - 55°F, wind was strong and gusty from the northwest. A total of five test runs were performed following U.S. EPA Methods.

The whey dryer emission did not look normal to Mr. Marquardt and the production was stopped after the second test. A cyclone was found to be plugged. This situation was corrected and testing resumed. Mr. Dick Marquardt is the company contact.

The exhaust gas ranged in temperature from 115 - 132°F. The sampling isokinetic rates were 98.0, 98.5, 98.4, 99.1 and 99.1 percent.

The results of the tests are as follows:

Test Run	Date	Volumetric Flow Rate scfh (dry)	Particulate Emission Rate lb./hr.	Particulate Concentration lb./1000 lb. Gas
1	4-9-86	1.314×10^6	5.3119	0.0540
2	4-9-86	1.323×10^6	6.6208	0.0669
3	4-9-86	1.324×10^6	4.7507	0.0480
4	4-9-86	1.322×10^6	3.8910	0.0393
5	4-10-86	1.324×10^6	4.1446	0.0418

The arithmatic average of the five results is 0.0500 lb/1000 lb. gas. The limitation on this source is 0.20 lb/1000 lb. gas.

NAME OF SOURCE: NORTHLAND FOOD CO-OP

LOCATION OF SOURCE: SHAWANO WI

PROCESS TESTED: WHEY DRYER

DATE OF TEST: 4-9-86

RUN NUMBER: 1

N NUMBER OF SAMPLING POINTS= 24

VM DGM VOL,METER COND DRY= 48.903 CFD

PB BAR PRESS,STATION= 29.1 IN HG

VL TOTAL VOL OF WATER COLLECTED= 69.4 ML

%CO2 % CARBON DIOXIDE BY VOL,DRY BASIS= .5 %

%O2 % OXYGEN BY VOL,DRY BASIS= 20 %

%CO % CARBON MONOXIDE BY VOL, DRY BASIS= 0 %

%N2 % NITROGEN BY VOL,DRY BASIS= 79.5 %

CP PITOT TUBE COEFFICIENT= .83

PS STACK PRESS= 29.12 IN HG

AS AREA OF THE SAMPLING SITE= 5.906 SQ FEET

MT TOTAL DRY PARTICULATE= .0844 GM

T TOTAL SAMPLING TIME= 72 MIN

AN AREA OF THE NOZZLE= .0001761 SQ FEET

NORTHLAND FOOD CO-OP,WHEY DRYER,RUN: 1

PARTICULATE FIELD DATA

SAMPLING POINT NUMBER	STACK TEMP DEG F	VELOCITY PRESS IN H2O	SQ ROOT VEL PRESS	ORIFICE METER PRESS DROP IN H2O	DRY GAS METER TEMP DEG F INLET	DRY GAS METER TEMP DEG F OUTLET
1	117.0	2.250	1.50000	2.050	80.0	68.0
2	118.0	1.850	1.36015	1.690	82.0	68.0
3	118.0	1.700	1.30384	1.550	84.0	67.0
4	116.0	1.550	1.24499	1.420	86.0	67.0
5	116.0	1.600	1.26491	1.470	88.0	66.0
6	115.0	1.550	1.24499	1.430	90.0	66.0
7	116.0	1.900	1.37840	1.750	88.0	66.0
8	115.0	1.900	1.37840	1.890	94.0	66.0
9	115.0	1.750	1.32288	1.750	96.0	66.0
10	116.0	1.500	1.22474	1.500	98.0	66.0
11	116.0	1.400	1.18322	1.400	97.0	67.0
12	115.0	1.550	1.24499	1.550	97.0	67.0
13	115.0	1.800	1.34164	1.790	90.0	70.0
14	115.0	1.800	1.34164	1.800	96.0	70.0
15	115.0	1.650	1.28452	1.660	98.0	70.0
16	116.0	1.500	1.22474	1.500	98.0	70.0
17	115.0	1.400	1.18322	1.410	99.0	70.0
18	115.0	1.500	1.22474	1.510	100.0	70.0
19	115.0	1.650	1.28452	1.660	96.0	72.0
20	115.0	1.450	1.20416	1.460	100.0	72.0
21	116.0	1.350	1.16190	1.360	100.0	72.0
22	115.0	1.250	1.11803	1.260	100.0	72.0
23	117.0	1.300	1.14018	1.310	100.0	72.0
24	116.0	1.050	1.02470	1.060	100.0	72.0
AVERAGE VALUES	TS= 575.75 DEG R		SR(VP)= 1.257729	OP= 1.55125 IN H2O	TM= 541.4375 DEG R	

NORTHLAND FOOD CO-OP,WHEY DRYER,RUN: 1

CALCULATED RESULTS

VMSTD DGM VOL,STD COND DRY= 46.56413 SCFD

VWSTD VOL OF WATER VAPOR,STD COND= 3.266658 SCF

%M % MOISTURE IN STACK GAS BY VOL,STD COND= 6.555502 %

MD MOLE FRACTION OF DRY GAS= .934445

MWD MOLECULAR WT OF STACK GAS,DRY BASIS= 28.88 LB/LB-MOLE

MWS MOLECULAR WT OF STACK GAS,WET BASIS= 28.16676 LB/LB-MOLE

VS AVE STACK GAS VELOCITY,STACK COND= 74.77104 FPS

QSTD AVE STACK GAS FLOW RATE,STD COND DRY= 22098.44 SCFMD

%EA AVE % EXCESS AIR= 2024.294 %

PMRA AVE PMR BY RATIO OF AREAS METHOD= 5.200341 LB/HR

PMRC AVE PMR BY CONC METHOD= 5.298347 LB/HR

PMR(AVE) AVE PMR,STD COND DRY= 5.249344 LB/HR

C EMISSION CONC,STD COND DRY= 2.796771E-02 GR/SCFD

DGR AVE STACK GAS RATE,STD COND DRY= 99399.45 LB/HR

LB/MLB EMISSION CONC,STD COND DRY= 5.281059E-02 LB/MLB OF DRY GAS

WGR AVE STACK GAS RATE,STD COND WET= 103745.7 LB/HR

LB/MLB EMISSION CONC,STD COND WET= .0505982 LB/MLB OF WET GAS

%I % ISOKINETIC RATIO= 98.15025 %

NAME OF SOURCE: NORTHLAND FOOD CO-OP

LOCATION OF SOURCE: SHAWANO WI

PROCESS TESTED: WHEY DRYER

DATE OF TEST: 4-9-86

RUN NUMBER: 2

N NUMBER OF SAMPLING POINTS= 24

VM DGM VOL,METER COND DRY= 41.691 CFD

PB BAR PRESS,STATION= 29.1 IN HG

VL TOTAL VOL OF WATER COLLECTED= 54.9 ML

%CO2 % CARBON DIOXIDE BY VOL,DRY BASIS= .5 %

%O2 % OXYGEN BY VOL,DRY BASIS= 20 %

%CO % CARBON MONOXIDE BY VOL, DRY BASIS= 0 %

%N2 % NITROGEN BY VOL,DRY BASIS= 79.5 %

CP PITOT TUBE COEFFICIENT= .83

PS STACK PRESS= 29.12 IN HG

AS AREA OF THE SAMPLING SITE= 5.906 SQ FEET

MT TOTAL DRY PARTICULATE= .0881 GM

T TOTAL SAMPLING TIME= 60 MIN

AN AREA OF THE NOZZLE= .0001761 SQ FEET

NORTHLAND FOOD CO-OP,WHEY DRYER,RUN: 2

PARTICULATE FIELD DATA

SAMPLING POINT NUMBER	STACK TEMP DEG F	VELOCITY PRESS IN H2O	SQ ROOT VEL PRESS	ORIFICE METER PRESS DROP IN H2O	DRY GAS METER TEMP DEG F INLET	OUTLET
1	122.0	2.250	1.50000	2.220	86.0	78.0
2	123.0	1.900	1.37840	1.880	92.0	78.0
3	123.0	1.750	1.32288	1.740	97.0	77.0
4	123.0	1.600	1.26491	1.590	96.0	76.0
5	124.0	1.600	1.26491	1.590	98.0	76.0
6	123.0	1.600	1.26491	1.590	98.0	76.0
7	123.0	1.850	1.36015	1.840	96.0	76.0
8	124.0	1.900	1.37840	1.890	98.0	76.0
9	123.0	1.850	1.36015	1.850	100.0	76.0
10	121.0	1.650	1.28452	1.650	102.0	76.0
11	124.0	1.500	1.22474	1.500	102.0	76.0
12	124.0	1.600	1.26491	1.600	102.0	76.0
13	118.0	1.800	1.34164	1.800	100.0	76.0
14	122.0	1.800	1.34164	1.800	102.0	76.0
15	125.0	1.650	1.28452	1.650	103.0	76.0
16	127.0	1.500	1.22474	1.490	102.0	76.0
17	118.0	1.450	1.20416	1.460	102.0	76.0
18	120.0	1.400	1.18322	1.410	102.0	76.0
19	120.0	1.650	1.28452	1.650	98.0	76.0
20	121.0	1.450	1.20416	1.450	102.0	76.0
21	124.0	1.300	1.14018	1.290	102.0	76.0
22	125.0	1.300	1.14018	1.290	102.0	76.0
23	124.0	1.400	1.18322	1.400	102.0	76.0
24	122.0	1.100	1.04881	1.100	102.0	76.0
AVERAGE VALUES	TS= 582.625 DEG R		SR(VP)= 1.268745	OP= 1.61375 IN H2O	TM= 547.8125 DEG R	

NORTHLAND FOOD CO-OP,WHEY DRYER,RUN: 2

CALCULATED RESULTS

VMSTD DGM VOL,STD COND DRY= 9.24126 SCFD

VWSTD VOL OF WATER VAPOR,STD COND= 2.584143 SCF

%M % MOISTURE IN STACK GAS BY VOL,STD COND= 6.178405 %

MD MOLE FRACTION OF DRY GAS= .938216

MWD MOLECULAR WT OF STACK GAS,DRY BASIS= 28.88 LB/LB-MOLE

MWS MOLECULAR WT OF STACK GAS,WET BASIS= 28.20779 LB/LB-MOLE

VS AVE STACK GAS VELOCITY,STACK COND= 75.81969 FPS

QSTD AVE STACK GAS FLOW RATE,STD COND DRY= 22233.31 SCFMD

%EA AVE % EXCESS AIR= 2024.294 %

PMRA AVE PMR BY RATIO OF AREAS METHOD= 6.513983 LB/HR

PMRC AVE PMR BY CONC METHOD= 6.60275 LB/HR

PMR(AVE) AVE PMR,STD COND DRY= 6.558366 LB/HR

C EMISSION CONC,STD COND DRY= 3.464167E-02 GR/SCFD

DGR AVE STACK GAS RATE,STD COND DRY= 100006.1 LB/HR

LB/MLB EMISSION CONC,STD COND DRY= 6.557967E-02 LB/MLB OF DRY GAS

WGR AVE STACK GAS RATE,STD COND WET= 104110.7 LB/HR

LB/MLB EMISSION CONC,STD COND WET= 6.299415E-02 LB/MLB OF WET GAS

%I % ISOKINETIC RATIO= 98.6556 %

NAME OF SOURCE: NORTHLAND FOOD CO-OP

LOCATION OF SOURCE: SHAWANO WI

PROCESS TESTED: WHEY DRYER

DATE OF TEST: 4-9-86

RUN NUMBER: 3

N NUMBER OF SAMPLING POINTS= 24

VM DGM VOL,METER COND DRY= 41.528 CFD

PB BAR PRESS,STATION= 29.1 IN HG

VL TOTAL VOL OF WATER COLLECTED= 54.9 ML

%CO2 % CARBON DIOXIDE BY VOL,DRY BASIS= .6 %

%O2 % OXYGEN BY VOL,DRY BASIS= 19.8 %

%CO % CARBON MONOXIDE BY VOL, DRY BASIS= 0 %

%N2 % NITROGEN BY VOL,DRY BASIS= 79.6 %

CP PITOT TUBE COEFFICIENT= .83

PS STACK PRESS= 29.13 IN HG

AS AREA OF THE SAMPLING SITE= 5.906 SQ FEET

MT TOTAL DRY PARTICULATE= .0632 GM

T TOTAL SAMPLING TIME= 60 MIN

AN AREA OF THE NOZZLE= .0001761 SQ FEET

NORTHLAND FOOD CO-OP,WHEY DRYER,RUN: 3

PARTICULATE FIELD DATA

SAMPLING POINT NUMBER	STACK TEMP DEG F	VELOCITY PRESS IN H2O	SQ ROOT VEL PRESS	ORIFICE METER PRESS DROP IN H2O	DRY GAS METER TEMP DEG F INLET	OUTLET
1	123.0	2.250	1.50000	2.190	74.0	74.0
2	127.0	1.950	1.39642	1.900	84.0	74.0
3	127.0	1.750	1.32288	1.710	90.0	74.0
4	127.0	1.600	1.26491	1.570	92.0	74.0
5	126.0	1.650	1.28452	1.630	94.0	74.0
6	127.0	1.750	1.32288	1.720	96.0	74.0
7	127.0	1.950	1.39642	1.920	96.0	72.0
8	126.0	2.000	1.41421	1.970	98.0	72.0
9	126.0	1.900	1.37840	1.880	100.0	72.0
10	125.0	1.700	1.30384	1.680	100.0	72.0
11	126.0	1.550	1.24499	1.530	102.0	72.0
12	127.0	1.550	1.24499	1.530	102.0	72.0
13	125.0	1.850	1.36015	1.830	98.0	72.0
14	127.0	1.850	1.36015	1.830	102.0	72.0
15	126.0	1.650	1.28452	1.630	102.0	72.0
16	126.0	1.450	1.20416	1.430	102.0	72.0
17	126.0	1.400	1.18322	1.390	103.0	73.0
18	127.0	1.400	1.18322	1.390	103.0	73.0
19	126.0	1.750	1.32288	1.720	96.0	72.0
20	127.0	1.450	1.20416	1.440	102.0	74.0
21	127.0	1.250	1.11803	1.240	102.0	74.0
22	124.0	1.200	1.09545	1.190	102.0	74.0
23	125.0	1.350	1.16190	1.340	102.0	74.0
24	127.0	1.050	1.02470	1.040	102.0	74.0
AVERAGE	TS=		SR(VP)=	OP=	TM=	
VALUES	586.125 DEG R		1.274041	1.6125 IN H2O	545.3333 DEG R	

NORTHLAND FOOD CO-OP,WHEY DRYER,RUN: 3

CALCULATED RESULTS

VMSTD DGM VOL,STD COND DRY= 39.26542 SCFD

VWSTD VOL OF WATER VAPOR,STD COND= 2.584143 SCF

%M % MOISTURE IN STACK GAS BY VOL,STD COND= 6.174839 %

MD MOLE FRACTION OF DRY GAS= .9382517

MWD MOLECULAR WT OF STACK GAS,DRY BASIS= 28.888 LB/LB-MOLE

MWS MOLECULAR WT OF STACK GAS,WET BASIS= 28.21568 LB/LB-MOLE

VS AVE STACK GAS VELOCITY,STACK COND= 76.34075 FPS

QSTD AVE STACK GAS FLOW RATE,STD COND DRY= 22260.92 SCFMD

%EA AVE % EXCESS AIR= 1630.436 %

PMRA AVE PMR BY RATIO OF AREAS METHOD= 4.672913 LB/HR

PMRC AVE PMR BY CONC METHOD= 4.739556 LB/HR

PMR(AVE) AVE PMR,STD COND DRY= 4.706235 LB/HR

C EMISSION CONC,STD COND DRY= 2.483549E-02 GR/SCFD

DGR AVE STACK GAS RATE,STD COND DRY= 100158 LB/HR

LB/MLB EMISSION CONC,STD COND DRY= .0469881 LB/MLB OF DRY GAS

WGR AVE STACK GAS RATE,STD COND WET= 104265.2 LB/HR

LB/MLB EMISSION CONC,STD COND WET= 4.513715E-02 LB/MLB OF WET GAS

%I % ISOKINETIC RATIO= 98.5939 %

Table of Contents

WHEY DRYER EMISSION TEST

I. Introduction and Summary

Badger Laboratories & Engineering Co., Inc. was retained by Northland Foods of Shawano, WI to determine the concentration of particulate matter in the exhaust from a whey dryer. The purpose of the test was to show compliance with State of Wisconsin particulate limitations.

Emission tests were conducted April 9 & 10, 1986 by Sander E. Sundberg, PhD and Bruce Lamers. Larry Weix of the Wisconsin Department of Natural Resources visited the test site. The ambient temperature during the test was 45 - 55°F, wind was strong and gusty from the northwest. A total of five test runs were performed following U.S. EPA Methods.

The whey dryer emission did not look normal to Mr. Marquardt and the production was stopped after the second test. A cyclone was found to be plugged. This situation was corrected and testing resumed. Mr. Dick Marquardt is the company contact.

The exhaust gas ranged in temperature from 115 - 132°F. The sampling isokinetic rates were 98.0, 98.5, 98.4, 99.1 and 99.1 percent.

The results of the tests are as follows:

Test Run	Date	Volumetric Flow Rate scfh (dry)	Particulate Emission Rate lb./hr.	Particulate Concentration lb./1000 lb. Gas
1	4-9-86	1.314×10^6	5.3119	0.0540
2	4-9-86	1.323×10^6	6.6208	0.0669
3	4-9-86	1.324×10^6	4.7507	0.0480
4	4-9-86	1.322×10^6	3.8910	0.0393
5	4-10-86	1.324×10^6	4.1446	0.0418

The arithmatic average of the five results is 0.0500 lb/1000 lb. gas. The limitation on this source is 0.20 lb/1000 lb. gas.

II. Process Data

The stack carries exhaust gases from a whey dryer. The production rates measured by Northland Foods are as follows:

Test Run	Whe Powder Production Throughput Rate lb/hr.	
1	5732	
2	5602	
3	5313	5549
4	5594	
5	5595	

The normal average production rate is 5500 lb./hr.

The process uses natural gas as a fuel with propane as a standby fuel. The whey is sprayed into the primary dryer. The powder passes into a secondary dryer and is then bagged. The emission source tested is the exhaust from the primary dryer. There are two cyclones in place for collecting particulate fines.

III. Stack Testing and Analytical Procedures

The procedure for sampling, testing, instrumentation and analysis as described by the U.S. EPA were followed. The EPA reference methods used in the testing program are summarized below.

Method: Sample and Velocity Traverse Locations

The sampling site lies in a straight section of 28 x 32 inch rectangular steel stack. The sampling site is approximately 4.2 equivalent diameters downstream from the last disturbance and 0.8 equivalent diameters upstream from the stack top (equivalent diameters 29.8"). Twenty-four points were sampled, six on each traverse. Sampling time was 3 minutes per point. The location of the traverse points is shown in Table #1 below. There are four ports located equidistant on the 32" side of the duct.

Table #1

Location of Traverse Points from Stack Wall

Stack Dimensions = 28 x 32 inches.

Traverse Point No.	Inches from Back Wall
1	4
2	8
3	12
4	16
5	20
6	24

Method 2: Stack Gas Velocity and Volumetric Flow Rate

For each test run, a velocity traverse was made with a calibrated Type "S" pitot tube having a co-efficient of 0.845. The velocity head was read on an inclined manometer to the nearest 0.01 inches of water. Temperature was measured with a chromel-alumel thermocouple.

Sampling site barometric pressure was obtained from National Weather Service data.

Method 3: Component Gas Analysis

Analyses for Carbon Dioxide (CO_2), Oxygen (O_2), and Nitrogen plus Carbon Monoxide (N_2 + CO) were performed in the field using an Orsat type analyzer. Prior to testing, the Orsat apparatus was checked for leaks and the activity of the absorbing solution was determined to be adequate. Results were read and recorded to the nearest 0.2 percent volume, dry basis.

Method 4: Moisture Content

The moisture content of the stack gas was determined by condensing in three impingers in an ice bath and absorbing any remaining moisture in a fourth impinger containing silica gel.

Method 5: Particulate Emission

Particulate material is withdrawn isokinetically from the stack and collected on a glass fiber filter maintained in the temperature range of 223°F to 273°F. The sample gas stream is dried as in Method 4 above. The sample gas is then passed through a metering system which measures both the cumulative volume of gas sampled and the instantaneous sampling rate.

Sampling Train

A schematic of the sampling train used in this method is shown in Figure 1. The sampling train consists of the following components:

1. Stainless steel, buttonhook-type nozzle.
2. Asbestos gasket.
3. Stainless steel probe.
5. Fritted glass filter holder.
6. Electrically heated enclosed sample box.
7. Ice-water bath.
8. Modified Greenburg-Smith impinger.
9. Greenburg-Smith impinger.
10. Modified Greenburg-Smith impinger.
11. Modified Greenburg-Smith impinger.
12. Check valve.
13. Vacuum tube.
14. Vacuum gauge.
15. Vacuum valve.
16. Leak-free vacuum pump.
17. By-pass valve.
18. Dry gas meter.
19. Calibrated orifice.
20. Dual manometer. (Dwyer Micro Manometer.)
21. Type "S" pitot tube.

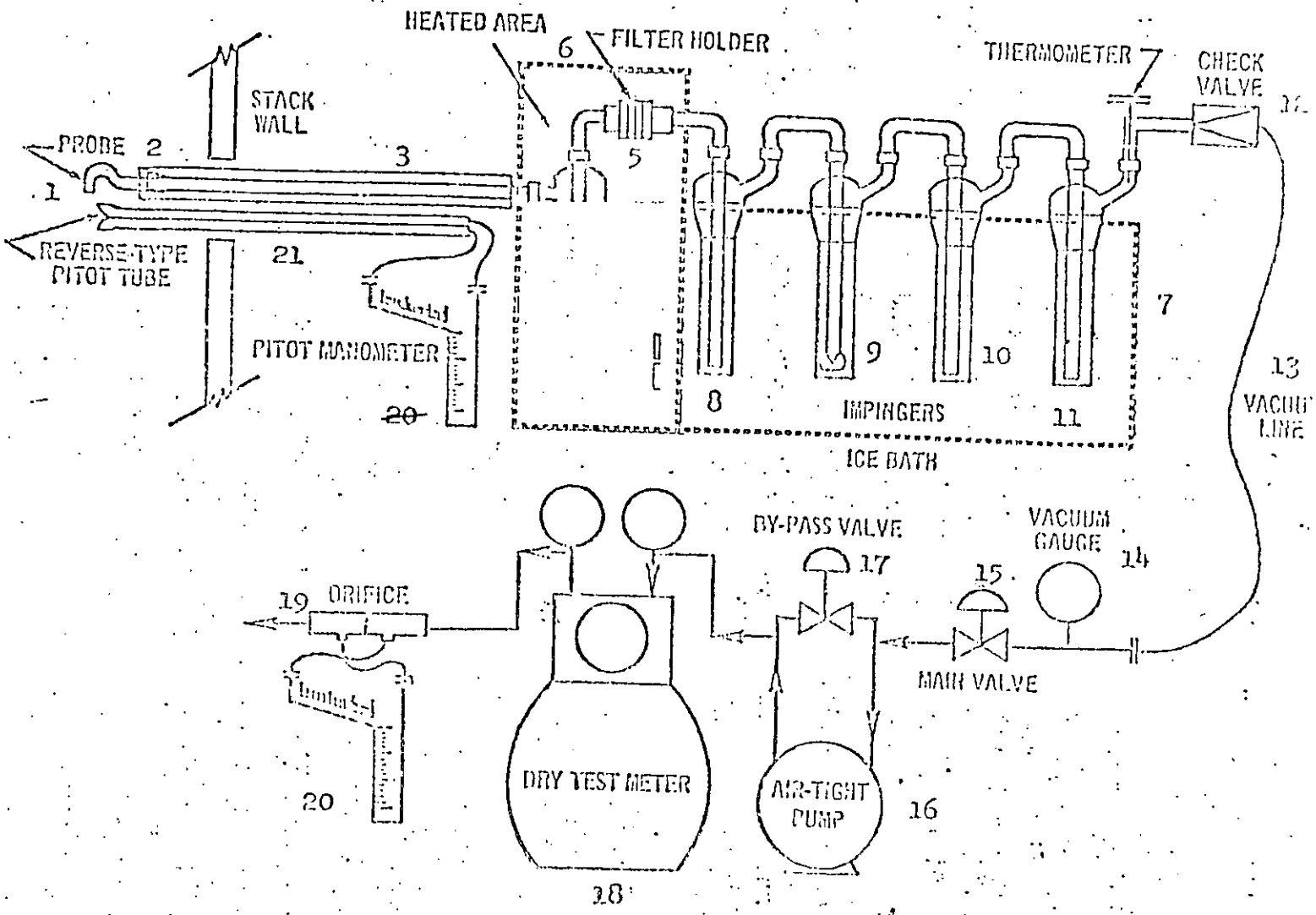


Figure 1. Particulate sampling train.

A more detailed description of the sampling train components follows:

1. Probe Nozzle: Stainless steel with sharp, tapered leading edge. A 0.1797 inch diameter (as measured on site with a caliper) nozzle was used in all tests.

2. Probe Liner: Stainless steel with a heating system is used to maintain a gas temperature at the exit during sampling of 223°F - 273°F.

3. Pitot Tube: A Type "S" pitot tube attached to the probe allowed constant monitoring of the stack gas velocity. The pitot tube co-efficient was determined by comparison with a standard pitot tube on April 8, 1986. ΔP was read from an inclined manometer.

4. Differential Pressure Gauge: A Dwyer magalhelic gauge with a range of 0 - 10 inches water was used to obtain ΔH.

5. Filter Holder: Borosilicate glass, with a glass frit filter support and a silicone rubber gasket.

6. Filter Heating System: Thermostat controlled electrical resistance type heater capable of maintaining a temperature of 223°F - 273°F around the filter holder.

7. Impingers: Four pyrex glass impingers connected in series with a leak-free ground glass fitting. The first, third, and fourth impingers were Greenburg-Smith design with a modified (straight) tip. The second impinger was a Greenburg-Smith design with a standard tip. A thermometer was in place to measure the temperature at the outlet of the fourth impinger.

8. Metering System: The vacuum gauge, leak-free pump, thermometer, temperature compensated dry gas meter, and related equipment are shown in Figure 1 (as shown in Page #5). The sampler is a LSI Model 31.

Sampling Procedures

Prior to testing, the sampling train is cleaned and set-up as follows:

A four-inch diameter glass fiber filter was dried in a 105°C oven overnight. The filter was then placed in a desiccator for two hours and weighed on an analytical balance to the nearest 0.1 milligram (mg.). One hundred milliliters (ml.) of distilled water was placed in each of the first two impingers. Two hundres grams dry silica gel (indicating) was placed in the fourth impinger. The third impinger was left dry and empty. The sampling train was assembled as shown in Figure 1 (Page #5). Based on the preliminary velocity and temperature traverse, an appropriate nozzle size was selected to provide an adequate sampling rate.

After assembly, the sampling train was leak-checked at the inlet to the filter holder at 15 inches mercury vacuum. If a leak rate of greater than 0.02 ft. ^{3}/min. was observed, the system was checked and leaks corrected. The leak check procedure was repeated until the leakage rate was less than 0.02 ft. ^{3}/min.

Approximately one half hour before the start of the test, the probe and filter box heaters were turned on and allowed to warm up to sampling temperatures. Ice was placed around the impingers.

At the start of a test run, the dry gas meter reading was recorded on the data sheet, the probe was placed in the stack at the first sampling point, and the velocity pressure was read. Using an isokinetic flow rate calculator, the desired orifice meter pressure was determined. The sample pump was than turned on and the time was recorded. The main and by-pass valves were immediately adjusted to give the desired sampling rate. For each point the following data was recorded: traverse point number, sampling time, stack temperature, velocity head, orifice meter reading, dry gas meter volume, meter temperature, box temperature, and pump vacuum. Near the end of the sampling time (approximately 10 seconds remaining), the nozzle was moved to the next point and exactly at the start of the next sampling period, the dry gas meter volume was recorded. The point by point sampling procedures were then repeated until the test run was completed. While moving between ports, the pump was turned-off. At the completion of the test tun, the pump was turned-off, the dry gas meter volume recorded, and the probe was removed from the stack. The sample train was leak-checked from the sample nozzle at two inches mercury vacuum and at 15 inches mercury vacuum from the filter inlet to verify the leak-free integrity of the system.

Sample Recovery

Sample recovery was accomplished near the sampling site. While the probe and filter holder were cooling, the contents of the first three impingers were measured volumetrically and discarded. The silica gel in the fourth impinger was transferred to a clean, dry container. This was weighed in the lab at a later time.

Sample Recovery Cont...

The filter was carefully transferred to a petri dish. Any filter material which stuck to the gasket was scraped loose and transferred to the petri dish. The upstram portion of the filter holder was washed with acetone, which was collected in a clean glass container labelled to identify the test run. The probe nozzle was then removed and the inner surfaces rinsed with acetone along with cleaning by a brush until no visible particulate was present in the rinse. The probe liner was washed with acetone and brushing. Both the probe liner and nozzle washes were collected in the same container as the filter holder washings.

Sample Analysis

In the laboratory, the filter and any loose particulate were placed in a 105°C overn overnight. The material was then transferred to a desiccator for two hours and weighed on an analytical balance to the nearest 0.1 mg.

The volume of the upstream acetone wash was measured and transferred to a tared beaker. The acetone was evaporated without boiling. After desiccation, the beaker was reweighed. Simultaneously, a 100 ml. acetone blank was evaporated and the residue weight was determined. The net residue weight of the sample washes has been adjusted for the acetone blank.

The total particulate collected was taken as the net residue weight of the acetone wash plus the weight gain of the filter.

The silica gel from each run was weighed to the nearest 0.1 gm. The weight gain of the silica gel was added to the volume of liquid water collected in the first three impingers to obtain the total amount of water collected.

Data Handling and Calculations

All mathematical calculations were made according to accepted techniques using U.S. EPA equations. Standard conditions of 29.92 inches mercury pressure and 70°F temperature were used. Field calculations were rechecked, and the final results for each test run and presented in detail in the Appendix.

CONVERSION CALCULATIONS

To convert the results for each test run to lbs. particulate/1000 lbs. gas (dry), the following calculation was made:

$$C''_s = C_s (1-B_{wo}) \frac{1}{R} \frac{1}{M_d} 1000$$

where...

C''_s = Concentration of particulate, lbs./1000 lbs. gas (dry).

C_s = Concentration of particulate, lbs./scf (dry).

B_{wo} = Proportion of water vapor in gas stream.

R = Ideal gas constant = $\frac{1 \text{ lb. - mole}}{386 \text{ scf}}$

M_d = Molecular weight of stack gas, dry $\frac{\text{lb.}}{\text{lb. - mole}}$

To convert the results to a 12% CO_2 corrected basis, the following calculation was made:

$$C_{12} = \frac{12 \, C''_s}{\% \, CO_2}$$

Where...

C_{12} = Concentration of particulate corrected to 12% CO_2.

C''_s = Concentration of particulate, lbs./1000 gas (dry).

% CO_2 = Percent CO_2 as measured by Method 3.

IV. APPENDIX

LOCATION...WHEY DRYER

DATE.....04-09-86

TIME.....0850-1006 HRS

TEST RUN #.1

STACK GAS DATA

TEMPERATURE, F	115.0
VELOCITY, ft/sec	74.94
GAS VOLUME, ACFM	26554.9
GAS VOLUME, SCFM(WET)	23698.0
GAS VOLUME, SCFH(DRY)	1314420.0
MOISTURE, %	7.6
CARBON DIOXIDE, %(DRY)	0.5
OXYGEN, %(DRY)	20.0
CARBON MONOXIDE, %(DRY)	0.0
NITROGEN, %(DRY)	79.5
MOLECULAR WEIGHT, (WET)	28.06

SAMPLING DATA

TOTAL TIME, min	72.0
VOLUME, SCF(DRY)	46.050
ISOKINETIC RATIO, %	98.0

TOTAL PARTICULATES

AMOUNT COLLECTED, mg	84.4
CONCENTRATION, Grains/SCF	0.0283
EMISSION RATE, lb/hr	5.3119
CONC., lb/1000 lb gas dry	0.0540
CONC., corrected to 12% CO2	1.2963

SOURCE TEST DATA SUMMARY

COMPANY....NORTHLAND FOODS
LOCATION...KNEY DRYER
DATE.....04-09-86
TIME.....0850-1006 HRS
TEST RUN #.1

VOLUME THRU DG METER	Vm	=	48.903 cu-ft
VOLUME OF CONDENSATE	Vlc	=	69.4 ml
MOISTURE FRACTION THRU DG METER		=	0.010
BAROMETRIC PRESSURE	Pbar	=	29.10 in,Hg
STATIC PRESSURE	STATIC	=	0.25 in,H2O
ABS. STACK GAS PRESSURE	Ps	=	29.12 in,Hg
ABS. GAS METER PRESSURE	Pm	=	29.21 in,Hg
ABS. STACK GAS TEMPERATURE	Ts	=	575.8 R
ABS. GAS METER TEMPERATURE	Tm	=	541.4 R
STACK AREA	As	=	5.906 sq-ft
PITOT TUBE COEFFICIENT	Cp	=	0.830
AVE. VELOCITY HEAD OF STACK GAS		=	1.258
NOZZLE AREA	An	=	0.000176 sq-ft

STACK GAS DATA

TEMPERATURE, F	115.8
VELOCITY, ft/sec	74.94
GAS VOLUME, ACFM	26554.9
GAS VOLUME, SCFM(WET)	23698.0
GAS VOLUME, SCFH(DRY)	1314420.0
MOISTURE, %	7.6
CARBON DIOXIDE, %(DRY)	0.5
OXYGEN, %(DRY)	20.0
CARBON MONOXIDE, %(DRY)	0.0
NITROGEN, %(DRY)	79.5
MOLECULAR WEIGHT, (WET)	28.06

SAMPLING DATA

TOTAL TIME, min	72.0
VOLUME, SCF(DRY)	46.050
ISOKINETIC RATIO, %	93.0

TOTAL PARTICULATES

AMOUNT COLLECTED, mg	94.4
CONCENTRATION, Grains/SCF	0.0283
EMISSION RATE, lb/hr	5.3119
CONC., lb/1000 lb gas dry	0.0540
CONC., corrected to 12% CO2	1.2963

LOCATION...WHEY DRYER

DATE.....04-09-86

TIME.....1104-1207 HRS

TEST RUN #.2

STACK GAS DATA

TEMPERATURE, F	122.6
VELOCITY, ft/sec	75.98
GAS VOLUME, ACFM	26923.4
GAS VOLUME, SCFM(WET)	23749.5
GAS VOLUME, SCFH(DRY)	1322650.0
MOISTURE, %	7.2
CARBON DIOXIDE, %(DRY)	0.5
OXYGEN, %(DRY)	20.6
CARBON MONOXIDE, %(DRY)	0.0
NITROGEN, %(DRY)	79.5
MOLECULAR WEIGHT, (WET)	28.10

SAMPLING DATA

TOTAL TIME, min	60.0
VOLUME, SCF(DRY)	38.800
ISOKINETIC RATIO, %	98.5

TOTAL PARTICULATES

AMOUNT COLLECTED, mg	89.1
CONCENTRATION, Grains/SCF	0.0350
EMISSION RATE, lb/hr	6.6208
CONC., lb/1000 lb gas dry	0.0669
CONC., corrected to 12% CO2	1.6057

SOURCE TEST DATA SUMMARY

COMPANY....NORTHLAND FOODS
LOCATION...WHEY DRYER
DATE.....04-09-86
TIME.....1104-1207 HRS
TEST RUN #.2

VOLUME THRU DG METER	Vm	=	41.691 cu-ft
VOLUME OF CONDENSATE	Vlc	=	54.9 ml
MOISTURE FRACTION THRU DG METER		=	0.010
BAROMETRIC PRESSURE	Pbar	=	29.10 in,Hg
STATIC PRESSURE	STATIC	=	0.30 in,H2O
ABS. STACK GAS PRESSURE	Ps	=	29.12 in,Hg
ABS. GAS METER PRESSURE	Pm	=	29.22 in,Hg
ABS. STACK GAS TEMPERATURE	Ts	=	582.6 R
ABS. GAS METER TEMPERATURE	Tm	=	547.8 R
STACK AREA	As	=	5.906 sq-ft
PITOT TUBE COEFFICIENT	Cp	=	0.830
AVE. VELOCITY HEAD OF STACK GAS		=	1.269
NOZZLE AREA	An	=	0.000176 sq-ft

STACK GAS DATA

TEMPERATURE, F	122.6
VELOCITY, ft/sec	75.98
GAS VOLUME, ACFM	26923.4
GAS VOLUME, SCFM(WET)	23749.5
GAS VOLUME, SCFH(DRY)	1322650.0
MOISTURE, %	7.2
CARBON DIOXIDE, %(DRY)	0.5
OXYGEN, %(DRY)	20.0
CARBON MONOXIDE, %(DRY)	0.0
NITROGEN, %(DRY)	79.5
MOLECULAR WEIGHT, (WET)	28.10

SAMPLING DATA

TOTAL TIME, min	60.0
VOLUME, SCF(DRY)	38.808
ISOKINETIC RATIO, %	98.5

TOTAL PARTICULATES

AMOUNT COLLECTED, mg	88.1
CONCENTRATION, Grains/SCF	0.0350
EMISSION RATE, lb/hr	6.6206
CONC., lb/1000 lb gas dry	0.0669
CONC., corrected to 12% CO2	1.6057

LOCATION...WHEY DRYER

DATE.....09-07-86

TIME.....1430-1533 HRS

TEST RUN #.3

STACK GAS DATA

TEMPERATURE, F	126.1
VELOCITY, ft/sec	76.49
GAS VOLUME, ACFM	27105.1
GAS VOLUME, SCFM(WET)	23770.0
GAS VOLUME, SCFM(DRY)	1323840.0
MOISTURE, %	7.2
CARBON DIOXIDE, %(DRY)	0.6
OXYGEN, %(DRY)	19.8
CARBON MONOXIDE, %(DRY)	0.0
NITROGEN, %(DRY)	79.6
MOLECULAR WEIGHT, (WET)	28.11

SAMPLING DATA

TOTAL TIME, min	60.0
VOLUME, SCF(DRY)	38.834
ISOKINETIC RATIO, %	98.4

TOTAL PARTICULATES

AMOUNT COLLECTED, mg	63.2
CONCENTRATION, Grains/SCF	0.0251
EMISSION RATE, lb/hr	4.7507
CONC., lb/1000 lb gas dry	0.0480
CONC., corrected to .3% CO2	0.9590

SOURCE TEST DATA SUMMARY

COMPANY....NORTHLAND FOODS
LOCATION...WHEY DRYER
DATE.....04-09-86
TIME.....1430-1533 HRS
TEST RUN #3

VOLUME THRU DG METER	Vm	=	91.528 cu-ft
VOLUME OF CONDENSATE	Vlc	=	54.9 ml
MOISTURE FRACTION THRU DG METER		=	0.010
BAROMETRIC PRESSURE	Pbar	=	29.10 in,Hg
STATIC PRESSURE	STATIC	=	0.35 in,H2O
ABS. STACK GAS PRESSURE	Ps	=	29.13 in,Hg
ABS. GAS METER PRESSURE	Pm	=	29.22 in,Hg
ABS. STACK GAS TEMPERATURE	Ts	=	586.1 R
ABS. GAS METER TEMPERATURE	Tm	=	545.3 R
STACK AREA	As	=	5.906 sq-ft
PITOT TUBE COEFFICIENT	Cp	=	0.830
AVE. VELOCITY HEAD OF STACK GAS		=	1.274
NOZZLE AREA	An	=	0.000176 sq-ft

STACK GAS DATA

TEMPERATURE, F	126.1
VELOCITY, ft/sec	76.49
GAS VOLUME, ACFM	27105.1
GAS VOLUME, SCFM(WET)	23770.0
GAS VOLUME, SCFM(DRY)	1323849.0
MOISTURE, %	7.2
CARBON DIOXIDE, %(DRY)	0.5
OXYGEN, %(DRY)	19.6
CARBON MONOXIDE, %(DRY)	0.0
NITROGEN, %(DRY)	79.6
MOLECULAR WEIGHT, (WET)	28.11

SAMPLING DATA

TOTAL TIME, min	60.0
VOLUME, SCF(DRY)	38.834
ISOKINETIC RATIO, %	98.4

TOTAL PARTICULATES

AMOUNT COLLECTED, mg	63.2
CONCENTRATION, Grains/SCF	0.0251
EMISSION RATE, lb/hr	4.7507
CONC., lb/1000 lb gas dry	0.0480
CONC., corrected to 12% CO2	0.9590

LOCATION...WHEY DRYER

DATE.....04-09-86

TIME.....1630-1733

TEST RUN #.4

STACK GAS DATA

TEMPERATURE, F	127.8
VELOCITY, ft/sec	76.67
GAS VOLUME, ACFM	27169.5
GAS VOLUME, SCFM(WET)	23755.7
GAS VOLUME, SCFH(DRY)	1322290.0
MOISTURE, %	7.2
CARBON DIOXIDE, %(DRY)	0.6
OXYGEN, %(DRY)	19.8
CARBON MONOXIDE, %(DRY)	0.0
NITROGEN, %(DRY)	79.6
MOLECULAR WEIGHT, (WET)	28.10

SAMPLING DATA

TOTAL TIME, min	60.0
VOLUME, SCF(DRY)	39.040
ISOKINETIC RATIO, %	99.1

TOTAL PARTICULATES

AMOUNT COLLECTED, mg	52.1
CONCENTRATION, Grains/SCF	0.0206
EMISSION RATE, lb/hr	3.8910
CONC., lb/1000 lb gas dry	0.0393
CONC., corrected to 12% CO2	0.7864

SOURCE TEST DATA SUMMARY

COMPANY....NORTHLAND FOODS
LOCATION...WHEY DRYER
DATE.....04-09-86
TIME.....1630-1733
TEST RUN #.4

VOLUME THRU DRY METER	Vm	=	41.528 cu-ft
VOLUME OF CONDENSATE	Vlc	=	35.7 ml
MOISTURE FRACTION THRU DG METER		=	0.010
BAROMETRIC PRESSURE	Pbar	=	29.10 in,Hg
STATIC PRESSURE	STATIC	=	0.32 in,H2O
ABS. STACK GAS PRESSURE	Ps	=	29.12 in,Hg
ABS. GAS METER PRESSURE	Pm	=	29.22 in,Hg
ABS. STACK GAS TEMPERATURE	Ts	=	587.8 R
ABS. GAS METER TEMPERATURE	Tm	=	542.4 R
STACK AREA	As	=	5.906 sq-ft
PITOT TUBE COEFFICIENT	Cp	=	0.830
AVE. VELOCITY HEAD OF STACK GAS		=	1.273
NOZZLE AREA	An	=	0.000176 sq-ft

STACK GAS DATA

TEMPERATURE, F	127.8
VELOCITY, ft/sec	76.67
GAS VOLUME, ACFM	27169.5
GAS VOLUME, SCFM(WET)	23755.7
GAS VOLUME, SCFM(DRY)	1272290.0
MOISTURE, %	7.2
CARBON DIOXIDE, %(DRY)	0.6
OXYGEN, %(DRY)	19.8
CARBON MONOXIDE, %(DRY)	0.0
NITROGEN, %(DRY)	79.6
MOLECULAR WEIGHT, (WET)	28.10

SAMPLING DATA

TOTAL TIME, min	60.0
VOLUME, SCF(DRY)	39.040
ISOKINETIC RATIO, %	99.1

TOTAL PARTICULATES

AMOUNT COLLECTED, mg	52.1
CONCENTRATION, Grains/SCF	0.0206
EMISSION RATE, lb/hr	3.8910
CONC., lb/1000 lb gas dry	0.0393
CONC., corrected to 12% CO2	0.7864

LOCATION...WHEY DRYER

DATE.....04-10-86

TIME.....0831-0934 HRS

TEST RUN #.5

STACK GAS DATA

TEMPERATURE, F	124.3
VELOCITY, ft/sec	76.08
GAS VOLUME, ACFM	26960.6
GAS VOLUME, SCFM(WET)	23716.1
GAS VOLUME, SCFH(DRY)	1323770.0
MOISTURE, %	7.0
CARBON DIOXIDE, %(DRY)	0.8
OXYGEN, %(DRY)	19.4
CARBON MONOXIDE, %(DRY)	0.0
NITROGEN, %(DRY)	79.8
MOLECULAR WEIGHT, (WET)	28.14

SAMPLING DATA

TOTAL TIME, min	60.0
VOLUME, SCF(DRY)	39.087
ISOKINETIC RATIO, %	99.1

TOTAL PARTICULATES

AMOUNT COLLECTED, mg	55.5
CONCENTRATION, Grains/SCF	0.0219
EMISSION RATE, lb/hr	4.1446
CONC., lb/1000 lb gas dry	0.0418
CONC., corrected to 12% CO2	0.6272

SOURCE TEST DATA SUMMARY

COMPANY....NORTHLAND FOODS
LOCATION...WHEY DRYER
DATE.....04-10-86
TIME.....0831-0934 HRS
TEST RUN #.5

VOLUME THRU DG METER	Vm	=	41.592 cu-ft
VOLUME OF CONDENSATE	Vlc	=	53.3 ml
MOISTURE FRACTION THRU DG METER		=	0.010
BAROMETRIC PRESSURE	Pbar	=	29.10 in.Hg
STATIC PRESSURE	STATIC	=	0.35 in.H2O
AVG. STACK GAS PRESSURE	Ps	=	29.13 in.Hg
AVG. GAS METER PRESSURE	Pm	=	29.22 in.Hg
AVG. STACK GAS TEMPERATURE	Ts	=	584.3 R
AVG. GAS METER TEMPERATURE	Tm	=	542.6 R
STACK AREA	As	=	5.906 sq-ft
PITOT TUBE COEFFICIENT	Cp	=	0.830
AVE. VELOCITY HEAD OF STACK GAS		=	1.270
NOZZLE AREA	An	=	0.000176 sq-ft

STACK GAS DATA

TEMPERATURE, F	124.3
VELOCITY, ft/sec	76.00
GAS VOLUME, ACFM	26960.6
GAS VOLUME, SCFM(WET)	23716.1
GAS VOLUME, SCFH(DRY)	1323770.0
MOISTURE, %	7.0
CARBON DIOXIDE, %(DRY)	0.8
OXYGEN, %(DRY)	19.4
CARBON MONOXIDE, %(DRY)	0.0
NITROGEN, %(DRY)	79.8
MOLECULAR WEIGHT, (WET)	28.14

SAMPLING DATA

TOTAL TIME, min	60.0
VOLUME, SCF(DRY)	39.087
ISOKINETIC RATIO, %	99.1

TOTAL PARTICULATES

AMOUNT COLLECTED, mg	55.5
CONCENTRATION, Grains/SCF	0.0219
EMISSION RATE, lb/hr	4.144
CONC., lb/1000 lb gas dry	0.0418
CONC., corrected to 12% CO2	0.6272

LABORATORY DATA

COMPANY [illegible]

LOCATION [illegible]

DATE [illegible]

TEST RUN # [illegible]

FILTER NUMBER _____

AMOUNT OF LIQUID LOST DURING TRANSPORT —

ACETONE BLANK VOLUME, ml [illegible]

ACETONE WASH VOLUME, ml [illegible]

ACETONE BLANK CONCENTRATION, mg/ml [illegible]

TOTAL ACETONE WASH BLANK, mg [illegible]

WEIGHT OF PARTICULATE COLLECTED

FILTER

FINAL WEIGHT [illegible]

TARE WEIGHT - [illegible]

WEIGHT GAIN [illegible]

ACETONE WASH

FINAL WEIGHT [illegible]

TARE WEIGHT - [illegible]

WEIGHT GAIN [illegible]

ACETONE BLANK - [illegible]

NET GAIN [illegible]

TOTAL WEIGHT OF PARTICULATES [illegible] mg

COMPANY NORTHLAND — AMBIENT TEMPERATURE 40 — SAMPLE BOX #

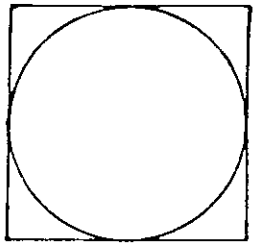
LOCATION WEST DOCK — BAROMETRIC PRESSURE 29.1 — METER BOX #

DATE 04-01-96 — ASSUMED MOISTURE, % 12 — METER ΔH@ 1.85

TEST RUN # 1 01 — HEATER BOX SETTING 250 — C FACTOR

STACK AREA 27" X 31.5 — PROBE HEATER SETTING 250 — PROBE LENGTH

OPERATOR GS, DL — FILTER NUMBER 1 — NOZZLE DIAMETER 23/128" 1.761 x 10^-4 ft^2



STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE (in.H_2O)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	VELOCITY HEAD ($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft^3)	DRY GAS METER INLET (T_{mi}, °F)	DRY GAS METER OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM (in.Hg)		
0850	D 6	3.0		117	2.25	1.500	2.05	358.154	80	63	250		2.35	
53	5			119	1.35	1.360	1.69	60.36	92	68		7.5	2.14	60 51
56	4			118	1.70	1.304	1.55	63.20	84	67			2.05	62.94
59	3		4.20	116	1.55	1.245	1.42	64.80	86	67			1.96	64.91
0902	2			116	1.60	1.265	1.47	66.72	88	66 77			1.99	66.9
05	1			115	1.55	1.245	1.43	68.90	90	66			1.96	68.84
0909	C 6			116	1.90	1.378	1.75	71.99	85	66			2.17	70.10
12	5			115	1.90	1.379	1.89	73.20	94	66 80			2.26	73.0
15	4		4.30	115	1.75	1.323	1.75	75.43	96	66 81			2.12	75.
18	3			116	1.50	1.225	1.50	77.69	98	66 82			2.01	77.51
21	2			116	1.40	1.183	1.40	79.75	97	67			1.94	79.52
24	1			115	1.55	1.245	1.55	81.71	97	67			1.95	81.46
TOTAL		30		1913		15.051	19.45	83.75	1050	900				83.51
AVERAGE														

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL				
INITIAL				
NET H_2O				
TOTAL H_2O COLLECTED, ml				

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
	0.5	20.0		
AVERAGE				

COMMENTS:

COMPANY NORTHLAND — AMBIENT TEMPERATURE ____ — SAMPLE BOX # ____

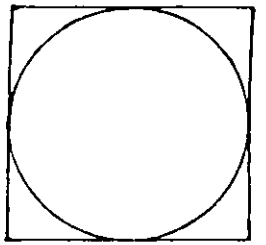
LOCATION [illegible] DENVER — BAROMETRIC PRESSURE ____ — METER BOX # ____

DATE 04 07 96 — ASSUMED MOISTURE, % ____ — METER Δ H@ ____

TEST RUN # 1 P2 — HEATER BOX SETTING ____ — C FACTOR Cp = .83

STACK AREA ____ — PROBE HEATER SETTING ____ — PROBE LENGTH ____

OPERATOR ____ — FILTER NUMBER 1 — NOZZLE DIAMETER .1797"


STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE (in.H_2O)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft^3)	DRY GAS METER INLET (T_{mi}, °F)	DRY GAS METER OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM (in.Hg)		
2?4	B 6	30		115	.90	1.342	1.79	83.75	90	70	250	7.1	2.20	33.5
32	5		+.30	115	0	1.342	1.50	85.98	96	70			1.91	35.
35	4			115	.95	1.255	1.66	88.14	98	70			2.12	8
38	3			115	.95	1.225	1.50	90.27	98	70			2.02	90.
41	2			115	1.40	1.183	1.41	92.37	99	70			1.95	92.
44/47	1			115	1.50	1.225	1.51	94.36	100	70			2.02	93
48	A 6			115	1.65	1.285	1.66	96.18	96	72			2.12	96
51	5			115	1.45	1.204	1.46	98.41	100	72.36			1.99	98.
54	4			116	1.35	1.162	1.36	100.30	100	72			1.72	100.
57	3		+.20	115	1.25	1.18	1.26	02.13	100	72			1.54	02.
60	2			117	1.30	1.140	1.31	03.90	100	72			1.86	03.
1003/1006	1			116	1.05	1.025	1.06	05.68	100	72			1.69	05.
TOTAL		36		1385		14.536	12.86	907.357	1177	852				907.4
AVERAGE			1.02	115.3		1.253	1.55	49.903	98.1	71.4				

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL	3.9			
INITIAL	2.0			
NET H_2O				1.1
TOTAL H_2O COLLECTED, ml	69.4			

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
AVERAGE				

COMMENTS:

LABORATORY DATA

COMPANY _____

LOCATION _____

DATE 4-9-76

TEST RUN # _____

FILTER NUMBER _____

AMOUNT OF LIQUID LOST DURING TRANSPORT —

ACETONE BLANK VOLUME, ml 100

ACETONE WASH VOLUME, ml 115

ACETONE BLANK CONCENTRATION, mg/ml _____

TOTAL ACETONE WASH BLANK, mg _____

WEIGHT OF PARTICULATE COLLECTED

FILTER

FINAL WEIGHT _____

TARE WEIGHT - _____

WEIGHT GAIN _____

ACETONE WASH

FINAL WEIGHT _____

TARE WEIGHT - _____

WEIGHT GAIN _____

ACETONE BLANK - _____

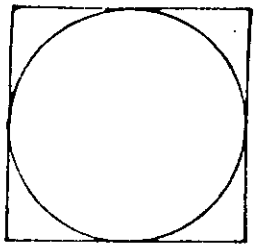
NET GAIN _____

TOTAL WEIGHT OF PARTICULATES _____ mg

COMPANY NORTHLAND
LOCATION WHEY DRIVE
DATE 04-09-96
TEST RUN # 2 P1
STACK AREA 27" x 31.5" (5.9)
OPERATOR SD

AMBIENT TEMPERATURE 49/52
BAROMETRIC PRESSURE 29.1
ASSUMED MOISTURE, % 3
HEATER BOX SETTING 250
PROBE HEATER SETTING 250
FILTER NUMBER 2

SAMPLE BOX #
METER BOX #
METER ΔH@ 1.87
C FACTOR .83
PROBE LENGTH 5' 3"
NOZZLE DIAMETER 3/16"


STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE (in.H_2O)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	VELOCITY HEAD ($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft^3)	DRY GAS METER INLET (T_{mi}, °F)	DRY GAS METER OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM (in.Hg)		
1104	D 6	2.5		122	2.25	1.500	2.72	507.682	86	78			2.05	
	5			123	1.70	1.376	1.88	9165	92	78	250	6	1.53	09.73
09	4		+.30	123	1.75	1323	1.74	11.65	97	77			1.81	11.61
	3			123	1.60	1.265	1.59	13.44	96	76			1.73	13.47
14	2			124	1.60	1.265	1.59	15.24	98	76			1.73	15.14
19	1			123	1.60	1.265	1.59	17.00	98	76			1.73	16.87
20	C 6			123	1.85	1.360	1.84	18.73	96	76		6.0	1.86	18.6
	5		+0.30	124	1.90	1.378	1.89	20.15	98	76			1.93	20.4
25	4			123	1.85	1.360	1.85	22.50	100	76			1.86	22.54
	3			121	1.65	1.285	1.65	24.34	102	76			1.76	24.30
30	2			124	1.50	1.225	1.50	26.05	102	76			1.68	25.96
35	1			124	1.60	1.265	1.60	27.74	102	76			1.73	27.63
TOTAL		30		1477		15.861	20.11	219.49	1167	917				29.56
AVERAGE														

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL				
INITIAL	200	200		
NET H_2O				
TOTAL H_2O COLLECTED, ml				

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
	2.5	20.0	79.5	
AVERAGE				

COMMENTS:

COMPANY NORTHLAND | AMBIENT TEMPERATURE _____ | SAMPLE BOX # _____

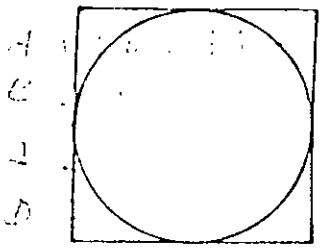
LOCATION [illegible] | BAROMETRIC PRESSURE _____ | METER BOX # _____

DATE 04-09-[illegible] | ASSUMED MOISTURE, % _____ | METER ΔH@ _____

TEST RUN # 2 | HEATER BOX SETTING _____ | C FACTOR _____

STACK AREA 5.90 | PROBE HEATER SETTING _____ | PROBE LENGTH _____

OPERATOR _____ | FILTER NUMBER _____ | NOZZLE DIAMETER _____



STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE (in.H_2O)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft^3)	INLET (T_{mi}, °F)	OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM (in.Hg)		
1135	6	2.5		118	1.30	1.342	1.30	27.49	100	76	250	5.3	1.84	29.30
	5		+.30	122	1.80	1.342	1.30	31.35	102	76			1.31	31.20
41	4			125	1.65	1.285	1.65	33.24	103	76			1.76	33.04
	3			127	1.50	1.225	1.49	34.99	102	76			1.67	34.10
46	2			118	1.45	1.204	1.46	36.66	102	76			1.66	35.44
51	1			120	1.40	1.183	1.41	38.09	102	76			1.42	37.11
1152				120	1.65	1.285	1.65	39.72	95	76			1.63	38.74
				121	1.45	1.204	1.45	41.50	102	76			1.65	41.39
57			+.30	124	1.30	1.140	1.29	43.16	102	76			1.55	43.04
				125	1.30	1.140	1.31	44.75	102	76			1.55	[illegible]
202				124	1.40	1.183	1.40	46.32	102	76			1.47	[illegible]
207				122	1.10	1.049	1.10	47.95	102	76			1.49	47.51
TOTAL		30	1.30	1463		14.592	17.1	349.37	1219	912				47.33
AVERAGE			[illegible]	122.0		1.291	(.12)	41.69 ✓	97.3	(547.5				

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL	2[illegible]5			
INITIAL	200			
NET H_2O		5		[illegible]
TOTAL H_2O COLLECTED, ml	54.9			

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
AVERAGE				

COMMENTS:

LABORATORY DATA

COMPANY [illegible]

LOCATION [illegible]

DATE 4-9-86

TEST RUN # 3

FILTER NUMBER 3

AMOUNT OF LIQUID LOST DURING TRANSPORT —

ACETONE BLANK VOLUME, ml [illegible]

ACETONE WASH VOLUME, ml [illegible]

ACETONE BLANK CONCENTRATION, mg/ml [illegible]

TOTAL ACETONE WASH BLANK, mg [illegible]

WEIGHT OF PARTICULATE COLLECTED

FILTER

FINAL WEIGHT [illegible]

TARE WEIGHT - [illegible]

WEIGHT GAIN 27.9 ✓

ACETONE WASH

FINAL WEIGHT [illegible]

TARE WEIGHT - [illegible]

WEIGHT GAIN [illegible]

ACETONE BLANK - [illegible]

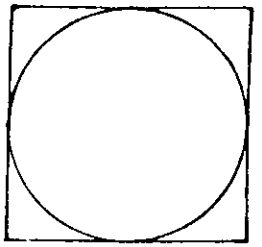
NET GAIN 35.3

TOTAL WEIGHT OF PARTICULATES 63.2 mg ✓

COMPANY NORTHLAND
LOCATION WHEY DRIER
DATE 04-09-86
TEST RUN # 3 p1
STACK AREA 5.906
OPERATOR SHS BL

AMBIENT TEMPERATURE 54
BAROMETRIC PRESSURE 29.1
ASSUMED MOISTURE, % 7
HEATER BOX SETTING 250
PROBE HEATER SETTING 250
FILTER NUMBER #3

SAMPLE BOX # —
METER BOX # —
METER ΔH@ 1.98
C FACTOR
PROBE LENGTH 5' 5S
NOZZLE DIAMETER 23/17 (


STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE (in.H_2O)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	VELOCITY HEAD ($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft^3)	DRY GAS METER INLET (T_{mi}, °F)	DRY GAS METER OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM (in.Hg)		
1430	D 6	2.5		123	2.25	1.500	2.19	849.629	74	74	250		2.02	
	5		+.50	127	1.95	1.396	1.90	51.67	84	74 74		6.5	1.87	51.65
1435	4			127	1.75	1.323	1.71	53.62	90	74 82			1.79	53.54
	3			127	1.60	1.265	1.57	55 42	92	74 83			1.72	55.33
40/	2			126	1.65	1.285	1.63	57.07	94	74 84			1.75	57.05
-1 /4	1			127	1.75	1.323	1.72	58.80	96	74 85			1.80	58.[illegible]
1446	C 6			127	1.95	1.396	1.92	60.64	96	72 84			1.90	60.59
	5		+.30	126	2.00	1.414	1.97	62.56	98	72 85			1.92	62.49
51	4			126	1.90	1.378	1.88	64.47	100	72 86			1.88	64.41
	3			125	1.70	1.304	1.68	66.34	100	72 75			1.77	66.29
55	2			126	1.55	1.245	1.53	68.14	102	72 87			1.70	68.07
1:55	1			127	1.55	1.245	1.53	69.74	102	72 87			1.70	69.76
TOTAL		35		1514		16.974	21.23	71.39	1128	876				71.45
AVERAGE														

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL				
INITIAL	200			
NET H_2O				
TOTAL H_2O COLLECTED, ml				

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
1250	0.4	19.8	~~11.1~~	79.6
AVERAGE				

COMMENTS:

COMPANY NORTHLAND — AMBIENT TEMPERATURE 51 — SAMPLE BOX #

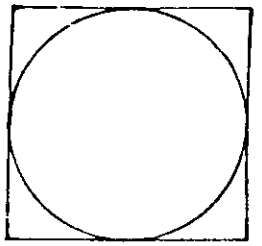
LOCATION WHEY DRYER — BAROMETRIC PRESSURE — METER BOX #

DATE 04-07-96 — ASSUMED MOISTURE, % — METER ΔH@

TEST RUN # 3 P2 — HEATER BOX SETTING — C FACTOR

STACK AREA — PROBE HEATER SETTING — PROBE LENGTH

OPERATOR — FILTER NUMBER — NOZZLE DIAMETER



STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE ($in.H_2O$)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft^3)	DRY GAS METER INLET (T_{mi}, °F)	DRY GAS METER OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM ($in.Hg$)		
1502	B 6	2.5		125	1.35	1.162	1.33	71.39	98	72	250	5 0	1.35	71.45
	5	✓	+.30	127	1.55	1.330	1.53	73.26	102	72 97			1.85	73.31
07	4	(		126	1.65	1.[illegible]	1.63	75.09	102	72 87			1.75	75.16
	3	)		126	1.45	1.249	1.43	76.82	102	72			1.64	76.91
12	2			126	1.40	1.183	1.39	78.44	103	73 94			1.61	78.55
17	1			127	1.40	1.183	1.39	80.00	103	73			1.61	80.16
1518	A 6			126	1.75	1.323	1.72	81.62	96	72 84			1.80	81.78
	5		+.30	127	1.45	1.204	1.44	83.35	102	74 88			1.64	83.57
23	4			127	1.25	1.118	1.24	85.04	102	74 96			1.52	85.22
	3			124	1.20	1.095	1.17	86.63	102	74			1.50	86.74
28	2			125	1.35	1.162	1.34	88.16	102	74			1.59	88.24
33	1			127	1.05	1.025	1.04	89.75	102	74			1.40	91.82
TOTAL		30		1513		14.502		91.157						91.22
AVERAGE						1.274		41.528✓						

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL	247			
INITIAL	197			
NET H_2O				
TOTAL H_2O COLLECTED, ml	549			

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
AVERAGE				

COMMENTS:

LABORATORY DATA

COMPANY [illegible]

LOCATION [illegible]

DATE 4-9-80

TEST RUN # 4

FILTER NUMBER 11

AMOUNT OF LIQUID LOST DURING TRANSPORT	—
ACETONE BLANK VOLUME, ml	100
ACETONE WASH VOLUME, ml	80
ACETONE BLANK CONCENTRATION, mg/ml	0.0
TOTAL ACETONE WASH BLANK, mg	0.0

WEIGHT OF PARTICULATE COLLECTED

FILTER	FINAL WEIGHT	[illegible]	
	TARE WEIGHT	- [illegible]	
	WEIGHT GAIN		26.8
ACETONE WASH			
	FINAL WEIGHT	[illegible]	
	TARE WEIGHT	- [illegible]	
	WEIGHT GAIN	[illegible]	
	ACETONE BLANK	- [illegible]	
	NET GAIN		25.3
	TOTAL WEIGHT OF PARTICULATES		52.1

COMPANY NORTHEAST

LOCATION

DATE 04-03

TEST RUN # 41

STACK AREA

OPERATOR

AMBIENT TEMPERATURE 53

BAROMETRIC PRESSURE 29.

ASSUMED MOISTURE, % 7

HEATER BOX SETTING 250

PROBE HEATER SETTING 250

FILTER NUMBER 41

SAMPLE BOX # —

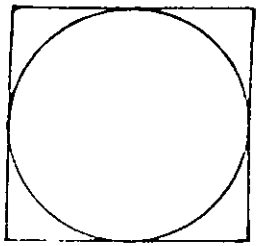
METER BOX #

METER ΔH@ 1.88

C FACTOR

PROBE LENGTH 5' 5S

NOZZLE DIAMETER .23/.128



STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE (in.H_2O)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	VELOCITY HEAD ($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft³)	DRY GAS METER INLET (T_{mi}, °F)	DRY GAS METER OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM (in.Hg)	
1630	D6	2.5		121	2.25	1.500	2.21	891.426	54	72	250	7.0	911.47
	5		1.30	120	1.95	1.396	1.93	893.50	72	72			13.47
35	4			112	1.75	1.323	1.73	95.57	92	72			15.38
	3			120	1.60	1.265	1.59	97.15	94	72			17.13
40	2			122	1.60	1.265	1.59	98.95	95	73			18.90
1645	1			121	1.75	1.323	1.74	[illegible]	96	72			[illegible]
1646	C6			130	1.90	1.378	1.86	902.20	94	72			02.1
	5			130	1.90	1.378	1.86	903.80	16	72			[illegible]
	4			131	1.85	1.360	1.66	06.46	95	72			05.16
	3			129	1.65	1.285	1.62	08.14	9[illegible]	72			[illegible]
	2			129	1.55	1.245	1.52	09.68	98	72			11.52
	1			129	1.65	1.285	1.52	11.11	98	72			11.30
TOTAL				[illegible]		[illegible]	20.19	112.91	1135	955			13.10
AVERAGE													

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL				
INITIAL				
NET H_2O				
TOTAL H_2O COLLECTED, ml				

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
	9.6	11.8		
AVERAGE				

COMMENTS:

COMPANY [illegible] | AMBIENT TEMPERATURE _____ | SAMPLE BOX # _____

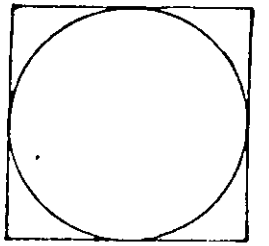
LOCATION [illegible] | BAROMETRIC PRESSURE _____ | METER BOX # _____

DATE 04-01-[illegible] | ASSUMED MOISTURE, % _____ | METER ΔH@ _____

TEST RUN # 4 [illegible] | HEATER BOX SETTING _____ | C FACTOR _____

STACK AREA _____ | PROBE HEATER SETTING _____ | PROBE LENGTH _____

OPERATOR _____ | FILTER NUMBER #4 | NOZZLE DIAMETER _____



STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE (in.H_2O)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft^3)	DRY GAS METER INLET (T_{mi}, °F)	DRY GAS METER OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM (in.Hg)	
1702	B 6	2.5		130	1.55	1.240	1.30	912.91	94	63 [illegible]			13.1
	5	1		131	1.35	1.[illegible]0	1.30	19.75	96	68 [illegible]			11.19
07	4	(	+.30	132	1.55	1.285	1.61	16.72	97	69 [illegible]			16.73
	3			130	1.50	1.225	1.47	18.50	98	69 [illegible]			18.71
12	2			131	1.40	1.183	1.36	20.18	98	68 [illegible]			20.17
1722	1			130	1.60	1.265	1.56	21.64	95	67 [illegible]			21.77
1718	A 6			127	1.55	[illegible]	1.51	23.45	90	66 [illegible]			23.43
	5			130	1.45	1.204	1.41	25.21	94	67 [illegible]			25.21
23	4			131	1.35	1.140	1.36	26.92	95	67 [illegible]			26.94
	3		+.35	130	1.[illegible]	1.[illegible]	1.17	28.52	95	67 [illegible]			28.51
28	2			130	1.35	1.162	1.31	30.00	94	67 [illegible]			29.98
31	1			130	1.[illegible]	1.[illegible]	1.32	31.55	94	67 [illegible]			31.47
TOTAL		30		[illegible]		[illegible]	[illegible]	32.764	1141	812			32.41
AVERAGE				[illegible]		1.275	[illegible]	41.528	92.4				

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL	24[illegible]			
INITIAL	200			
NET H_2O				7
TOTAL H_2O COLLECTED, ml				

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
	0.6	19.6	79.2	
AVERAGE				

COMMENTS:

LABORATORY DATA

COMPANY [illegible]

LOCATION [illegible]

DATE 4-10-80

TEST RUN # 5

FILTER NUMBER 5

AMOUNT OF LIQUID LOST DURING TRANSPORT —

ACETONE BLANK VOLUME, ml 100

ACETONE WASH VOLUME, ml 90

ACETONE BLANK CONCENTRATION, mg/ml 0.0

TOTAL ACETONE WASH BLANK, mg 0.0

WEIGHT OF PARTICULATE COLLECTED

FILTER

FINAL WEIGHT 480.9

TARE WEIGHT - [illegible]

WEIGHT GAIN 31.9

ACETONE WASH

FINAL WEIGHT [illegible]

TARE WEIGHT - [illegible]

WEIGHT GAIN [illegible]

ACETONE BLANK - 0.0

NET GAIN 23.6

TOTAL WEIGHT OF PARTICULATES 55.5

COMPANY NORTHLAND | AMBIENT TEMPERATURE 44 | SAMPLE BOX # |

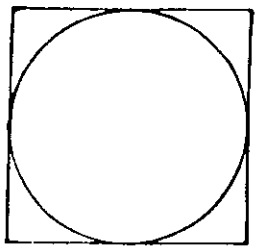
LOCATION WHEY DRYER | BAROMETRIC PRESSURE 29.0 | METER BOX # |

DATE 04-10-96 | ASSUMED MOISTURE, % 7 | METER ΔH@ 1.87

TEST RUN # 5 P1 | HEATER BOX SETTING 250 | C FACTOR |

STACK AREA 5.906 | PROBE HEATER SETTING 250 | PROBE LENGTH 5' 5"

OPERATOR SEB, BC | FILTER NUMBER #5 | NOZZLE DIAMETER 23/128



STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE ($in.H_2O$)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	VELOCITY HEAD ($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft^3)	DRY GAS METER INLET (T_{mi}, °F)	DRY GAS METER OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM ($in.Hg$)	
0831	P 6	2.5		116	2.20	1.483	2.18	923,197	76	68	250	6.0	23.20
	5		+.40	117	1.90	1.378	1.86	25.00	78	66 70			25.22
36	4			120	1.65	1.285	1.61	26.95	82	66 74			27.09
"	3			127	1.50	1.225	1.46	28.69	88	66 77			29.82
41	2			127	1.50	1.225	1.46	30.35	88	66			30.48
46	1			121	2.00	1.414	1.94	31.96	90	66 79			32.13
0847	P 6			122	1.85	1.360	1.82	33.89	90	63 79			34.03
	5		-	126	1.90	1.378	1.86	35.75	94	68 81			35.87
52	4		+.35	126	1.75	1.323	1.72	37.67	96	67 82			37.75
"	3			127	1.60	1.265	1.57	39.49	98	68 83			39.54
57	2			125	1.40	1.183	1.38	41.21	98	68 83			41.26
0902	1			124	1.450	1.204	1.43	42.87	97	67			42.86
TOTAL		30		1486		15.723	20.29		1076	80½			44.50
AVERAGE													

23.20
25.22

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL				
INITIAL	200			
NET H_2O				
TOTAL H_2O COLLECTED, ml				

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
	0.8	19.4	79.8	
AVERAGE				

COMMENTS:

COMPANY NORTHLAND | AMBIENT TEMPERATURE _____ | SAMPLE BOX # _____

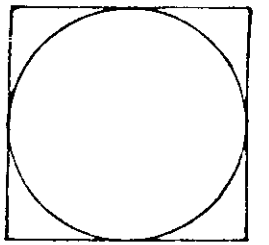
LOCATION IVORY DRYER | BAROMETRIC PRESSURE _____ | METER BOX # _____

DATE 04-10-96 | ASSUMED MOISTURE, % _____ | METER ΔH@ _____

TEST RUN # 5 P2 | HEATER BOX SETTING _____ | C FACTOR _____

STACK AREA _____ | PROBE HEATER SETTING _____ | PROBE LENGTH _____

OPERATOR _____ | FILTER NUMBER #5 | NOZZLE DIAMETER _____



STACK CROSS SECTION

	TRAVERSE POINT NUMBER	SAMPLING TIME (θ, min)	STATIC PRESSURE (in.H_2O)	STACK TEMP (T_s, °F)	VELOCITY HEAD (Δp)	($\sqrt{\Delta p}$)	ORIFICE METER (ΔH)	DRY GAS METER VOLUME (V_m, ft^3)	DRY GAS METER INLET (T_{mi}, °F)	DRY GAS METER OUTLET (T_{mo}, °F)	BOX TEMP (°F)	PUMP VACUUM (in.Hg)	
0903	B 6	2.5		124	1.85	1.360	1.83	44.52	96	72			44.50
	5		+.35	123	1.85	1.360	1.83	46.35	98	72			46.36
08	4			123	1.65	1.285	1.64	48.20	100	72			48.21
	3			126	1.50	1.225	1.49	49.97	102	72			49.96
13	2			125	1.45	1.204	1.44	51.65	102	72			51.63
0918	1			126	1.50	1.225	1.49	53.31	102	72			53.28
0919	A 6			123	1.70	1.304	1.69	55.00	102	72			54.74
	5			127	1.50	1.225	1.49	56.76	102	74			56.73
24	4		+.30	126	1.40	1.183	1.39	58.44	102	74			58.40
	3			124	1.40	1.183	1.40	60.07	104	74			60.01
29	2			125	1.40	1.183	1.40	61.73	104	74			61.63
0934	1			125	1.05	1.025	1.05	63.36	104	74			63.24
TOTAL		30		1497		14.762	1814	964.789	1218	864			64.64
AVERAGE				124.3		1.270	1.60	41.592	82.6				

WATER COLLECTED	IMPINGERS 1	2	3	4
FINAL				
INITIAL				
NET H_2O				
TOTAL H_2O COLLECTED, ml				

PARTICULATE COLLECTED	FILTER	PROBE WASH
FINAL		
TARE		
NET GAIN		
TOTAL WEIGHT, mg		

ORSATS TIME	CO_2	O_2	CO	N_2
AVERAGE				

COMMENTS:

PITOT TUBE CALIBRATION DATA

Date 04-08-86 Calibrated by S. ESUNDBERG

Pitot opening alignment OK? ✓

Internal tubing diameter Dt = ✓ inches

Center-to-opening plane distances PA = ✓ inches

PB = ✓ inches

Pitot-nozzle distance X = ✓ inches

Pitot-probe sheath distance Y = ✓ inches

Pitot-thermocouple distance Z = ✓ inches

5'5S

A-Side (Normal) Calibration data

RDG	Δ Pstd in/H2O	Δ P(s) in/H2O	Δ Pstd / Δ P(s)	Cp(s)	DEVIATION Cp(s)-Cp(a)
1	0.95	1.35	.7037	.8305	.0001
2	0.90	1.30	.6923	.8237	.0067
3	0.95	1.35	.7037	.8305	.0001
4	1.00	1.40	.7143	.8367	.0063
			Cp(a) = .8304		Sigma = .0033

$$Cp(s) = 0.99 \sqrt{\Delta Pstd / \Delta P(s)}$$

$$Sigma = \sum_{1}^{4} |Cp(s) - Cp(a)| / 4$$

THERMOCOUPLE CALIBRATION

Room Temperature:	NBS Certified Thermometer	=	65°F
	Stack Sampler Thermocouple	=	66°F
Hot Water Temperature:	NBS Certifier Thermometer	=	203°F
	Stack Sampler Thermocouple	=	203°F

Calibrated 4-7-86 by Stephen C. Taylor

DRY GAS METER CALIBRATION

H Meter = 1.85.

CAL. BY | TYPE | MFGR. | MFGR. NUMBER | PUR. | LAST TEST | LAST REPAIRS MADE | DATE 1 5 6 0 6 0 | COMPANY NUMBER

SERVICE ADDRESS | CUSTOMER NAME | ACCOUNT NUMBER

METER TO:

METER FROM:

MARKS:

	READING BEFORE -	TESTED BY	READING AFTER -	TESTED BY
DATE	04 03 86	MC	04 03 86	MC
DIAL	9 7 5 . 1 9 8 0	DIFF. OK	1 0 0 0 . 1 9 9 6	OK

REASON FOR TEST: 1

1. NEW
2. PERIODIC
3. D. R.
4. DPG
5. LEAK
6. WATER
7. DAMAGE
8. TAMPERING
9. HIGH BILL COMPLAINT
0. OTHER

L 5

REPAIRS AND ADJUSTMENTS: 2

1. O K
2. ADJUST ONLY
3. LIGHT REPAIR
4. PARTIAL REPAIR
5. GENERAL REPAIR
6. T. C. CONVERSION
7. CONDEMNED
8. RETEST
9. OTHER

CLX REPLACED ☐

Dry Gas Meter Correction Factor = 1.00.

SOURCE TESTING

Source testing is the set of procedures by which an investigator can estimate the emissions from a particular emission source. It involves representative sampling of the parameters of interest. For any given contaminant it is necessary only to know the rate of gas flow and the concentration of the contaminant to determine the emission rate.

Gas Flow

Stack gas velocity is usually determined with a device called a pitot tube which when connected to a manometer measures the velocity pressure of the moving gas. The equation of the stack gas velocity is:

$$V_s = 85.48 \; C_p \; (\sqrt{\Delta p})_{avg.} \sqrt{\frac{T_s}{P_s \quad M_s}}$$

where: V_s = Stack gas velocity, feet per second (ft/sec).

C_p = Pitot tube co-efficient for actual stack conds.

$(\Delta p)_{avg}$ = Average of square roots of velocity pressures (also called average velocity head).

T_s = Absolute stack gas temperature, ^{o}R ($^{o}R = {}^{o}F + 460$).

P_s = Absolute stack gas pressure, inches of Hg.

M_s = Molecular weight of the stack gas (wet basis) lb/lb-mole.

The molecular weight of the stack gas is determined from knowledge of its gaseous composition using the equation:

$$M_s = (1-B_{wo}) \; (.44 \; (\%CO_2) + .32 \; (\%O_2) + .28 \; (\%CO + \%N_2)) = 18 \; B_{wo}$$

where: B_{wo} = Proportion by volume of water vapor in the gas stream, dimensionless.

$\%CO_2$ = Percent carbon dioxide by vilume, dry basis.

$\%O_2$ = Percent oxygen by volume, dry basis.

$\%CO$ = Percent carbon monoxide by volume, dry basis.

$\%N_2$ = Percent nitrogen by volume, dry basis.

.44 = Molecular weight of CO_2 divided by 100.

.32 = Molecular weight of O_2 divided by 100.

.28 = Molecular weight of CO and N_2 divided by 100.

18 = Molecular weight of water.

Source Testing Cont...

For stacks serving combustion processes the CO_2, O_2, and CO are measured with an Orsat type gas analyzer. The N_2 is taken to be the remaining fraction. For non-combustion processes, CO_2 and CO are taken to be 0, O_2 - 21% and N_2 = 79%.

The proportion of water vapor by volume may be measured using a psychrometer, or by condensation and/or absorption by silica gel (see below) or it may be estimated from the vapor pressure for gas streams that are saturated with water.

The volumetric flow rate is determined by multiplying the velocity by the cross-sectional area of the stack. In most cases, the volumetric flow rate is adjusted to standard conditions of temperature (70°F) and pressure (29.92 in. Hg.) using the equation:

$$Q_s = 3600\ (1-B_{wo})\ V_s\ A\ \frac{T_{std}}{T_s}\ \frac{P_s}{P_{std}}$$

where: Qs = Volumetric flow rate, dry basis, standard conditions, ft^3/hour.

A = Cross-sectional area of the stack, ft^2.

T_{std} = Absolute temperature at standard conditions, 530°R.

P_{std} = Absolute pressure at standard conditions, 29.92 in. Hg.

and other terms are as defined previously.

Contaminant Concentration

The concentration of a contaminant in a gas stream is usually determined by isolating the contaminant present in a representative gas sample of known volume.

In order to obtain a representative sample of the stack gas, a hollow probe is intruduced into the stack, the nozzle opening is directed into the gas stream, and a composite sample is removed from each of several points. For particulates it is necessary that the velocity be equal to the velocity in the nozzle, or in other words the sampling rate be as nearly isokinetic as possible. This is because large particles tend to travel in a straight line and are less likely to be affected by flow disturbances, while small particles tend to follow the flow lines. Thus, varying too much from isokinetic will tend to cause bias with respect to certain particle sizes and will therefore give erroneous results. Generally, variations within the range of 90 - 110% of isokinetic is acceptable.

Sampling for gases contaminants need not be isokinetic by should be in proportion to the velocity at the sampling points.

Source Testing Cont...

Isolation of the contaminant is accomplished in one of many ways. A filter os some sort (ceramic or glass fiber depending on stack conditions and particulate characteristics) it usually used to collect particulate matter. Various chemical solutions are used to absorb other contaminants (e.g. 3% hydrogen peroxide will absorb sulfer dioxide, etc.). The total amount of the contaminant is then determined.

The total volume of the gas sample is determined using a displacement type dry gas meter. Since metering conditions tend to vary, it is necessary to measure the meter temperature and pressure in order to adjust the volume to standard conditions. To protect the metering system from moisture, the gas sample is passed through a series of condensers or impingers to remove all or most of the water vapor present. Furthermore, by measuring the amount of water collected, the moisture content of the stack gas can be estimated by the following equation:

$$B_{wo} = \frac{V_{w_{std}}}{V_{w_{std}} + V_{m_{std}}}$$

where: B_{wo} = Proportion by volume of water vapor in the gas stream, dimensionless.

$V_{w_{std}}$ = Volume of water in the gas sample (standard conditions) ft^3.

$V_{m_{std}}$ = Volume of gas sample through the dry gas meter (standard conditions) ft^3.

For the above equation:

$$V_{m_{std}} = V_m \frac{T_{std}}{T_m} \frac{P_m}{P_{std}}$$

where: V_m = Volume of gas sample through the dry gas meter (meter conditons) ft^3.

T_m = Average absolute gas meter temperature, ^oR.

P_m = Average absolute meter pressure, inches Hg.

and: $V_{w_{std}} = 0.0474\ V_{l_c}$

where: V_{l_c} = Total volume of water collected in condensers, ml.

The concentration of material is calculated from the equation:

$$c'_s = 0.0154 \frac{M_n}{V_{m_{std}}}$$

Source Testing Cont...

where: c'_s = Concentration of the contaminant in the stack gas, grains/scf, dry basis.

M_n = Total amount of contaminant collected, milligrams.

The concentrations of certain gaseous components of a gas stream are most often reported in parts per million by volume, ppm. (vol.). This then reports the number of cubic feet of the contaminant present in 1,000,000 cubic feet of gas. Conversion from ppm. (vol.) to pounds made use of the fact that at standard conditions a pound-mole of gas occupies 385.1 ft^3.

Emission Rates

The emission rate of the contaminant is calculated from the equation:

$$c'_s Q_s = (2.205 \times 10^{-6}) \frac{M_n}{V_{m\,std}} Q_s$$

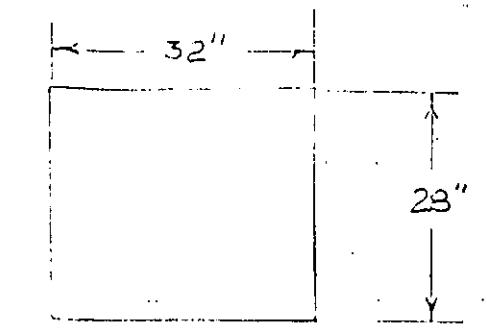
where:

$c'_s Q_s$ = Emission rate, lb/hr.

NOMENCLATURE

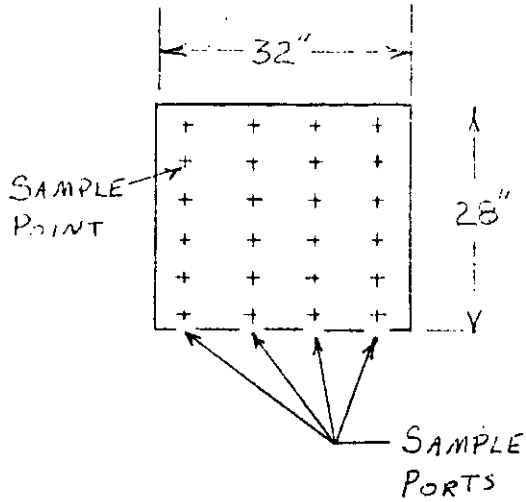
The following is a partial list of abbreviations and nomenclature used in preparing this report. Other terms used are defined in the test of the preceding Source Testing section.

ACFM	=	Actual cubic feet per minute at stack conditions, wet basis. (cfm(wet)).
CU-FT	=	Actual cubic feet at specified condition (ft^3)
DSCF	=	Cubic feet at standard conditions, dry (scf(dry)).
DSCFH	=	Cubic feet at standard conditions, dry, per hour (scfh(dry)). May be written in exponential form, e.g., 543,774 - $.543774 \times 10^6$.
F	=	Degrees Fahrenheight (^oF).
FT/SEC	=	Feet per second (ft/sec.).
GR	=	Grains (gr.) (1 pount = 7000 grains).
IN,Hg	=	Inches of mercury (in.Hg or inches Hg).
IN,H2O	=	Inches of water in.H_2O or inches H_2O).
LB/HR	=	Pounds per hour (lb/hr).
MG	=	Milligrams (mg.).
MIN	=	Minutes (min.).
ML	=	Milliliters (ml.).
R	=	Degrees Rankine (^oR).
SQ-FT	=	Square feet (ft^2).
WSCFM	=	Cubic feet at standard conditions, wet basis, per minute (scfm(wet)).



TOP VIEW

DETAIL OF SAMPLING PORTS AND POINTS



FRONT VIEW

EXHAUST FAN, DISCHARGE STACK & EXTENSION FOR 60' DRY WHEY DRYER

Scale. ½" = 1'

NORTHLAND FOODS
SHAWANO, WI.