AP42 Section:	11.7
Reference:	16
Title:	Particulate Emission Evaluation For Steward, Inc., Chattanooga, TN, March 30, 1993, FBT Engineering and Environmental Services, Chattanooga, TN, May 1993

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FINAL TEST REPORT
PARTICULATE EMISSION EVALUATION
STEWARD, INC.
CHATTANOOGA, TENNESSEE

prepared for

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by

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May, 1993

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FINAL REPORT
PARTICULATE EMISSION EVALUATION
STEWARD, INC
CHATTANOOGA, TENNESSEE

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1.0 INTRODUCTION

FBT Engineering and Environmental Services (FBT) was retained by Steward, Inc. to perform a particulate emission evaluation on the No. 4 Anhydro Spray Dryer at their facility in Chattanooga, Tennessee. The purpose of the evaluation was to demonstrate compliance with applicable provisions of the Chattanooga Air Pollution Control Ordinance. Specifically, this process, controlled by a Mikro Pul baghouse, is limited to particulate emissions of no more than 0.65 pounds per hour. The test was conducted March 30, 1993. The test team consisted of Mr. Chris Gottschalk and Mr. Jason Fraley, of FBT. Mr. Wayne Bishop, Steward, Inc. coordinated testing with plant operations. The test was witnessed by W. C. Markham, Jr., Chattanooga-Hamilton County Air Pollution Control Bureau.

2.0 SUMMARY OF RESULTS

The test consisted of three USEPA Method 5 runs performed on the discharge of the Mikro Pul baghouse. The results of these three runs yielded an average particulate emission rate for the test of 0.075 pounds per hour. The average rate of ferrite powder processed during the test was 2500 pounds per hour. A summary of the results of this test is presented in Table 1. Pertinent parameters and results from each run are given in Tables 2, 3, and 4. Sample calculations for run A-2 are presented in Appendix A. Field data sheets and process weight rate data are presented in Appendix C. Test Equipment calibration data is given in Appendix E. Laboratory analytical data is presented in Appendix F.

3.0 Conclusions

The results of this test showed that the average particulate matter emission rate from the Mikro Pul baghouse on the No. 4 Anhydro Spray Dryer was 0.075 pounds per hour at a ferrite powder process rate of 2500 pounds per hour. Comparing this result with the allowable particulate emission rate of 0.65 pounds per hour shows that this source is in compliance with the applicable provisions of the Chattanooga Air Pollution Control Ordinance.

TABLE 1

SUMMARY OF RESULTS

CLIENT:	STEWARD, INC.
SAMPLE LOCATION:	NO. 4 SPRAY DRYER BAGHOUSE DISCHARGE
EMISSION MEASURED:	PARTICULATE MATTER
ALLOWABLE RATE:	0.65 LB/HR
STACK DIMENSIONS:	15" x 36"

TEST DATE:	3/30/93			
RUN #	A-1	A-2	A-3	AVERAGES
TIME, EST	1054-1208	1320-1430	1505-1615	
STACK TEMP, °F	203	207	204	205
MOISTURE, %	11.3	10.7	11.7	11.2
VELOCITY, fps	23.8	23.3	22.6	23.2
GAS FLOW, SCFM	3758	3677	3544	3660
% ISOKINETIC	95	98	101	
PROCESS WEIGHT, LB/HR	2520	2520	2460	2500
EMISSIONS:				
Gr/DSCF	0.0008	0.0041	0.0023	0.0024
lb/hr	0.026	0.128	0.070	0.075

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TABLE 2
TEST RESULTS

CLIENT/PROJECT #:	STEWARD, INC.
SAMPLE LOCATION:	#4 SPRAY DRYER BAGHOUSE DISCHARGE
DATE/TIME:	3-30-93/1054-1208

RUN #: A-1

STATIC PRESSURE("H2O):	0.05	"HG	29.68
BAROMETRIC("HG):	29.68		
SAMPLE TIME(min):	60.00	Vm(corr)	42.359
ACTUAL METER VOLUME:	42.359	DSCF	42.663
SQ. ROOT /\P:	0.369		
AVG ORIFICE /\H:	1.56		
AVG STACK TEMP °F:	202.8	°R	662.8
AVG METER TEMP °F:	95.5		
Cp PITOT :	0.84		
NOZZLE DIA.(inches):	0.371	An(ft²) =	7.51E-04
METER GAMMA:	1.064		
LEAK RATE(IF > 0.02):			
CIRC STACK? 1=Y,0=N:	0	As(ft²) =	3.75
DIA OR DIM (inches):	540.00	= 15 in * 36 in	
% O2 :	20.50	DRY MOLE WT	28.82
% CO2 :	0.00	ST MOLE WT	27.60
VOL CONDENSATE(ml):	115.30	% H20	11.29
FILTER GAIN(mg):	-1.00		
RINSE GAIN(mg):	3.20	NET WT(mg)	2.20

**********CALCULATED RESULTS**********

GAS VELOCITY (Vs):	23.82	FT/SEC
STACK GAS FLOW (Qs):	5359.6	ACFM
:	3757.8	DSCFM
STACK GAS TEMP :	203	Deg F
MOISTURE (%H2O):	11.29	%
ISOKINETIC :	94.58	%

PARTICULATE MATTER EMISSION DATA

CONCENTRATION (Cs):	7.94E-04	Gr/DSCF
:	1.13E-07	lb/DSCF
EMISSION RATE (Er):	0.026	lb/hr

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TABLE 3
TEST RESULTS

CLIENT/PROJECT #:	STEWARD, INC.
SAMPLE LOCATION:	#4 SPRAY DRYER BAGHOUSE DISCHARGE
DATE/TIME:	3-30-93/1320-1430

RUN #: A-2

STATIC PRESSURE("H2O):	0.05	"HG	29.70
BAROMETRIC("HG):	29.70		
SAMPLE TIME(min):	60.00	Vm(corr)	23.392
ACTUAL METER VOLUME:	23.392	DSCF	23.614
SQ. ROOT ΔP:	0.360		
AVG ORIFICE ΔH:	0.43		
AVG STACK TEMP °F:	206.9	°R	666.9
AVG METER TEMP °F:	93.0		
Cp PITOT :	0.84		
NOZZLE DIA.(inches):	0.274	An(ft^2) =	4.09E-04
METER GAMMA:	1.064		
LEAK RATE(IF>0.02):			
CIRC STACK? 1=Y,0=N:	0	As(ft^2) =	3.75
DIA OR DIM (inches):	540.00	= 15 in * 36 in	
% O2 :	20.40	DRY MOLE WT	28.82
% CO2 :	0.00	ST MOLE WT	27.66
VOL CONDENSATE(ml):	60.20	% H20	10.71
FILTER GAIN(mg):	1.65		
RINSE GAIN(mg):	4.60	NET WT(mg)	6.25

**********CALCULATED RESULTS**********

GAS VELOCITY (Vs):	23.28	FT/SEC
STACK GAS FLOW (Qs):	5238.6	ACFM
:	3676.7	DSCFM
STACK GAS TEMP :	207	Deg F
MOISTURE (%H2O):	10.71	%
ISOKINETIC :	98.09	%

PARTICULATE MATTER EMISSION DATA

CONCENTRATION (Cs):	4.08E-03	Gr/DSCF
:	5.82E-07	lb/DSCF
EMISSION RATE (Er):	0.128	lb/hr

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TABLE 4
TEST RESULTS

CLIENT/PROJECT #: STEWARD, INC.
SAMPLE LOCATION: #4 SPRAY DRYER BAGHOUSE DISCHARGE
DATE/TIME: 3-30-93/1505-1615

RUN #: A-3

STATIC PRESSURE("H2O):	0.04	"HG	29.70
BAROMETRIC("HG):	29.70		
SAMPLE TIME(min):	60.00	Vm(corr)	23.249
ACTUAL METER VOLUME:	23.249	DSCF	23.326
SQ. ROOT ΔP:	0.349		
AVG ORIFICE ΔH:	0.41		
AVG STACK TEMP °F:	203.8	°R	663.8
AVG METER TEMP °F:	96.4		
Cp PITOT :	0.84		0.84
NOZZLE DIA.(inches):	0.274	An(ft^2) =	4.09E-04
METER GAMMA:	1.064		
LEAK RATE(IF>0.02):			
CIRC STACK? 1=Y,0=N:	0	As(ft^2) =	3.75
DIA OR DIM (inches):	540.00 = 15 in * 36 in		
% O2 :	20.50	DRY MOLE WT	28.82
% CO2 :	0.00	ST MOLE WT	27.56
VOL CONDENSATE(ml):	65.60	% H20	11.69
FILTER GAIN(mg):	-1.05		
RINSE GAIN(mg):	4.55	NET WT(mg)	3.50

**********CALCULATED RESULTS**********

GAS VELOCITY (Vs):	22.59	FT/SEC
STACK GAS FLOW (Qs):	5082.3	ACFM
:	3544.3	DSCFM
STACK GAS TEMP :	204	Deg F
MOISTURE (%H2O):	11.69	%
ISOKINETIC :	100.51	%

PARTICULATE MATTER EMISSION DATA

CONCENTRATION (Cs):	2.31E-03	Gr/DSCF
:	3.30E-07	lb/DSCF
EMISSION RATE (Er):	0.070	lb/hr

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4.0 Emission Source Description

The No. 4 Anhydro Spray Dryer process located in the Steward, Inc. facility on East 36th Street in Chattanooga, Tennessee operates under Bureau Certificate of Operation No. 0780-30500899-30C. This spray dryer dries a ferrite powder/water slurry with hot air, which is heated with a natural gas burner. Hot, moist air exiting the spray dryer passes first through a cyclone and then through a Mikro Pul baghouse filter for ferrite powder removal. The hot, moist, filtered air is finally discharged to the atmosphere. The dry ferrite powder processing rate of the spray dryer is nominally 2,500 pounds per hour.

The Mikro Pul baghouse is designed for hot operation and utilizes a pulse jet cleaning system. Its discharge duct is 15-inches by 36-inches which exits the building horizontally and then turns 90 degrees upward. To provide the necessary straight run of duct for testing the 90 degree elbow was removed and a temporary 7-ft straight duct extension was installed as shown in Appendix D.

5.0 Sampling Protocol

The sampling and analytical procedures used during this test were USEPA Reference Methods described in the *Code of Federal Regulations* (CFR), 40 Part 60, Appendix A, Revised July 1, 1991. Following is a list of these Methods. Sampling, analytical, and laboratory procedures are described in Appendix B.

5.1 Measurement Sites (Method 1)
The location of measurement sites and the number of sample points were determined as specified in **USEPA Reference Method 1**, "Sample and Velocity Traverses for Stationary Sources."

5.2 Velocity and Volumetric Flow Rates (Method 2)
The duct/stack gas velocities and volumetric flow rates were determined using **USEPA Reference Method 2**, "Determination of Stack Gas Velocity and Volumetric Flow Rate."

5.3 Dry Molecular Weight (Method 3)
The dry molecular weight of the duct/stack gases was determined using **USEPA Reference Method 3**, "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight." Three grab samples were collected and analyzed during test with a Fyrite combustion gas analyzer.

5.4 Moisture (Method 4)
The moisture content of the stack gas was determined using **USEPA Reference Method 4**, "Determination of Moisture Content in Stack Gases."

APPENDIX A

SAMPLE CALCULATIONS

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EXAMPLE CALCULATION

CLIENT/PROJECT NUMBER:	STEWARD, INC.
SAMPLE LOCATION:	#4 SPRAYDRYER BAGHOUSE
DATE/TIME:	3-30-93/1320-1430
RUN #:	A-2

1. METER CORRECTIONS:

(LEAKAGE): Vmc = Vm-(Lp-La)ø = Vm-(Lp-0.02)ø =	23.392
(DSCF;68°F,29.92"Hg): Vm(std) = 17.647*Vmc*Y*(Pbar+■H/13.6)/Tm°R =	23.614

2.MOISTURE:

(VOLUME, SCF): Vw(std) = Vwc*0.04707 =	2.83
(FRACTION H2O): Bws = Vw(std)/(Vw(std)+Vm(std)) =	0.11
(% MOISTURE): %H2O = Bws*100 =	10.71

3.MOLECULAR WEIGHT(M):

(DRY MOLE WT.): Md = 0.44*(%CO2)+0.32*(%O2)+0.28(%N2+%CO) =	28.82
(STACK MOLE WT.): Ms = Md*(1-Bws)+(18.0*Bws) =	27.66

4.VOLUMETRIC FLOW RATE(Q):

(VELOCITY,ft/sec): Vs = 85.49*Cp*[Avg■P*Ts°R/(Ps"Hg*Ms)] ^ 0.5 =	23.28
(ACFM): Qa = Vs*60*As(ft²) =	5238.6
(DSCFM, 68°F & 29.92"Hg): Qstd = Qa*17.647*(1-%H2O)*Ps/Ts°R =	3676.7

5.ISOKINETIC:

%I = 0.0945*Ts*Vm(std)/[Ps*Vs*An*ø*(1-Bws)] =	98.09

6.CONCENTRATION(Cs):

(GRAINS PER DSCF) = gr/dscf = 0.0154*WT(mg)/Vm(std) =	4.08E-03
(POUNDS PER DSCF) = lb/dscf = 1.49E-03 * Cs(gr/dscf) =	5.82E-07
(Cs CORRECTED FOR CO2) = Cs(gr/dscf)*%CO2(corr)/%CO2(meas) =	NA

7.EMISSION RATE(Er):

(POUNDS PER HOUR) = lb/hr = Cs(lb/dscf)*Qstd*60 =	0.128

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FILTER/PROBE RINSE ANALYTICAL DATA

Client: **Steward, Inc.**

Sample Location: #4 Spray Dryer bag house Discharge

Date: 3/30/93

Run #: A - 2

ACETONE RINSE DATA

		Volume(V_a):	100.0 ml
Date/Time wt#1:	4/9/93 0700	Gross wt:	3820.8 mg
Date/Time wt#2:	4/9/93 1630	Gross wt:	3819.7 mg
		Average wt:	3820.3 mg
		- Tare wt:	3814.2 mg
		= Gain(m_a):	6.1 mg
Blank Calculation:		- Blank($C_a \times V_a$):	1.5 mg
$C_a = m_{ab} \div V_{ab}$ = 1.5mg ÷ 100ml = .015 mg/ml		=**Net Gain(m_a):**	4.6 mg

FILTER DATA

Date/Time wt#1:	4/5/93 - 1510hr	Gross wt:	353.1 mg
Date/Time wt#2:	4/7/93 - 0830 hr	Gross wt:	352.0 mg
		Average wt:	352.55mg
		- Tare wt:	350.90mg
		=**Net Gain(m_f):**	1.65mg
		TOTAL	6.25mg

Note: Average difference must be less than 5 mg or 2% of weight of sample, whichever is less.

Remarks: _____

Signature of analyst: Bill Dobbler

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APPENDIX B

SAMPLING AND LABORATORY PROCEDURES

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APPENDIX B
SAMPLING AND LABORATORY PROCEDURES

The sampling and analytical procedures used during this test were USEPA Reference Methods 1, 2, 3, 4, and 5 which are described in the *Code of Federal Regulations* (CFR), 40 Part 60, Appendix A, Revised July 1, 1991. Following is a summary description of these procedures:

B.1 Measurement Sites (Method 1)

The location of measurement sites and the number of sample points were determined as specified in **USEPA Reference Method 1**, "Sample and Velocity Traverses for Stationary Sources."

A 7-ft test duct extension was installed in the 15" x 36" existing duct having 4 test 3" test ports located 30" from the discharge. The test ports were located 5.5 equivalent duct diameters (De) downstream from the nearest flow disturbance, a 45° elbow and 1.4 De's upstream from the duct discharge. See sketch in Appendix D. Per Method 1, a 20 point, 4 x 5, sampling matrix was established with each sampling point located at the center of a 3.75" x 7.2" area.

B.2 Velocity and Volumetric Flow Rates (Method 2)

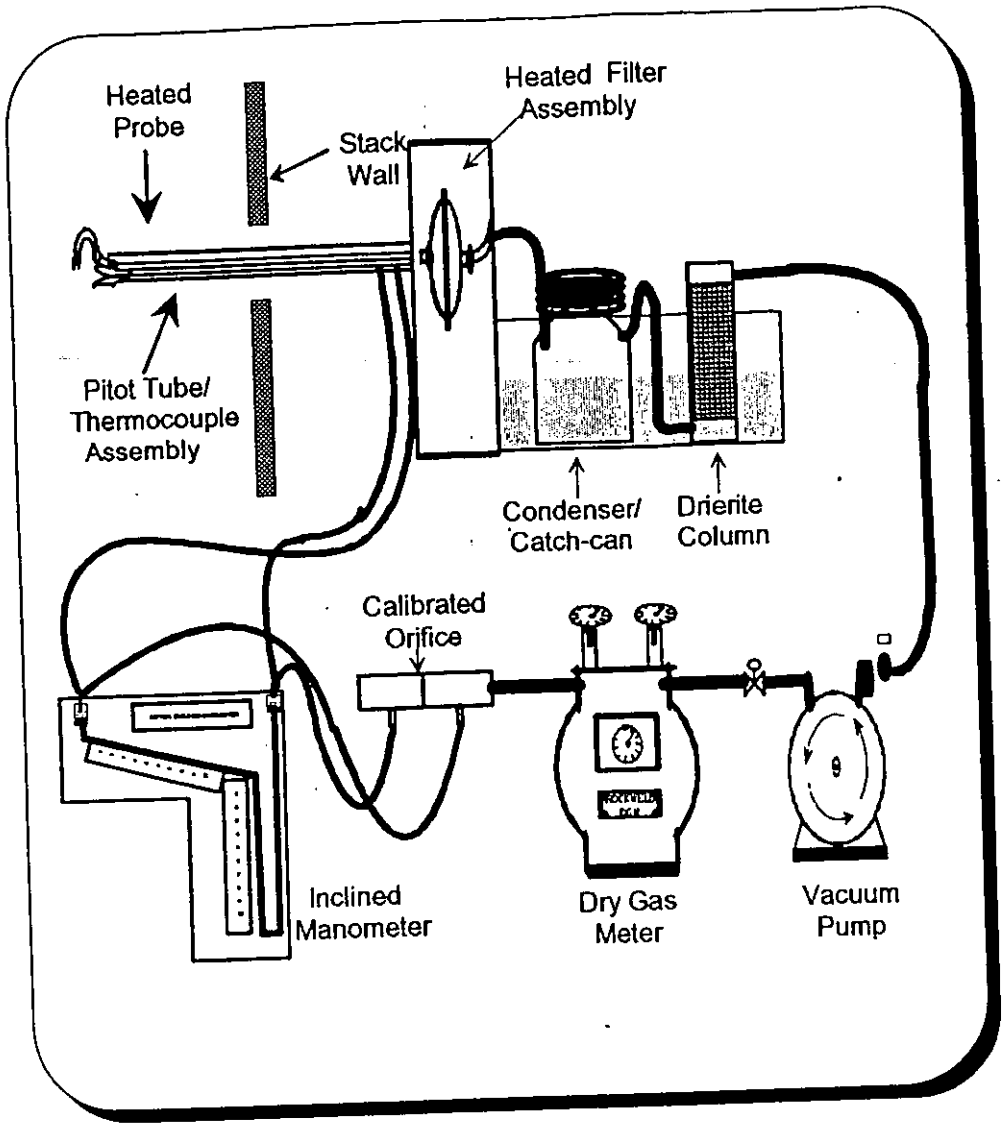
The duct/stack gas velocities and volumetric flow rates were determined using **USEPA Reference Method 2**, "Determination of Stack Gas Velocity and Volumetric Flow Rate." Velocity pressures were measured with an "S" type pitot tube and temperatures with a calibrated type "K" thermocouple. Pressure differentials and static pressures were measured with inclined manometers. See Figure B.5.1.

B.3 Dry Molecular Weight (Method 3)

The dry molecular weight of the duct/stack gases were determined using **USEPA Reference Method 3**, "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight." One grab sample was collected and analyzed for oxygen and carbon dioxide during each run with a Fyrite combustion gas analyzer.

B.4 Moisture (Method 4)

The moisture content of the stack gas was determined using **USEPA Reference Method 4**, "Determination of Moisture Content in Stack Gases." A time integrated sample of gas was withdrawn isokinetically during each run. Moisture in the gas was condensed in an ice bath condensing device and determined volumetrically. Residual moisture was then removed in a column containing a known amount of silica gel and determined gravimetrically. Dry gas volume was measured with a dry gas meter. See Figure B.5.1.



Method 5 with condenser

Figure B.5.1

APPENDIX C

FIELD DATA SHEETS

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FIELD DATA SHEET

Client/City: D.M. Steward
Probe Length/Type: 4' GLASS
Date: 3-30-93 Run #: A-1
Nozzle Size: .371, ____, ____ = .371
Location: Baghouse out. #4 Spraydryer
Meter Box #: 1M-1 ΔH@: 1.728 γ: 1.064
Sample Type: M-5
Assumed H_2O: 10 % Reference ΔP: 1=11.5
Operator: J.FRALEY
Leak ☑: Pre: .003 ft³ @ 7 "hg
Pbar: 29.68 Ps: 0.05
Post: .001 ft³ @ 5 "hg
Initial: Pitot Leak ☑ ✓ / Orsat Leak ☑____
Final: Pitot Leak ☑ ✓ / Orsat Leak ☑____
Filter #: 3086

Drying Column
Initial Wt = 822.5
Final Wt =
Process Wt: 25201bs/hr

Fyrite Data:

O_2: 20.5, ____, ____, ____	ml H_2O	g Sil. Gel
CO_2: 0, ____, ____, ____	90 ml	25.3 g

Moisture Data:

Page ____ of ____ Record data every 3.0 minutes

Trav. #	Sample Time	Clock Time	Meter Reading	Pitot # ____ ΔP	ΔH(calc)	ΔH(act)	# ____ Probe	# ____ Stack	Tm In	TmOut	# ____ Filter	# ____ Exit	Pump Vac.
	0	10:54	616.185										
A-1	3		618.394	0.16	1.8	1.8	HI	202	85	84	256	65	3
2	6		620.598	0.15	1.70	1.7		202	93	89	252	64	3
3	9		622.700	0.13	1.5	1.5		202	94	90	254	64	3
4	12		624.871	0.14	1.6	1.6		203	95	92	255	63	3
5	15		627.023	0.14	1.6	1.6		202	96	92	258	63	3
B-1	18		629.174	0.15	1.7	1.7		202	94	92	250	66	3
2	21		631.306	0.14	1.6	1.6		204	97	94	251	70	3
3	24		633.501	0.14	1.6	1.6		203	97	94	251	72	3
4	27		635.630	0.14	1.6	1.6		205	97	95	251	65	3
5	30		637.719	0.13	1.5	1.5		204	98	95	251	63	3
C-1	33		639.796	0.13	1.5	1.5		201	95	93	251	63	3
2	36		641.950	0.14	1.6	1.6		203	98	93	251	62	3
3	39		644.049	0.14	1.6	1.6		204	98	96	251	62	3
4	42		646.239	0.14	1.6	1.6		204	99	97	251	65	3
5	45		648.366	0.13	1.5	1.5		204	100	97	251	71	3
D-1	48		650.403	0.12	1.4	1.4		202	97	99	252	73	3
2	51		652.427	0.13	1.5	1.5		202	100	98	242	78	3
3	54		654.581	0.13	1.5	1.5		203	101	98	242	79	3
4	57		656.600	0.13	1.5	1.5		203	101	98	244	80	3
5	60	11:00	658.544	0.11	1.3	1.3	↓	201	101	98	244	81	2
		12:08											
			$\sqrt{\Delta P}$ =	.369	Adj ΔH =	1.56	Avg ΔT =	202.8	Avg Temp	Meter 95.5			

Chris Hatteschelle, FBT Project Manager

FBT

FIELD DATA SHEET

Client/City: DM Steward
Probe Length/Type: 4' GLASS
Date: 3-30-93 Run #: A-2
Nozzle Size: .274, ____, ____ = .274
Location: Baghouse out. #4 spraydryer
Meter Box #: Im-1 ΔH@: 1.728 γ: 1.064
Sample Type: M-5
Assumed H_2O: 10 % Reference ΔP: 1 = 3.4
Operator: J. FRALEY
Leak ☑: Pre: .008 ft³ @ 7 "hg
Pbar: 29.7 Ps: .05
Post: .004 ft³ @ 4 "hg
Initial: Pitot Leak ☑ ✓ / Orsat Leak ☑ ____
Final: Pitot Leak ☑ ✓ / Orsat Leak ☑ ____
Filter #: 3085

Fyrite Data:

O_2: 20.4, ____, ____, ____	
CO_2: 0, ____, ____, ____	

Moisture Data:

ml H_2O	g Sil. Gel
59 ml	1.2 g

Process Wt.
Same as A-1
(2520 lbs/hr)

Page ____ of ____ Record data every 3.0 minutes

Trav. #	Sample Time	Clock Time	Meter Reading	Pitot # ____ ΔP	Pitot # ____ ΔH(calc)	Pitot # ____ ΔH(act)	# ____ Probe	# ____ Stack	Tm In	TmOut	# ____ Filter	# ____ Exit	Pump Vac.
	0	1320	658.633										
A-1	3		659.900	0.15	0.51	0.51	H1	208	91	90	249	53	0.5
2	6		661.153	0.15	0.51	0.51		208	92	92	245	47	0.5
3	9		662.308	0.12	0.40	0.40		202	92	92	248	46	0.5
4	12		663.451	0.13	0.42	0.42		207	92	91	248	62	0.5
5	15		664.600	0.13	0.42	0.42		205	93	92	250	65	0.5
B-1	18		665.811	0.14	0.48	0.48		208	92	91	252	53	0.5
2	21		667.033	0.14	0.48	0.48		209	93	92	251	47	0.5
3	24		668.245	0.13	0.42	0.42		209	94	92	251	45	0.5
4	27		669.400	0.13	0.42	0.42		211	94	93	251	45	0.5
5	30		670.464	0.12	0.40	0.40		211	94	93	251	45	0.5
C-1	33		671.592	0.12	0.40	0.40		208	93	92	255	45	0.5
2	36		672.813	0.14	0.48	0.48		209	94	93	251	45	1
3	39		674.031	0.14	0.48	0.48		208	94	93	253	44	1
4	42		675.215	0.13	0.42	0.42		208	94	93	252	45	0.5
5	45		676.357	0.12	0.40	0.40		207	94	93	250	45	0.5
D-1	48		677.471	0.12	0.40	0.40		202	93	92	252	48	0.5
2	51		678.600	0.12	0.40	0.40		205	96	93	251	46	0.5
3	54		679.875	0.13	0.42	0.42		206	95	94	250	46	0.5
4	57		681.009	0.12	0.40	0.40		204	95	94	251	46	0.5
5	60		682.025	0.11	0.38	0.38	↓	202	96	94	251	46	0.5
		1430											
			NOP =	.360	AVG ΔH =	0.43		206.9	Avg Meter	= 93			

Chris Rotterschalk, FBT Project Manager

FBT

FIELD DATA SHEET

Client/City: DW Steward | Probe Length/Type: 4' GLASS

Date: 3-30-93 | Run #: A-3 | Nozzle Size: .274, ____, ____ = .274

Location: Baghouse Out #4 Spraydryer | Meter Box #: Im-1 | ΔH@: 1.728 | γ: 1.064

Sample Type: M-5 | Assumed H_2O: 10 % | Reference ΔP: 1=3.4

Operator: JFRALEY | Leak ☑: Pre: .001 ft^3 @ 5 "hg

Pbar: 29.7 | Ps: 0.04 | Post: .005 ft^3 @ 4 "hg

Initial: Pitot Leak ☑____ / Orsat Leak ☑____ | Final: Pitot Leak ☑ ✓ / Orsat Leak ☑____

Filter #: 3087

Initial Meter 682.100

2460 lb/hr = Process Wt.

Fyrite Data:

O_2: 20.5, ____, ____, ____	
CO_2: 0, ____, ____, ____	

Moisture Data:

ml H_2O	g Sil. Gel
62 ml	3.6 g

Page ____ of ____ Record data every 3.0 minutes

Trav. #	Sample Time	Clock Time	Meter Reading	Pitot # ΔP	ΔH(calc)	ΔH(act)	# Probe	# Stack	Tm In	TmOut	# Filter	# Exit	Pump Vac.
	0	3:05	~~682.132~~ 682.100										
A1	3		683.331	0.14	0.48	0.48	HI	201	91	91	251	45	1
2	6		684.530	0.14	0.48	0.48		204	94	93	249	41	1
3	9		685.700	0.12	0.40	0.40		198	95	93	247	40	1
4	12		686.831	0.12	0.40	0.40		196	94	93	249	40	1
5	15		688.001	0.12	0.40	0.40		199	95	93	248	40	1
B-1	18		689.215	0.14	0.48	0.48		202	93	92	248	41	1
2	21		690.400	0.13	0.42	0.42		203	94	93	252	40	1
3	24		691.555	0.13	0.42	0.42		203	95	94	251	41	1
4	27		692.710	0.13	0.42	0.42		205	96	95	252	42	1
5	30		693.860	0.12	0.40	0.40		205	97	95	252	43	1
C-1	33		695.024	0.13	0.42	0.42		204	95	95	253	45	1
2	36		696.154	0.12	0.40	0.40		206	97	96	252	43	1
3	39		697.300	0.12	0.40	0.40		208	98	97	252	45	1
4	42		698.440	0.12	0.40	0.40		208	99	97	252	45	1
5	45		699.570	0.11	0.38	0.38		206	100	98	252	46	1
D-1	48		700.751	0.11	0.38	0.38		203	99	97	253	48	0.5
2	51		701.801	0.11	0.38	0.38		207	102	99	252	48	0.5
3	54		702.911	0.12	0.40	0.40		207	102	100	252	47	1
4	57		704.044	0.11	0.38	0.38		206	103	101	252	47	1
5	60		705.381	0.10	0.34	0.34	↓	204	103	101	253	63	0.5
		4:15											
			Avg $\sqrt{VOP}$ = .349		Avg ΔH = 0.41		Avg T_S =	203.8	Avg T_m =	96.4			

Chris Gatschalk, FBT Project Manager

FBT

VELOCITY TRAVERSE DATA

Date: 5/30/92

Client: D.M. Steward PN: PN #1

Location: Baghouse out. #4 Spraydryer

Site: _____

Run #: Protest 1 Time 0940 Pbar 29.68" Hg Ps .01 " H_2O

POINT #	DELTA P	TEMP	CYCLONIC °	POINT #	DELTA P	TEMP	CYCLONIC °
A-1	.17	195		A-5	.15	193	
2	.17	193					
3	.14	191					
4	.15	194					
B-1	.15	194		B-5	.14	196	
2	.15	195					
3	.14	195					
4	.15	197					
C-1	.12	192		C-5	.12	194	
2	.14	195					
3	.15	195					
4	.13	195					
D-1	.13	192		D-5	.13	192	
2	.14	193					
3	.14	194					
4	.14	194					

Averages

Δp = _____

$\sqrt{\Delta p}$ = _____

Temp= _____

Chris Hattschalk, FBT Project Mgr.

FBT

2580 lbs — 10 45 AM

2,460 lbs — 11 00 AM

2,520 lbs — 11 15 AM

2,520 lbs — 11 30 AM

2520 lbs — 11 45 AM

2520 lbs — 12 00 PM

2,460 lbs — 12 30 PM

2,340 lbs — 12 45 PM

2520 lbs — 1 00 PM

2,580 lbs — 1 15 PM

2,580 lbs — 1 30 PM

2,460 lbs — 1 45 PM

2,460 — 2:00 PM

2,520 — 2:15 PM

2400 — 3:00 PM

2,460 — 3:15 PM

2,460 — 3:30 PM

2,460 — 3:45 PM

2520 — 4:00 PM

TRAVERSE POINT LOCATIONS FOR RECTANGULAR DUCTS

PLANT D. M. Steward

DATE 3/30/93

SAMPLING LOCATION Baghouse out, # 4 Spraydryer

INSIDE STACK DIMENSIONS 36" x 15"

INSIDE OF NEAR WALL TO OUTSIDE OF NIPPLE. (Distance B) 0.1"

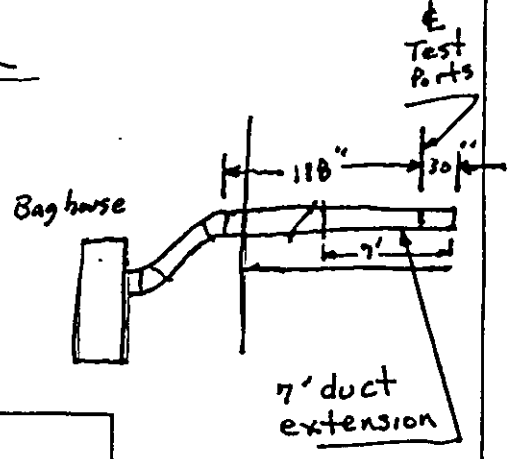
EQUIVALENT STACK I.D. (2x15x36)/(15+36) = 21.2

NEAREST UPSTREAM DISTURBANCE 118" (5.5 De)

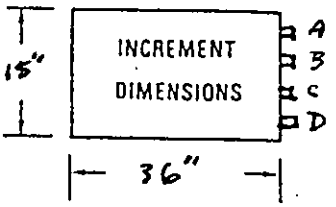
NEAREST DOWNSTREAM DISTURBANCE 30" (1.4 De)

NUMBER OF TRAVERSE POINTS 20 ARRAY 4 x 5

CALCULATOR CG



ILLUSTRATE PORT LOCATIONS AND STACK DIMENSIONS



TRAVERSE POINT NUMBER	INSIDE OF NEAR WALL TO TRAVERSE POINT (Distance A)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF DISTANCES A+B)	PORT LOCATION	DISTANCE FROM EDGE OF STACK
1	32.4"	0.1"	32.5		
2	25.2		25.3		
3	18.0		18.1		
4	10.8		10.9		
5	3.6		3.7		

Chris Kittscholk, FBT Project Manager

FBT

TRAVERSE POINT LOCATIONS FOR RECTANGULAR DUCTS

PLANT D. M. Steward

DATE 3/30/93

SAMPLING LOCATION Baghouse out, #4 spraydryer

INSIDE STACK DIMENSIONS 36" x 15"

INSIDE OF NEAR WALL TO OUTSIDE OF NIPPLE. (Distance B) 0.1"

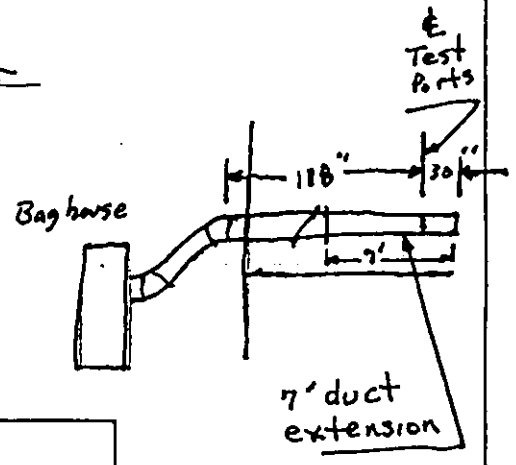
EQUIVALENT STACK I.D. (2x15x36)/(15+36) = 21.2

NEAREST UPSTREAM DISTURBANCE 118" (5.5 De)

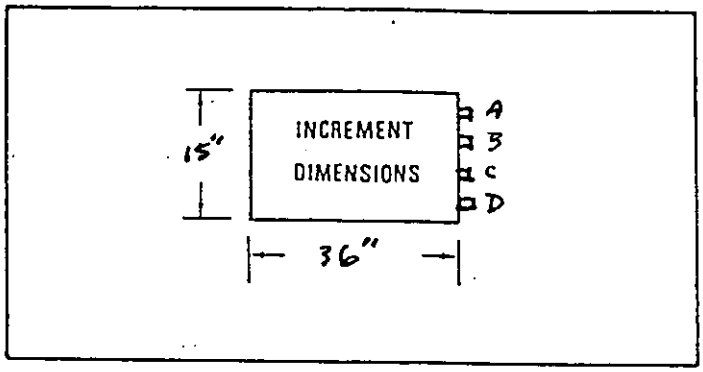
NEAREST DOWNSTREAM DISTURBANCE 30" (1.4 De)

NUMBER OF TRAVERSE POINTS 20 ARRAY 4 x 5

CALCULATOR CG



ILLUSTRATE PORT LOCATIONS AND STACK DIMENSIONS



TRAVERSE POINT NUMBER	INSIDE OF NEAR WALL TO TRAVERSE POINT (Distance A)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF DISTANCES A+B)	PORT LOCATION	DISTANCE FROM EDGE OF STACK
1	32.4"	0.1"	32.5		
2	25.2		25.3		
3	18.0		18.1		
4	10.8		10.9		
5	3.6		3.7		

Chris Hattschadt, FBT Project Manager

FBT

APPENDIX D

SCHEMATIC OF SAMPLING SITE

FBT

TRAVERSE POINT LOCATIONS FOR RECTANGULAR DUCTS

PLANT D. M. Steward

DATE 3/30/93

SAMPLING LOCATION Baghouse out, #4 Spraydryer

INSIDE STACK DIMENSIONS 36" x 15"

INSIDE OF NEAR WALL TO OUTSIDE OF NIPPLE. (Distance B) 0.1"

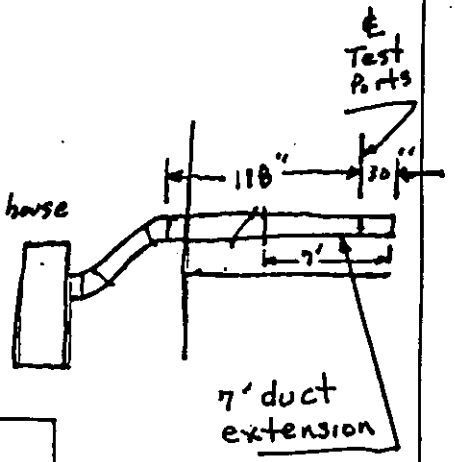
EQUIVALENT STACK I.D. (2 x 15 x 36)/(15+36) = 21.2

NEAREST UPSTREAM DISTURBANCE 118" (5.5 De)

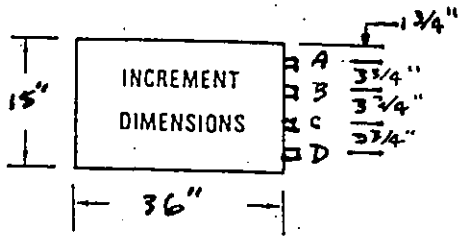
NEAREST DOWNSTREAM DISTURBANCE 30" (1.4 De)

NUMBER OF TRAVERSE POINTS 20 ARRAY 4 x 5

CALCULATOR CG



ILLUSTRATE PORT LOCATIONS AND STACK DIMENSIONS



TRAVERSE POINT NUMBER	INSIDE OF NEAR WALL TO TRAVERSE POINT (Distance A)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF DISTANCES A+B)	PORT LOCATION	DISTANCE FROM EDGE OF STACK
1	32.4"	0.1"	32.5		
2	25.2		25.3		
3	18.0		18.1		
4	10.8		10.9		
5	3.6		3.7		

Chris Mittschadt, FBT Project Manager

FBT

APPENDIX E
CALIBRATION DATA

This appendix contains test equipment calibration documentation and describes the specific QA/QC procedures employed by FBT in performing this test. The goal of the QA/QC activities for this project are intended to ensure, to the highest degree possible, the accuracy of the data collected. The procedures contained in the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume I. Principles, EPA-600/9-76-005, and Volume III. Stationary Sources Specific Methods, EPA-600/77-027b* are the basis for performance for all testing and related work activities.

CALIBRATION OF APPARATUS

The preparation and calibration of source sampling equipment is essential in maintaining data quality. Brief descriptions of the calibration procedures used by FBT follow:

Barometers

FBT uses aneroid barometers which are calibrated against a National Weather Service-Type mercurial barometer.

Temperature Sensors

Bimetallic dial thermometers and Type "K" thermocouples are calibrated using the procedure described in Section 3.4.2 of the Quality Assurance Handbook. Each temperature sensor is calibrated over the expected range of use against an ASTM 3C or 3F thermometer.

Pitot Tubes

FBT uses Type "S" pitot tubes which are constructed according to USEPA Reference Method 2 specifications. Pitot tubes meeting these criteria are assigned a baseline coefficient of 0.84 and need not be calibrated.

Differential Pressure Gauges

FBT uses Dwyer inclined/vertical manometers to measure differential pressures. These include velocity pressures, static pressures, and orifice pressure differentials. Manometers are selected with sufficient sensitivity to accurately measure pressures over the entire range of expected values. Manometers are leveled and zeroed prior to each run and checked periodically during the run. Manometers are primary standards and require no calibration.

Dry Gas Meters and Orifices
Dry gas meters and orifices are calibrated in accordance with Section 3.3.2 of the Quality Assurance Handbook. This procedure involves direct comparison of the dry gas meter to a reference wet test meter. The reference wet test meter is routinely calibrated against a bell prover. Before its initial use in the field, the metering system is calibrated over the entire range of operation. After each field use, the metering system is calibrated at a single intermediate setting based on the previous field test. Acceptable tolerances for the initial and final dry gas meter factors and orifice calibration factious are ± 0.02 and ± 0.20 from average, respectively.

ON-SITE MEASUREMENTS

On-site QA/QC activities included:

Measurement Sites
Prior to sampling, all stack/duct dimensions are measured to determine measurement site locations, location of test ports, and stack inside dimensions. Inside dimensions were checked through all available test ports to ensure uniformity of the stack cross-sectional area.

Verification of Absence of Cyclonic Flow
In situations where the measurement site is near possible flow disturbances, the presence or absence of cyclonic flow must be determined. Prior to testing, FBT conducted an evaluation of the measurement sites to determine the presence or absence of cyclonic flow. Acceptable criteria is that the average angle of rotation required to achieve a null pitot reading is < 20° rotation.

Velocity Measurements
All velocity measurement apparatus was assembled, leveled, zeroed, and leak checked prior to each test run. The static pressure was determined at a single point near the center of the stack.

Flue Gas Component Sampling
During test runs gas samples were withdrawn from a single point near the center of each test site and analyzed with a Fyrite combustion gas analyzer to determine percent concentrations of carbon dioxide and oxygen. The sample train was assembled and leak checked before sampling.

Moisture
Stack gas moisture was determined simultaneously with particulate matter. During sampling, the gas exiting the condenser was maintained below 68° F to ensure complete condensation of the

stack gas water vapor. The total moisture was determined gravimetrically.

Sample Trains

The sample trains were assembled, equilibrated to required temperatures and leak checked before testing. The nozzle size was determined in the field by making triplicate measurements along three different diameters using a dial caliper. The three measurements must vary no more than 0.004 inches between the high and low values.

At the conclusion of each test run, the sample trains were leak checked at the highest vacuum attained during the test run. Acceptable leakage rates are 0.02 cfm or 4 percent of the average sampling rate (whichever is less).

POST-TEST METER CALIBRATION

MB #: IM-1
DATE: April 5, 1993
PLANT: D. M. Steward
PERFORMED BY: B. Doebler

BAROMETRIC PRESS: 29.560 (in. hg.)
DGM PRETEST Y : 1.064
REFERENCE Y: 1.042
REFERENCE Ps: -7.150 (in. H2O)

	RUN 1	***RUN 2***	***RUN 3***
VACUUM ("Hg)	8.000	8.000	8.000
ΔH ("H2O)	3.000	3.000	3.000
INITIAL RTM	266.194	276.504	286.820
FINAL RTM	276.504	286.820	297.114
INITIAL DGM	705.895	715.399	724.956
FINAL DGM	715.399	724.956	734.533
TEMP. RTM (F)	72.000	72.000	72.000
TEMP. DGM (F)	62.500	68.500	69.000
TEST TIME (MIN.)	10.000	10.000	10.000
NET VOLUME RTM :	10.310	10.316	10.294
NET VOLUME DGM :	9.504	9.557	9.577
Y :	1.082	1.089	1.086
ΔH@ :	1.603	1.583	1.589

PRIOR Y = 1.064
RECHECK Y = 1.086
% DIFFERENCE = 2.052

AVERAGE ΔH@ = 1.592

^Y = (Vw x (Pb+Pref/13.6) x (Td + 460)) / (Vd (Pb + (ΔHd / 13.6)) x (Tw + 460)

^ΔH@ = 0.0317 x ΔH / (Pb (Td + 460)) x ((Tw + 460) x time) / Vwcorr)^2

COMMENTS:

FBT

POST-TEST METER CALIBRATION

Project: _____

Dry Gas Meter ID: IM-1 Pretest Y: _____

Reference Meter ID: 964006 Reference Y: _____

Performed by: B. DOEBLER Date: 4-5-93 Pbar: 29.56

Delta H	Reference Meter Volume Vr	Dry Gas Meter Volume Vt	Temperatures			Vacuum	Time
			Reference (Tr)	DGM (Td) IN	DGM (Td) OUT		
REF 7.15 / 3.0 METER	Initial 266.194	Initial 705.895	Initial 72	Initial 56	56	8" H_2O	10 MIN
	Final 276.504	Final 715.399	Final	Final 70	68		
	Net 10.31	Net 9.504	Average 72	Average 62.5			
7.15 / 3.0	Initial 276.504	Initial 715.399	Initial	Initial 70	68	8	10
	Final 286.820	Final 724.956	Final	Final 70	66		
	Net 10.316	Net 9.557	Average 72	Average 68.5			
7.15 / 3.0	Initial 286.820	Initial 724.956	Initial	Initial 70	66	8	10
	Final 297.114	Final 734.533	Final	Final 72	68		
	Net 10.294	Net 9.577	Average 72	Average 69			
	Initial	Initial	Initial	Initial			
	Final	Final	Final	Final			
	Net	Net	Average	Average			
	Initial	Initial	Initial	Initial			
	Final	Final	Final	Final			
	Net	Net	Average	Average			

FBT

Date: 2-15-93 Thermocouple No.: HB-1 / HB-2

Ambient Temperature: 73 °C Barometric pressure: 29.3 " Hg

Calibrator: BD Reference: Mercury-in-glass: _____

Other: _____

Reference point No.[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Difference,[c] %
1	HB-1 AMBIENT	73	73	0
2	BOILING WATER	210	212	.95
3	BOILING OIL	452	455	.66
4	ICE WATER	32	30	-6.7
1	HB-2 AMBIENT	73	73	0
2	BOILING WATER	210	211	.48
3	BOILING OIL	452	454	.44
4	ICE WATER	32	32	0

[a] Every 30°C (50°F) for each reference point

[b] Type of Calibration system used

[c] $\frac{\text{(Ref. temp: °C + 273) - (Test therm. temp. °C + 273)}}{\text{Ref. temp. °C + 273}} \times 100 \leq 1.5\%$

Stack Temperature Sensor Calibration Data Sheet

II-14

FBT

Date: 7.15.83 Thermocouple No.: IM-I / IM-O

Ambient Temperature: 74 °C Barometric pressure: 29.3 " Hg

Calibrator: BD Reference: Mercury-in-glass: _____

Other: _____

Reference point No.[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Difference,[c] %
1	IM-I AMBIENT	74	73	-1.4
2	ICE WATER	32	32	0
1	AMBIENT IM-O	74	73	-1.4
2	ICE WATER	32	32	0

[a] Every 30°C (50°F) for each reference point

[b] Type of Calibration system used

[c] $\frac{\text{(Ref. temp: °C + 273) - (Test therm. temp. °C + 273)}}{\text{Ref. temp. °C + 273}} \times 100 \leq 1.5\%$

Stack Temperature Sensor Calibration Data Sheet

FBT

Date: 2-15-93 Thermocouple No.: S3-3

Ambient Temperature: 76 °C Barometric pressure: 29.3 " Hg

Calibrator: BD Reference: Mercury-in-glass: _____

Other: _____

Reference point No.[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Difference,[c] %
1	AMBIENT	76	77	1.3
2	BOILING WATER	210	212	.95
3	BOILING OIL	442	450	1.8
4	ICE WATER	32	30	-.6.7

[a] Every 30°C (50°F) for each reference point

[b] Type of Calibration system used

[c] $\frac{\text{(Ref. temp: °C + 273) - (Test therm. temp. °C + 273)}}{\text{Ref. temp. °C + 273}} \times 100 \leq 1.5\%$

Stack Temperature Sensor Calibration Data Sheet

FBT

BALANCE CALIBRATION

Date: FEB 16 1993

Analyst: B. DOEBLER

Sartorius

Weight of Standard	Recorded Weight	Difference
1 mg	1 mg	0
10 mg	10 mg	0
500 mg	500 mg	0
10 g	10.0000 g	0
100g	100.0000 g	0

Toploader

Weight of Standard	Recorded Weight	Difference
20 g	20.0 g	0
50 g	50.0 g	0
100 g	100.0 g	0
150 g	150.0 g	0
200 g	200.0 g	0

APPENDIX F

ANALYTICAL DATA

FBT

FILTER/PROBE RINSE ANALYTICAL DATA

Client: **Steward, Inc.**

Sample Location: # 4 Spray Dryer Baghouse Out

Date: 3-30-93

Run #: A-1

ACETONE RINSE DATA

	Volume(V_a):	125 ml
Date/Time wt#1:	Gross wt:	mg
Date/Time wt#2:	Gross wt:	mg
	Average wt:	mg
	- Tare wt:	mg
	= Gain(m_a):	10.7 mg
Blank Calculation:	- Blank($C_a \times V_a$):	- 7.5
$C_a = m_{ab} \div V_{ab} =$ 2.4 mg ÷ 40 ml = 0.06 mg/ml		0.06 mg/ml × 125 ml =
	=Net Gain(m_a):	3.2 mg

FILTER DATA

Date/Time wt#1:	Gross wt:	mg
Date/Time wt#2:	Gross wt:	mg
	Average wt:	mg
	- Tare wt:	352.0 mg
	=Net Gain(m_f):	- 1.0 mg
	TOTAL	2.2 mg

Note: Average difference must be less than 5 mg or 2% of weight of sample, whichever is less.

Remarks: Probe rince, Acetone blank, and filter data for run # A-1 were provided by Chattanooga/Hamilton Co Air Pollution Control Bureau.

Signature of analyst: CR 4/30/93

FBT

FILTER/PROBE RINSE ANALYTICAL DATA

Client: **Steward, Inc.**

Sample Location: #4 Spray Dryer Baghouse out

Date: 3/30/93

Run #: A-3

ACETONE RINSE DATA

Date/Time wt#1: 4-9-93 / 0900

Date/Time wt#2: 4-9-93 / 1630

Volume(V_a):	100 ml
Gross wt:	3817.0 mg
Gross wt:	3815.5 mg
Average wt:	3816.25 mg
- Tare wt:	3810.2 mg
= Gain(m_{ab}):	6.05 mg
- Blank($C_a \times V_a$):	1.5 mg
=Net Gain(m_a):	4.55 mg

Blank Calculation:

$C_a = m_{ab} \div V_a =$ 1.5 mg ÷ 100 ml = .015 mg/ml

FILTER DATA

Date/Time wt#1: 4-5-93 / 1510

Date/Time wt#2: 4-7-93 / 0830

Gross wt:	348.5 mg
Gross wt:	349.4 mg
Average wt:	348.95 mg
- Tare wt:	350.0 mg
=Net Gain(m_f):	- 1.05 mg
TOTAL	3.50 mg

Note: Average difference must be less than 5 mg or 2% of weight of sample, whichever is less.

Remarks: _____

Signature of analyst: Bill Dobbs

FBT

FILTER/PROBE RINSE ANALYTICAL DATA

Client: **Steward, Inc.**

Sample Location: #4 Spray Dryer baghouse Discharge

Date: 3/30/93

Run #: A - 2

ACETONE RINSE DATA

		Volume(V_a):	100.0 ml
Date/Time wt#1:	4/9/93 0700	Gross wt:	3820.8 mg
Date/Time wt#2:	4/9/93 1630	Gross wt:	3819.7 mg
		Average wt:	3820.3 mg
		- Tare wt:	3814.2 mg
		= Gain(m_a):	6.1 mg
Blank Calculation:		- Blank($C_a \times V_a$):	1.5 mg
$C_a = m_{ab} \div V_{ab}$ = 1.5mg ÷ 100ml = .015 mg/ml			
		=**Net Gain(m_a):**	4.6 mg

FILTER DATA

Date/Time wt#1:	4/5/93 - 1510hr	Gross wt:	353.1 mg
Date/Time wt#2:	4/7/93 - 0830 hr	Gross wt:	352.0 mg
		Average wt:	352.65mg
		- Tare wt:	350.90mg
		=**Net Gain(m_f):**	1.65mg
		TOTAL	6.25mg

Note: Average difference must be less than 5 mg or 2% of weight of sample, whichever is less.

Remarks: _____

Signature of analyst: Bill Dobbler

FBT

Filter # 3086 # D.M. Steward A-1

Date/Time Dessicated _____ Project # _____

Date/Time/Analyst 3-19-93 1000 BD Tare Wt. 352.0 mg.
Date/Time/Analyst 3-22-93 0920 BD Tare Wt. 352.0 mg.
Date/Time/Analyst _____ Tare Wt. _____ mg.
Date/Time/Analyst _____ Tare Wt. _____ mg.

Filter # 3087 DM. STEWARD A-3

Date/Time Dessicated _____ Project # 93-075

Date/Time/Analyst 3-19-93 1015 BD Tare Wt. 350.2 mg.
Date/Time/Analyst 3-22-93 0920 BD Tare Wt. 350.0 mg.
Date/Time/Analyst 4-5-93 1510 BD Tare Wt. 348.5 mg.
Date/Time/Analyst 4-7-93 0930 BD Tare Wt. 349.4 mg.

Filter # 3088 _____

Date/Time Dessicated _____ Project # _____

Date/Time/Analyst 3-19-93 1015 BD Tare Wt. 349.6 mg.
Date/Time/Analyst 3-22-93 0920 BD Tare Wt. 350.0 mg.
Date/Time/Analyst _____ Tare Wt. _____ mg.
Date/Time/Analyst _____ Tare Wt. _____ mg.

Filter # 3089 _____

Date/Time Dessicated _____ Project # _____

Date/Time/Analyst 3-19-93 1015 BD Tare Wt. 353.1 mg.
Date/Time/Analyst 3-22-93 0920 BD Tare Wt. 353.0 mg.
Date/Time/Analyst _____ Tare Wt. _____ mg.
Date/Time/Analyst _____ Tare Wt. _____ mg.

FBT

Filter # B-24 # CMI/BRISTOL NAB-2
FR ACET/H2O

Date/Time Dessicated _____ Project # 93-071A 75-C

Date/Time/Analyst 3-29-93 1015 BD Tare Wt. 69414.6 mg.
Date/Time/Analyst 3-31-93 0630 BD Tare Wt. 69415.8 mg.
Date/Time/Analyst 4-5-93 1550 BD Tare Wt. 69443.2 mg.
Date/Time/Analyst 4-7-93 0820 BD Tare Wt. 69444.5 mg.

Filter # B-25 DM STEWARD and CMI/BRISTOL BLANK

Date/Time Dessicated _____ Project # - BLANK ACETONE

Date/Time/Analyst 3-29-93 1015 BD Tare Wt. 68618.1 mg.
Date/Time/Analyst 3-31-93 0630 BD Tare Wt. 68618.9 mg.
Date/Time/Analyst 4-02-93 0830 DW Tare Wt. 68620.0 mg.
Date/Time/Analyst 4-02-93 1300 BD Tare Wt. 68620.0 mg.

net 1.5

Filter # B _____

Date/Time Dessicated 3-30-93 Project # Core knockout fr 1/2

Date/Time/Analyst _____ Tare Wt. 67814.7 mg.
Date/Time/Analyst _____ Tare Wt. - mg.
Date/Time/Analyst 4-2-93 0900 Tare Wt. 68042.1 mg.
Date/Time/Analyst _____ Tare Wt. _____ mg.

Filter # P-66 Probe Wash A-2 FR ACET 100 ml

Date/Time Dessicated _____ Project # BM. Steward

Date/Time/Analyst 4-7-93 0825 BD Tare Wt. 3813.2 mg.
Date/Time/Analyst 4-8-93 1500 DW Tare Wt. 3815.2 mg.
Date/Time/Analyst 4-9-93 0700 DW Tare Wt. 3820.8 mg.
Date/Time/Analyst 4-9-93 1630 BD Tare Wt. 3829.7 mg.

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Filter # P-67 Probe wash # A-3 FR Kellett

Date/Time Dessicated _____ Project # DM Steward

Date/Time/Analyst 4-7-93 0825 BD	Tare Wt. 3809.0	mg.
Date/Time/Analyst 4-8-93 1500 DW	Tare Wt. 3811.4	mg.
Date/Time/Analyst 4-9-93 0900 BD	Tare Wt. 3817.0	mg.
Date/Time/Analyst 4-9-93 1630 BD	Tare Wt. 3815.6	mg.

Filter # P-68 HSI IM-1 250ml

Date/Time Dessicated 4-19-93 1750 Project # 93-079A

Date/Time/Analyst 4-14-93 0900 BD	Tare Wt. 3819.3	mg.
Date/Time/Analyst 4-19-93 1700 BD	Tare Wt. 3819.0	mg.
Date/Time/Analyst 4-23-93 0840 BD	Tare Wt. 4085.1	mg.
Date/Time/Analyst 4-26-93 1115 BD	Tare Wt. 4084.6	mg.

Filter # P-69 HSI IM-2 250ml

Date/Time Dessicated 4-19-93 1730 Project # 93-080A

Date/Time/Analyst 4-14-93 0900 BD	Tare Wt. 3813.7	mg.
Date/Time/Analyst 4-19-93 1700 BD	Tare Wt. 3813.7	mg.
Date/Time/Analyst 4-23-93 0840 BD	Tare Wt. 4116.3	mg.
Date/Time/Analyst 4-26-93 1115 BD	Tare Wt. 4115.3	mg.

Filter # P-70 HSI IM-3 200ml

Date/Time Dessicated 4-19-93 1730 Project # 93-081A

Date/Time/Analyst 4-14-93 0900 BD	Tare Wt. 3768.9	mg.
Date/Time/Analyst 4-19-93 1700 BD	Tare Wt. 3769.9	mg.
Date/Time/Analyst 4-23-93 0840 BD	Tare Wt. 4160.5	mg.
Date/Time/Analyst 4-26-93 1115 BD	Tare Wt. 4160.0	mg.

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FINAL TEST REPORT
PARTICULATE EMISSION EVALUATION
STEWARD, INC.
CHATTANOOGA, TENNESSEE

prepared for

STEWARD, INC
EAST 36TH STREET
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by

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May, 1993

FINAL REPORT
PARTICULATE EMISSION EVALUATION
STEWARD, INC
CHATTANOOGA, TENNESSEE

TABLE OF CONTENTS

FINAL TEST REPORT
PARTICULATE EMISSION EVALUATION
STEWARD, INC.
CHATTANOOGA, TENNESSEE

1.0 INTRODUCTION

FBT Engineering and Environmental Services (FBT) was retained by Steward, Inc. to perform a particulate emission evaluation on the No. 4 Anhydro Spray Dryer at their facility in Chattanooga, Tennessee. The purpose of the evaluation was to demonstrate compliance with applicable provisions of the Chattanooga Air Pollution Control Ordinance. Specifically, this process, controlled by a Mikro Pul baghouse, is limited to particulate emissions of no more than 0.65 pounds per hour. The test was conducted March 30, 1993. The test team consisted of Mr. Chris Gottschalk and Mr. Jason Fraley, of FBT. Mr. Wayne Bishop, Steward, Inc. coordinated testing with plant operations. The test was witnessed by W. C. Markham, Jr., Chattanooga-Hamilton County Air Pollution Control Bureau.

2.0 SUMMARY OF RESULTS

The test consisted of three USEPA Method 5 runs performed on the discharge of the Mikro Pul baghouse. The results of these three runs yielded an average particulate emission rate for the test of 0.075 pounds per hour. The average rate of ferrite powder processed during the test was 2500 pounds per hour. A summary of the results of this test is presented in Table 1. Pertinent parameters and results from each run are given in Tables 2, 3, and 4. Sample calculations for run A-2 are presented in Appendix A. Field data sheets and process weight rate data are presented in Appendix C. Test Equipment calibration data is given in Appendix E. Laboratory analytical data is presented in Appendix F.

3.0 Conclusions

The results of this test showed that the average particulate matter emission rate from the Mikro Pul baghouse on the No. 4 Anhydro Spray Dryer was 0.075 pounds per hour at a ferrite powder process rate of 2500 pounds per hour. Comparing this result with the allowable particulate emission rate of 0.65 pounds per hour shows that this source is in compliance with the applicable provisions of the Chattanooga Air Pollution Control Ordinance.

TABLE 1

SUMMARY OF RESULTS

CLIENT:	STEWARD, INC.
SAMPLE LOCATION:	NO. 4 SPRAY DRYER BAGHOUSE DISCHARGE
EMISSION MEASURED:	PARTICULATE MATTER
ALLOWABLE RATE:	0.65 LB/HR
STACK DIMENSIONS:	15" x 36"

TEST DATE:	3/30/93			
RUN #	A-1	A-2	A-3	AVERAGES
TIME, EST	1054-1208	1320-1430	1505-1615	
STACK TEMP, °F	203	207	204	205
MOISTURE, %	11.3	10.7	11.7	11.2
VELOCITY, fps	23.8	23.3	22.6	23.2
GAS FLOW, SCFM	3758	3677	3544	3660
% ISOKINETIC	95	98	101	
PROCESS WEIGHT, LB/HR	2520	2520	2460	2500
EMISSIONS:				
Gr/DSCF	0.0008	0.0041	0.0023	0.0024
lb/hr	0.026	0.128	0.070	0.075

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TABLE 2
TEST RESULTS

CLIENT/PROJECT #:	STEWARD, INC.
SAMPLE LOCATION:	#4 SPRAY DRYER BAGHOUSE DISCHARGE
DATE/TIME:	3-30-93/1054-1208

RUN #: A-1

STATIC PRESSURE("H2O):	0.05	"HG	29.68
BAROMETRIC("HG):	29.68		
SAMPLE TIME(min):	60.00	Vm(corr)	42.359
ACTUAL METER VOLUME:	42.359	DSCF	42.663
SQ. ROOT ΔP:	0.369		
AVG ORIFICE ΔH:	1.56		
AVG STACK TEMP °F:	202.8	°R	662.8
AVG METER TEMP °F:	95.5		
Cp PITOT :	0.84		
NOZZLE DIA.(inches):	0.371	An(ft^2) =	7.51E-04
METER GAMMA:	1.064		
LEAK RATE(IF > 0.02):			
CIRC STACK? 1=Y,0=N:	0	As(ft^2) =	3.75
DIA OR DIM (inches):	540.00 = 15 in * 36 in		
% O2 :	20.50	DRY MOLE WT	28.82
% CO2 :	0.00	ST MOLE WT	27.60
VOL CONDENSATE(ml):	115.30	% H20	11.29
FILTER GAIN(mg):	-1.00		
RINSE GAIN(mg):	3.20	NET WT(mg)	2.20

**********CALCULATED RESULTS**********

GAS VELOCITY (Vs):	23.82	FT/SEC
STACK GAS FLOW (Qs):	5359.6	ACFM
:	3757.8	DSCFM
STACK GAS TEMP :	203	Deg F
MOISTURE (%H2O):	11.29	%
ISOKINETIC :	94.58	%

PARTICULATE MATTER EMISSION DATA

CONCENTRATION (Cs):	7.94E-04	Gr/DSCF
:	1.13E-07	lb/DSCF
EMISSION RATE (Er):	0.026	lb/hr

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TABLE 3
TEST RESULTS

CLIENT/PROJECT #:	STEWARD, INC.
SAMPLE LOCATION:	#4 SPRAY DRYER BAGHOUSE DISCHARGE
DATE/TIME:	3-30-93/1320-1430

RUN #: A-2

STATIC PRESSURE("H2O):	0.05	"HG	29.70
BAROMETRIC("HG):	29.70		
SAMPLE TIME(min):	60.00	Vm(corr)	23.392
ACTUAL METER VOLUME:	23.392	DSCF	23.614
SQ. ROOT ΔP:	0.360		
AVG ORIFICE ΔH:	0.43		
AVG STACK TEMP °F:	206.9	°R	666.9
AVG METER TEMP °F:	93.0		
Cp PITOT :	0.84		
NOZZLE DIA.(inches):	0.274	An(ft^2) =	4.09E-04
METER GAMMA:	1.064		
LEAK RATE(IF > 0.02):			
CIRC STACK? 1=Y,0=N:	0	As(ft^2) =	3.75
DIA OR DIM (inches):	540.00 = 15 in * 36 in		
% O2 :	20.40	DRY MOLE WT	28.82
% CO2 :	0.00	ST MOLE WT	27.66
VOL CONDENSATE(ml):	60.20	% H2O	10.71
FILTER GAIN(mg):	1.65		
RINSE GAIN(mg):	4.60	NET WT(mg)	6.25

**********CALCULATED RESULTS**********

GAS VELOCITY (Vs):	23.28	FT/SEC
STACK GAS FLOW (Qs):	5238.6	ACFM
:	3676.7	DSCFM
STACK GAS TEMP :	207	Deg F
MOISTURE (%H2O):	10.71	%
ISOKINETIC :	98.09	%

PARTICULATE MATTER EMISSION DATA

CONCENTRATION (Cs):	4.08E-03	Gr/DSCF
:	5.82E-07	lb/DSCF
EMISSION RATE (Er):	0.128	lb/hr

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TABLE 4
TEST RESULTS

CLIENT/PROJECT #:	STEWARD, INC.
SAMPLE LOCATION:	#4 SPRAY DRYER BAGHOUSE DISCHARGE
DATE/TIME:	3-30-93/1505-1615

RUN #: A-3

STATIC PRESSURE("H2O):	0.04	"HG	29.70
BAROMETRIC("HG):	29.70		
SAMPLE TIME(min):	60.00	Vm(corr)	23.249
ACTUAL METER VOLUME:	23.249	DSCF	23.326
SQ. ROOT ΔP:	0.349		
AVG ORIFICE ΔH:	0.41		
AVG STACK TEMP °F:	203.8	°R	663.8
AVG METER TEMP °F:	96.4		
Cp PITOT :	0.84		0.84
NOZZLE DIA.(inches):	0.274	An(ft^2) =	4.09E-04
METER GAMMA:	1.064		
LEAK RATE(IF>0.02):			
CIRC STACK? 1=Y,0=N:	0	As(ft^2) =	3.75
DIA OR DIM (inches):	540.00 = 15 in * 36 in		
% O2 :	20.50	DRY MOLE WT	28.82
% CO2 :	0.00	ST MOLE WT	27.56
VOL CONDENSATE(ml):	65.60	% H20	11.69
FILTER GAIN(mg):	-1.05		
RINSE GAIN(mg):	4.55	NET WT(mg)	3.50

**********CALCULATED RESULTS**********

GAS VELOCITY (Vs):	22.59	FT/SEC
STACK GAS FLOW (Qs):	5082.3	ACFM
:	3544.3	DSCFM
STACK GAS TEMP :	204	Deg F
MOISTURE (%H2O):	11.69	%
ISOKINETIC :	100.51	%

PARTICULATE MATTER EMISSION DATA

CONCENTRATION (Cs):	2.31E-03	Gr/DSCF
:	3.30E-07	lb/DSCF
EMISSION RATE (Er):	0.070	lb/hr

FBT

4.0 Emission Source Description

The No. 4 Anhydro Spray Dryer process located in the Steward, Inc. facility on East 36th Street in Chattanooga, Tennessee operates under Bureau Certificate of Operation No. 0780-30500899-30C. This spray dryer dries a ferrite powder/water slurry with hot air, which is heated with a natural gas burner. Hot, moist air exiting the spray dryer passes first through a cyclone and then through a Mikro Pul baghouse filter for ferrite powder removal. The hot, moist, filtered air is finally discharged to the atmosphere. The dry ferrite powder processing rate of the spray dryer is nominally 2,500 pounds per hour.

The Mikro Pul baghouse is designed for hot operation and utilizes a pulse jet cleaning system. Its discharge duct is 15-inches by 36-inches which exits the building horizontally and then turns 90 degrees upward. To provide the necessary straight run of duct for testing the 90 degree elbow was removed and a temporary 7-ft straight duct extension was installed as shown in Appendix D.

5.0 Sampling Protocol

The sampling and analytical procedures used during this test were USEPA Reference Methods described in the *Code of Federal Regulations* (CFR), 40 Part 60, Appendix A, Revised July 1, 1991. Following is a list of these Methods. Sampling, analytical, and laboratory procedures are described in Appendix B.

5.1 Measurement Sites (Method 1)
The location of measurement sites and the number of sample points were determined as specified in **USEPA Reference Method 1**, "Sample and Velocity Traverses for Stationary Sources."

5.2 Velocity and Volumetric Flow Rates (Method 2)
The duct/stack gas velocities and volumetric flow rates were determined using **USEPA Reference Method 2**, "Determination of Stack Gas Velocity and Volumetric Flow Rate."

5.3 Dry Molecular Weight (Method 3)
The dry molecular weight of the duct/stack gases was determined using **USEPA Reference Method 3**, "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight." Three grab samples were collected and analyzed during test with a Fyrite combustion gas analyzer.

5.4 Moisture (Method 4)
The moisture content of the stack gas was determined using **USEPA Reference Method 4**, "Determination of Moisture Content in Stack Gases."

5.5 Particulate Matter (Method 5)

The particulate matter emissions were determined using USEPA Reference Method 5, "Determination of Particulate Emissions from Stationary Sources."

6.0 APPENDICES

A Sample Calculations

B Sampling and Laboratory Procedures

C Field Data Sheets

D Schematic of Sampling Site

E Calibration Data

F Analytical Data

EMISSIONS PRE-TEST AGREEMENT

Preamble

A source sampling test of the No. 4 Anhydro Spray Dryer (Certificate of Operation No. 0780-30500899-30C) controlled by a DCE baghouse will be conducted by Fluidized Bed Technologies, Inc., of Chattanooga, to demonstrate compliance with all applicable provisions of the Chattanooga Air Pollution Control Ordinance. The test will be conducted for particulate matter. The test shall be observed by representatives of the Chattanooga-Hamilton County Air Pollution Control Bureau (the Bureau) and shall be conducted under maximum representative operating conditions. Failure to meet the requirements specified herein or include all necessary information in the final report shall constitute sufficient basis for the Bureau's rejection of the test results and/or the final report.

Minimum Requirements

A. Process Requirements:

1. Th
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3. Tl
   tl
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Good to Go to the Lab
- Chain of Custody
- Lab Results

s/hr

by

r.

ıute

STEWACO, Inc
3/30/93
WCM

Run One

Pre Test Leak Check: 0.00 cfm GOOD

START: 10:53 AM STOP: 12:00 pm

Leak Check: 0.001 cfm @ / min

Total Flow: 42.359 cfm 0.02824 cfm

0.02 cfm

Process Wt: 2520 #/hr

Comments

- Excellent equipment
- Pressure leak-check on first try - 0.00 cfm
- 3 min per position - Twenty positions

	1	2	3	4	5
1	x	x	x	x	x
2	x	x	x	x	x
3	x	x	x	x	x
4	x	x	x	x	x

NOTE MOVE BOX (4 PORTS) FOUR (4) TIMES

* Average Sampling Rate: 0.02945 cfm

∴ Go with 0.02 cfm L.C.

@ First points

STOWERS INC
3/30/93
WCM

Run Two

Pre Test Leak Check: 0.008 cfm Good

Start: 1:18 pm Stop: 2:25 pm

Leak Check: 0.004 cfm

Total Flow: 23.392 cfm → 0.0156 cfm → 0.02

Process Weight: 2520 #/hr

Comments

- Passed Leak check on first attempt

Run Three

Pre Test Leak Check:

Start: 305 pm Stop: 4: pm

Leak Check: 0.005 cfm

Total Flow: 22.03 cfm

Process Weight: 2460 #/hr → 0.0147 cfm → 0.02

Comments