Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

AP-42 Section 11.28
Reference 9
Report Sect. 6R
Reference 11

PARTICULATE EMISSION COMPLIANCE TEST

ON

GRINDER BAGHOUSE

ON

AUGUST 8, 1989

AT

W. R. GRACE & COMPANY

KEARNEY EXFOLIATING PLANT

ENOREE, SOUTH CAROLINA 29335

BY

ENVIRONMENTAL ENGINEERING DIVISION, PSI

P. O. BOX 16411, STA. B

GREENVILLE, SOUTH CAROLINA 29606

PHONE: (803) 233-0597

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TABLE OF CONTENTS

The field and laboratory data contained in this Emission Test Report on the WR Grace-Enoree Plant are true and accurate to the best of my knowledge.

Signed E. A. Picklesimer

Date 8/24/89

SOUTH CAROLINA
REGISTERED PROFESSIONAL ENGINEER
No. 8278
E. A.

SIGNIFICANT DATA

NAME OF FACILITY: W. R. GRACE, KEARNEY EXFOLIATING PLANT

LOCATION: ENOREE, S. C.

SOURCE, CONTROL DEVICE TESTED: GRINDER BAGHOUSE

TEST DATE: AUGUST 8, 1989

S. C. DHEC OFFICIALS PRESENT: RANDY BISHOP & BOB JACKSON

SOURCE TEST TEAM: CARROLL RAINEY & JOE JEANES

FACILITY REPRESENTATIVE: JEFF DANNAKER

CORPORATE ENGINEERS PRESENT:

Joseph C. Cacciola
Project Engineer
Construction Products Division

GRACE

W.R. Grace & Co.-Conn.
62 Whittemore Ave.
Cambridge, MA 02140
(617) 876-1400 - Ext. 3711

Jay H. Burrill
Environmental Coordinator
Construction Products Division

GRACE

W.R. Grace & Co.
62 Whittemore Avenue
Cambridge, MA 02140
(617) 876-1400, Ext. 3705

PARTICULATE EMISSION RATE SUMMARY

RUN #	VOLUMETRIC FLOW RATE (DSCF/HR)	PARTICULATE CATCH (GM)	MEASURED EMISSIONS (GR/DSCF)
1	173,000	0.0397	0.0163
2	158,000	0.0401	0.0178
3	155,000	0.0443	0.0203
AVG.			0.018

This source is in compliance with the new source performance standards (NSPS) allowable emission rate of 0.02 gr/dscf.

SOURCE: W R GRACE, ENOREE, SC

TEST DATE: 8/8/89

TEST NUMBER:	1	2	3	AVG.
# Traverse Pts.	12	→		
Θ, Minutes	60	→		
MCF	.990	→		
Δ H @	1.96	→		
Δ H avg., "H_2O	1.4	1.2	1.2	
$\sqrt{\Delta P}$ avg., " H_2O	.59	.54	.53	
Tm avg., ^oR	540	548	550	
Ts avg., ^oR	576	578	582	
Pb, "Hg	29.12	29.14	29.12	
Ps, "H_2O	29.13	29.15	29.13	
STACK DIA., in.	17	→		
Nozzle Dia., in.	.249	.253	.253	
% CO_2	/			
% O_2	/			
% CO	/			
Vm, ft^3	39.3	37.0	36.0	
Vm_{STD}, ft^3	37.5	34.8	33.7	
% H_2O	1	1	1	
Md	30	→		
Ms	29.88	29.88	29.9	

SOURCE: W R GRACE, ENOREE, SC

TEST DATE: 8/8/89

TEST NUMBER	1	2	3	AVG
Vs, ft/sec	34.5	31.6	31.1	
Qa, acfm				
Qs, dscf~~m~~ hr	173,000	158,000	155,000	
PARTICULATE CATCH, gm	.0397	.0401	.0443	
PMR, lbs/hr	.403	.401	.449	
Cs, lbs/dscf				
I, %	101	99.5	98.6	

Vermiculite Grinder Operation
W. R. Grace & Co. - Conn.
Kearney Exfoliating Plant
Enoree, South Carolina

General

W. R. Grace & Co. - Conn. (Grace) markets a vermiculite product known as Fine Particle Size Vermiculite (FPSV), manufactured from exfoliated vermiculite. This product is currently manufactured in Ajax, Ontario, and Grace intends to install equipment at their Kearney plant to manufacture FPSV in the United States. The Kearney facility will be designed to have the capacity to produce 7,500 tons per year of FPSV.

Process Description

In general, the manufacturing process consists of grinding exfoliated vermiculite in an air swept pulverizer, utilizing the kinetic energy of impact to grind the material (hereafter, the "grinder"). The FPSV is conveyed pneumatically, and a baghouse is used as a product recovery device. The finished product is packaged in bags for shipment to customers.

The process flow is shown on the attached Vermiculite Grinder Schematic Diagram. Exfoliated vermiculite from one of two furnaces is discharged to a hopper, from which it is conveyed to the grinder feed hopper. The vermiculite is fed at a rate of 2,000 to 2,500 lb/hr., and the system is designed to make use of most of the conveying air to supply some of the air required to sweep the pulverizer. Air vented from the feed hopper is directed to the grinder feed, the grinder discharge conveyor, and the baghouse inlet lines, and as a result, none of the transfer air is vented to the atmosphere.

The FPSV discharged from the grinder is conveyed to the baghouse. Here the product flow is diverted by an end plate. The majority of the product falls to the baghouse collecting hopper, and only a fraction of the material is carried by the air stream to the filter media.

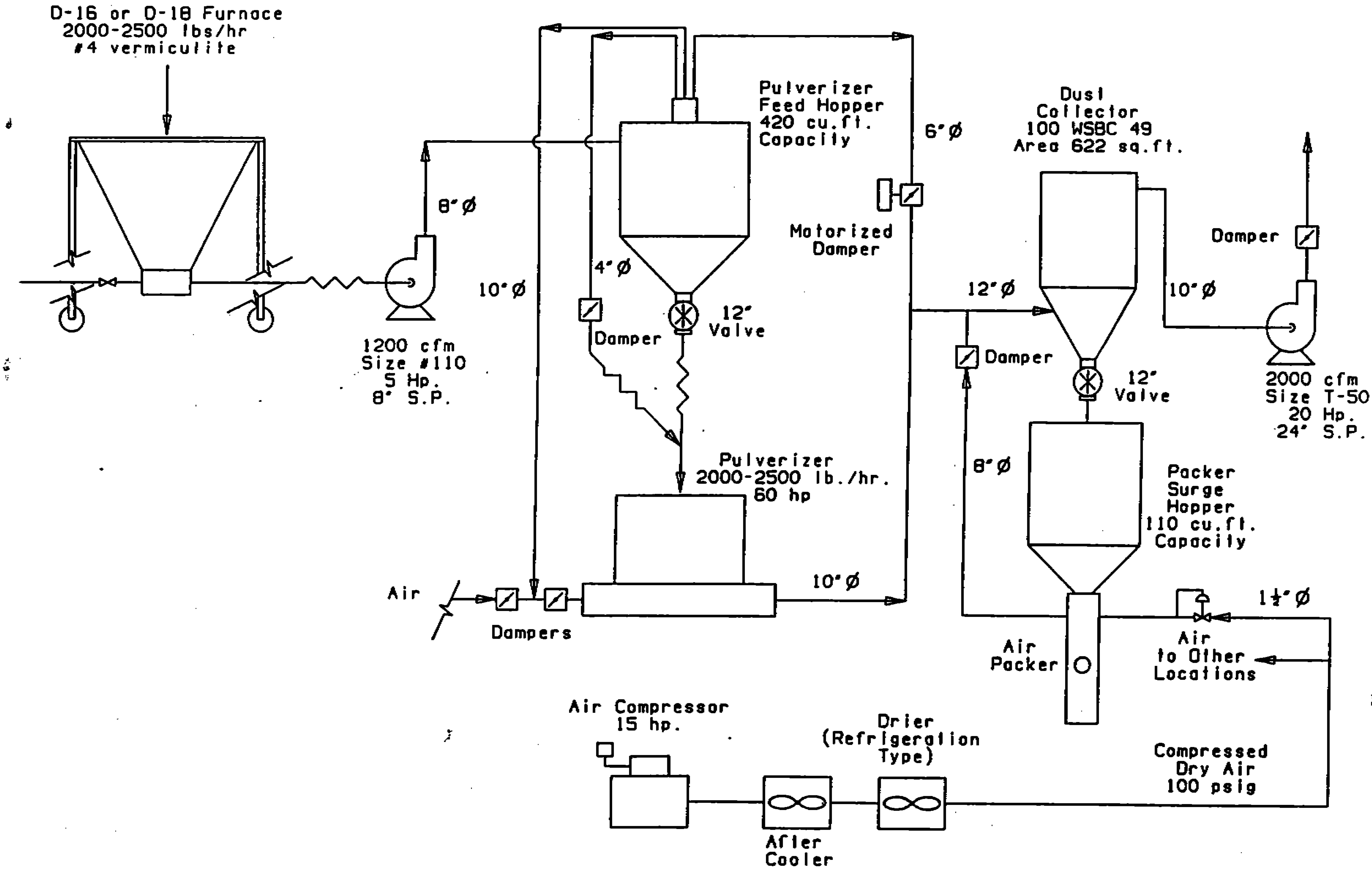
The baghouse is a continuous, self-cleaning, reverse pulse air jet design. All FPSV collected by the filter media, is thereby discharged to the baghouse collecting bin. From here, the finished product is fed to the packer surge hopper, and packaged using a valve-bag type air packer.

Vermiculite Grinder Operation
Kearney Exfoliating Plant
Enoree, South Carolina

Baghouse Design Criteria

Manufacturer	Flex Kleen
Model	100-WSBC-49(III)
Filter Media	16 oz. polypropylene fabric
Permeability	< 35 cfm/sq. ft., @ 0.5 in. Water W.G.
Filter Quantity	49
Filter Area	622 sq. ft.
Flow Rate	2,000 cfm.
Air to Cloth Ratio	3.2:1
Design Pressure	5 to 6 in. Water W.G. (negative)
Differential Pressure	< 4 in. Water W.G.
Design Temperature	250°F
Design Efficiency	+99.9%
Cleaning Action	Reverse pulse air jet on timer
Cleaning Air	100 psig.

JHB/sy
2/13/89



Vermiculite Grinder
Schematic Diagram

No Scale D.A. 1-13-1989

Furnace Production

Grinder — MACHINE | 1st — SHIFT | 8-8-89 — DATE

	BAGS				BULK	WGT		WGT
1	Test #1		9:00am	1	Test #3		11:43 AM	
2	8 Bags			2	9 Bags			
3	15 Bags	46 Bags.		3	15 Bags		48 Bags	
4	15 Bags			4	15 Bags			
5	8 Bags			5	9 Bags			
6				6				
7	Test #2	10:25 AM		7				
8	10 bags			8				
9	15 Bags	47 Bags		9				
10	15 Bags			10				
11	7 Bags			11				
12				12				
13				13				
14				14				
15				15				

[illegible]
W. R. Grace & Co.-Conn.
Kearney Expanding Plant
Enoree, SC 29335

NAME:

HOURS OPERATED:

CAR NUMBERS:

All bags were weighed with a spec. of 50 ± .6 #.

AIR ENGINEERING DIV.
PALMER SERVICES INC.

P.O. BOX 16411 ST
GREENVILLE, S. C.
PHONE (803)-244-

Method 1—Sample and Velocity Traverses for Stationary Sources
Sample Site Selection and Minimum Number of Traverse Points

Plant W R Grace Location Baghouse Date 4/7/89

Sampling location STACK

Sample team operator(s) Rainey + Jeanes

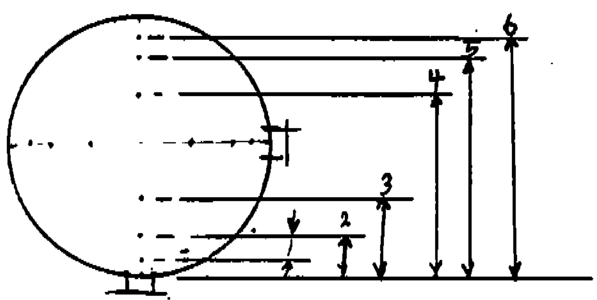
Sketch of stack geometry (including distances from sample site to any disturbances)

Interior duct cross-section dimension 1.4 ft
Sampling port diameter 3.0 in.
Sampling port nipple length 0 in.
Stack cross-sectional area 1.58 ft^2

Sampling site: diameter downstream of disturbance 9.4 Diameters upstream 25
Minimum number of sampling points 12 Individual point sample time 5
Total test time 60
Comments:

STACK DIA = 17"

Sketch of Stack Cross-Section Showing Sample Ports and all Dimensions



Sample point number	Circular stack % diameter	Distance from sample port opening in.
1.	4.4	1
2.	14.6	2.5
3.	29.6	5.0
4.	70.4	12.0
5.	85.4	14.5
6.	95.6	16.3
7.		
8.		
9.		
10.		
11.		
12.		

LCFD 4' - 60 sec 1.002 1.002 / 1000

Plant	W R Grace	Meter Calibration (Y)	.99	Sheet	1 of 1
City	Enoree	Pitot Tube (C_p)	.84	Nozzle Identification No.	1/4
Location	Baghouse	Probe Length	3'	Nozzle Diameter	0.249 ~~mm~~ (in.)
Operator	Raiper	Probe Liner Material	SS	Therm. No.	1
Date	8/18/89	Probe Heater Setting	20%	Final Leak Rate	.000 ~~m³~~/min. (cfm)
Run No.	1	Ambient Temperature	68	Vacuum During Leak Check	4 ~~mm Hg~~ (in. Hg)
Stack diam. ~~mm~~ (in.)	17	Barometric Pressure (P_b)	29.12 ~~mm Hg~~ (in. Hg)	Filter No.	305, 314, 315, 316
Sample Box No.	1	Assumed Moisture	4%	Remarks:	
Meter Box No.	RAC 5-1343	Static Pressure (P_s)	+.20 ~~mm H₂O~~ (in. H_2O)		
Meter ΔH@	1.96	C Factor	1.1		
		Reference ΔP	.45 ~~mm H₂O~~ (in. H_2O)		

SG_i = 744.4, 721.5, 654.4

Traverse point number	Sampling time, (θ), min.	Clock time, (24 hr)	Vacuum mm Hg (in. Hg)	Stack temperature (T_s), °C (°F)	Velocity head (ΔP_s), mm H_2O (in. H_2O)	Pressure differential across orifice meter (ΔH) mm H_2O (in. H_2O)	Gas sample volume (V_m) m³ (ft³)	Gas sample temperature at dry gas meter: Inlet, °C (°F)	Gas sample temperature at dry gas meter: Outlet, °C (°F)	Temperature of gas leaving condenser or last impinger, °C (°F)	Filter temp., °C (°F)
1	0-5	0900	0	114	.34	1.4	940.912	68	69	53	270
2		0905	0	113	.39	1.6	944.4	73	69	55	250
3		0910	0	115	.41	1.7	947.6	79	70	54	250
4		0915	0	117	.33	1.4	951.2	83	71	51	240
5		0920	0	115	.37	1.5	954.5	86	73	50	250
6		0925	0	116	.34	1.4	957.8	89	74	49	240
	STOP	0930	Chg	Port			961.214				
7		0933	0	118	.34	1.5		85	75	49	270
8		0938	0	114	.40	1.6	964.7	88	77	47	270
9		0943	0	118	.38	1.5	967.7	91	78	47	270
10		0948	0	117	.34	1.4	971.3	93	79	46	270
11		0953	0	116	.25	1.0	974.7	93	79	46	270
12		0958	0	118	.26	1.1	977.5	92	80	46	260
	STOP	1003					980.567				
	Total		Max. 0	Avg. 116	$\sqrt{.59}$	1.4	Total	Avg.	Avg. 80	Max. 58	
				116	0.59	1.4	39.655 39.655	80			

80

H_2O = 8.6

Part = 39.7 mg

METHOD 5

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant: W R GRACE, ENOREE, S C Sample date: 8/8/89
Sample location: BAG HOUSE Run no.: 1
Sample recovery person: RAINEY Recovery date: 8/8/89
Filter(s) no.: 305

MOISTURE

Impingers		Silica gel	
Final volume (wt)	203 ml(gm)	Final wt.	660.0 g
Initial volume (wt)	200 ml(gm)	Initial wt.	654.4 g
Net volume (wt)	03 ml(gm)	Net wt.	5.6 g

Total moisture ____ g

Color of silica gel PINKISH

Description of impinger water CLEAR

RECOVERED SAMPLE

Filter container no. 305 sealed YES

Description of particulate on filter TAN

Acetone rinse container no. 1 Liquid level marked YES

Acetone blank container no. BLANK Liquid level marked YES

Samples stored and locked YES

Remarks:

Date of laboratory custody 8/9/89

Laboratory personnel taking custody [signature]

Remarks:

METHOD 5 TRAIN ANALYTICAL PARTICULATE DATA

8/8/89

Plant WR GRACE, ENOREE, SC Run No. 1

Sample location BAG HOUSE

Relative humidity ____

Density of acetone (ρa) 0.784 g/ml

Sample type	Sample identifiable	Liquid level marked and/or container sealed
Acetone rinse	/	YES
filter(s)	305	YES

Acetone rinse container no. 1

Acetone rinse volume (Vaw) 90 ml

Acetone blank residue concentration (Ca) 7.65×10^{-6} mg/g

Wa = Ca Vaw ρa = (7.65×10^{-6})(90)(0.784) = .0005 mg

Date and time of wt 8/15/89 0915 Gross wt 69.5622 mg

Date and time of wt " " 1515 Gross wt 69.5626 mg

Average gross wt 69.5624 mg

Tare wt 69.5478 mg

Less acetone blank wt (Wa) .0005 mg

Weight of particulate in acetone rinse .0141 mg ✓

Filter(s) container no. 305

Date and time of wt 8/15/89 0915 Gross wt .2939 mg

Date and time of wt " " 1515 Gross wt .2937 mg

Average gross wt .2938 mg

Tare wt .2682 mg

Weight of particulate on filter(s) .0256 mg ✓

Weight of particulate in acetone rinse .0141 mg

Total weight of particulate .0397 mg

Note: In no case shall a blank residue greater than (.01 mg/g) or .001% of the weight of acetone used be subtracted from the sample weight.

Remarks: ____

Signature of analyst [signature]

Signature of reviewer Ed P

WR GRACE, ENOREE, SC
BAG HOUSE
RUN # 1
8/8/89

Method 5 Particulate Test

Calculation Form

I. Necessary Data

A. No. of Traverse Points 12

B. Total Test Time (θ) 60 minutes

C. Water Collected

1. Impinger H_2O 03 ml

2. Silica Gel 5.6 gm

D. Particulate Weight (m_n) .0397 gm

E. Volume Metered

V_m = 39.655 CF X DGMCF* .990 = 39.3 CF

F. Average $\sqrt{\Delta P}$ = .59 $\sqrt{\text{in } H_2O}$

G. Average ΔH = 1.4 in H_2O

H. Average Meter Temperature T_m 80 °F + 460 = 540 °R

I. Average Stack Temperature T_s 116 °F + 460 = 576 °R

J. Stack Absolute Pressure 29.13 in. Hg

K. Barometric Pressure 29.12 in. Hg

L. $\%CO_2$ — ; $\%O_2$ 20.9 ; %CO — ; $\%N_2$ 79.1 ;

M. Area of Stack 1.58 ft.² D = 17"

N. Area of Nozzle 3.38×10^{-4} ft.² d = .249"

II. Calculations

A. Standard Volume Metered

*DGMCF = Dry Gas meter calibration factor

$$V_{m(std)} = V_m \frac{T_{std}}{P_{std}} \frac{P_b + \frac{\Delta H}{13.6}}{T_m}$$

29.22

$$V_{m(std)} = (\underline{39.3}\text{ CF})\left(\frac{528°R}{29.92 \text{ in.Hg}}\right)\left(\frac{29.12 + \frac{1.4}{13.6} \text{ in.Hg}}{540 \text{ °R}}\right) = \underline{37.5} \text{ dscf}$$ ✓

W R GRACE, ENOREE, S
BAGHOUSE
RUN #1
8/8/89

B. Moisture Content of Stack Gas

1. H_2O collected in impingers in standard cubic feet

$$V_{wc(std)} = K\,(V_f - V_i)$$

$$V_{wc(std)} = 0.04707\ \text{ft.}^3/\text{ml}\ (\underline{\ 03\ }\ \text{ml}) = \underline{\ .14\ }\ \text{scf}$$

2. H_2O collected in Silica Gel in standard cubic feet

$$V_{wsg(std)} = K\,(W_f - W_i)$$

$$V_{wsg(std)} = 0.04715\ \text{ft.}^3/\text{gm.}\ (\underline{\ 5.6\ }\ \text{gm}) = \underline{\ .26\ }\ \text{scf}$$

3. Moisture Content of Stack Gas (B_{ws})

$$B_{ws} = \frac{V_{wc(std)} + V_{wsg(std)}}{V_{wc(std)} + V_{wsg(std)} + V_{m(std)}}$$

$$B_{ws} = \frac{(\underline{\ .14\ }\ \text{scf}) + (\underline{\ .26\ }\ \text{scf})}{(\underline{\ .14\ }\ \text{scf}) + (\underline{\ .26\ }\ \text{scf}) + (\underline{\ 37.5\ }\ \text{scf})} = \underline{\ .01\ }$$

C. Molecular Weight of Stack Gas (lB/lB-mole)

1. M_d (Dry Molecular Weight) = $\Sigma\, M_x\, B_x$

$$M_d = (44)\underline{\ -\ }\%CO_2 + (32)\underline{\ 20.9\ }\%O_2 + (28)\underline{\ -\ }\%CO + (.28)\underline{\ 79.1\ }\%N_2 =$$

$\underline{\ 30\ }$ lB/lB-mole

2. M_s (Wet Molecular Weight) = $M_d\,(1-B_{ws}) + 18\,B_{ws}$

$$M_s = \underline{\ 30\ }\ (1-\underline{\ .01\ }) + 18(\underline{\ .01\ }) = \underline{\ 29.88\ }\ \text{lB/lB-mole}$$

D. Average Stack Gas Velocity

$$\bar{V}_s = K_p C_p \left[\frac{T_s}{P_s M_s}\right]^{1/2} \left[\Delta P\right]^{1/2}$$

$$\bar{V}_s = 85.48\ \text{ft./sec.} \left[\frac{\text{lB/lB-mole(in.Hg)}}{^\circ\text{R(in.}H_2O)}\right]^{1/2} \underline{\ .84\ } \left[\frac{(\ 576\ )^\circ\text{R}}{(\underline{\quad}\ \text{in.Hg})(\underline{\ 29.88\ })\ \text{lB/lB-mole}}\right]$$

29.13

$$\left[\underline{\ .59\ }\right]\left[\text{in } H_2O\right]^{1/2} = \underline{\ 34.5\ }\ \text{ft./sec}$$

WR GRACE, ENOREE, S.C.
BAGHOUSE
RUN # 1
8/8/89

E. Average Stack Gas Volumetric Flow Rate

$$\bar{Q}_s = (3600\ \text{sec/hr})(\bar{V}_s)(A_s)(1-B_{ws})\ \frac{T_{std}}{P_{std}}\ \frac{P_s}{T_s}$$

$$\bar{Q}_s = (3600\ \text{sec/hr})(\underline{34.5}\ \text{ft./sec})(\underline{1.58}\ \text{ft.}^2)(1-\underline{.01})\ \frac{528°R}{29.92\text{in.Hg}}\left[\frac{\underline{29.13}\ \text{in.Hg}}{\underline{576}\ °R}\right] = 173{,}000\ \text{dscf/hr}$$

F. Pollutant Mass Rate

$$PMR = \left[\frac{M_n}{V_{m(std)}}\right] X\ Q_s$$

$$PRM = \frac{(\underline{.0397})\text{gm}}{\underline{37.5}\ \text{dscf}}\ X\ \underline{\quad\quad}\ \text{dscf/HR}\ X\ \frac{1}{454\text{gm/1B}} = \underline{0.403}\ \text{1B/HR}$$

G. % Isokinetic Variation (Intermediate Data)

$$\%I = \frac{T_s\ V_{m(std)}\ P_{std}\ 100}{\Theta\ \bar{V}_s A_n P_s\ T_{std}(60)(1-B_{ws})}$$

$$\%I = \frac{(\underline{576}\ °R)(\underline{37.5}\ \text{dscf})(29.92\ \text{in.Hg})(100)}{(\underset{3.38\times10^{-4}}{\underline{\quad\quad}}\ \text{ft}^2)(\underline{60}\ \text{min.})(\underline{34.5}\ \text{ft./sec.})(\underline{29.13}\ \text{in.Hg})(528°R)(60\ \text{sec./min.})\underbrace{(1-\underline{.01})}_{.99}}$$

$$\%I = 101\%$$

$$\text{EMMISIONS} = \left(\frac{M_n\ \text{gm}}{V_{m(std)}\ \text{dscf}}\right)\left(\frac{7000\ \text{gr/lb}}{454\ \text{gm/lb}}\right)$$

$$= \left(\frac{.0397\ \cancel{\text{gm}}}{37.5\ \text{dscf}}\right)\left(\frac{7000\text{gr}/\cancel{\text{lb}}}{454\ \cancel{\text{gm}/\text{lb}}}\right)$$

$$= 0.0163\ \text{gr/dscf}$$

LCP@4' - 60 sec .092 .092 .002

Plant: W R Grace
City: Enoree
Location: Baghouse
Operator:
Date: 8/8/89
Run No.: 2
Stack diam. ~~mm~~ (in.): 17.0
Sample Box No.: 2
Meter Box No.: RAC 5-1343
Meter ΔH@: 1.96

Meter Calibration (Y): .990
Pitot Tube (C_p): .84
Probe Length: 5' A
Probe Liner Material: SS
Probe Heater Setting: 205
Ambient Temperature: 73
Barometric Pressure (P_b): 29.14 ~~mm Hg~~ (in. Hg)
Assumed Moisture: 4%
Static Pressure (P_s): +.15 ~~mm H2O~~ (in. H_2O)
C Factor: 1.1
Reference ΔP: .45 ~~mm H2O~~ (in. H_2O)

Sheet 1 of 1
Nozzle Identification No.: 1/4
Nozzle Diameter: 0.253 ~~mm~~ (in.)
Therm. No.: 1
Final Leak Rate: .002 ~~M³/min.~~ (cfm)
Vacuum During Leak Check: 4 ~~mm Hg~~ (in. Hg)
Filter No.: 305, 314, 315, 316
Remarks:

SGi = 744.4, 721.5 654.4

RB

Traverse point number	Sampling time, (θ), min.	Clock time, (24 hr)	Vacuum mm Hg (in. Hg)	Stack temperature (T_s), °C (°F)	Velocity head (ΔP_s), mm H_2O (in. H_2O)	Pressure differential across orifice meter (ΔH) mm H_2O (in. H_2O)	Gas sample volume (V_m) m^3 (ft^3)	Gas sample temperature at dry gas meter: Inlet, °C (°F)	Gas sample temperature at dry gas meter: Outlet, °C (°F)	Temperature of gas leaving condenser or last impinger, °C (°F)	Filter temp., °C (°F)
1	0-5	1025	0	116	.30	1.2	981.150	82	81	52	255
2		1030	0	116	.29	1.2	984.3	88	82	64	270
3		1035	0	117	.32	1.3	987.3	92	82	56	265
4		1040	0	120	.31	1.3	990.15	94	83	57	270
5		1045	0	118	.30	1.2	993.7	95	83	53	265
6		1050	0	117	.26	1.1	996.8	95	84	52	260
	STOP	1055	Chg	Port			999.808				
7	SP 15	1057	0	119	.29	1.2		91	83	54	270
8		1102	0	119	.32	1.3	003.5	92	84	52	250
9		1107	0	117	.33	1.4	006.1	93	84	51	247
10		1112	0	120	.31	1.2	009.4	94	84	51	270
11		1117	0	119	.23	.95	012.8	95	84	51	260
12		1122	0	116	.26	1.1	015.5	96	87	52	260
	STOP Total	1127	Max. 0	Avg. 118	$\sqrt{.54}$	1.2	018.539 Total	Avg.	Avg.	Max. 64	
				118	.54	1.2	37.389 37.389	88 88			

$H_2O = 5.9$

Ount = 40.1

METHOD 5

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant: W R GRACE, ENOREE, S.C Sample date: 8/8/89
Sample location: BAGHOUSE Run no.: 2
Sample recovery person: RAINEY Recovery date: 8/8/89
Filter(s) no.: 314

MOISTURE

Impingers		Silica gel		
Final volume (wt)	202 ml(gm)	Final wt.	725.4 g	g
Initial volume (wt)	200 ml(gm)	Initial wt.	721.5 g	g
Net volume (wt)	02 ml(gm)	Net wt.	3.9 g	g

Total moisture _____ g

Color of silica gel PINKISH

Description of impinger water CLEAR

RECOVERED SAMPLE

Filter container no. 314 sealed YES

Description of particulate on filter TAN

Acetone rinse container no. 2 Liquid level marked YES

Acetone blank container no. BLANK Liquid level marked YES

Samples stored and locked YES

Remarks:

Date of laboratory custody 8/9/89

Laboratory personnel taking custody [signature]

Remarks:

METHOD 5 TRAIN ANALYTICAL PARTICULATE DATA

8/8/89

Plant WR GRACE Run No. 2

Sample location BAGHOUSE

Relative humidity ______

Density of acetone (ρa) 0.784 g/ml

Sample type	Sample identifiable	Liquid level marked and/or container sealed
Acetone rinse	2	YES
filter(s)	314	YES

Acetone rinse container no. 2

Acetone rinse volume (Vaw) 115 ml

Acetone blank residue concentration (Ca) 7.65×10^{-6} mg/g

Wa = Ca Vaw ρa = (7.65×10^{-6}) (115) (0.784) = .0007 mg

Date and time of wt 8/15/89 0915 Gross wt 68.3740 mg

Date and time of wt " " 1515 Gross wt 68.3738 mg

Average gross wt 68.3739 mg

Tare wt 68.3584 mg

Less acetone blank wt (Wa) .0007 mg

Weight of particulate in acetone rinse .0148 mg ✓

Filter(s) container no. 314

Date and time of wt 8/15/89 0915 Gross wt .2950 mg

Date and time of wt " " 1515 Gross wt .2948 mg

Average gross wt .2949 mg

Tare wt .2696 mg

Weight of particulate on filter(s) .0253 mg ✓

Weight of particulate in acetone rinse .0148 mg

Total weight of particulate .0401 mg ✓

Note: In no case shall a blank residue greater than (.01 mg/g) or .001% of the weight of acetone used be subtracted from the sample weight.

Remarks: ______

Signature of analyst [signature]

Signature of reviewer Ed P

W R GRACE, ENOREE, SC
BAG HOUSE
RUN #2
8/8/89

Method 5 Particulate Test

Calculation Form

I. Necessary Data

A. No. of Traverse Points 12

B. Total Test Time (θ) 60 minutes

C. Water Collected

1. Impinger H_2O 02 ml

2. Silica Gel 3.9 gm

D. Particulate Weight (m_n) .0401 gm

E. Volume Metered

V_m = 37.389 CF X DGMCF* (.990) = 37.0 CF

F. Average $\sqrt{\Delta P}$ = .54 $\sqrt{\text{in } H_2O}$

G. Average ΔH = 1.2 in H_2O

H. Average Meter Temperature T_m 88 °F + 460 = 548 °R

I. Average Stack Temperature T_s 118 °F + 460 = 578 °R

J. Stack Absolute Pressure 29.15 in. Hg

K. Barometric Pressure 29.14 in. Hg

L. $\%CO_2$ —; $\%O_2$ —; %CO —; $\%N_2$ —;

M. Area of Stack 1.58 ft.² D = 17"

N. Area of Nozzle 3.49×10^{-4} ft.² d = .253

II. Calculations

A. Standard Volume Metered

*DGMCF = Dry Gas meter calibration factor

$$V_{m(std)} = V_m \frac{T_{std}}{P_{std}} \frac{P_b + \frac{\Delta H}{13.6}}{T_m}$$

$$V_{m(std)} = (37.0 \text{ CF})\left(\frac{528°R}{29.92 \text{ in.Hg}}\right)\left(\frac{29.14 + \frac{1.2}{13.6} \text{ in.Hg}}{548 \text{ °R}}\right) = 34.8 \text{ dscf}$$ ✓

WR GRACE, ENOREE, SC
BAGHOUSE
RUN # 2
8/8/89

B. Moisture Content of Stack Gas

1. H_2O collected in impingers in standard cubic feet

$$V_{wc(std)} = K (V_f - V_i)$$

$V_{wc(std)}$ = 0.047O7 ft.^{3}/ml (02 ml) = .09 scf

2. H_2O collected in Silica Gel in standard cubic feet

$$V_{wsg(std)} = K (W_f - W_i)$$

$V_{wsg(std)}$ = 0.04715 ft.^{3}/gm. (3.9 gm) = .18 scf

3. Moisture Content of Stack Gas (B_{ws})

$$B_{ws} = \frac{V_{wc(std)} + V_{wsg(std)}}{V_{wc(std)} + V_{wsg(std)} + V_{m(std)}}$$

$$B_{ws} = \frac{(\ .09\ \text{scf}) + (\ .18\ \text{scf})}{(\ .09\ \text{scf}) + (\ .18\ \text{scf}) + (\ 34.8\ \text{scf})} = .01$$

C. Molecular Weight of Stack Gas (lB/lB-mole)

1. M_d (Dry Molecular Weight) = $\Sigma M_x B_x$

M_d = (44) — %CO_2 + (32) — %O_2 + (28) — %CO + (28) — %N_2 = 30 lB/lB-mole

2. M_s (Wet Molecular Weight) = M_d (1-B_{ws}) + 18 B_{ws}

M_s = 30 (1- .01) + 18(.01) = 29.88 lB/lB-mole

D. Average Stack Gas Velocity

$$\bar{V}_s = K_p C_p \left[\frac{T_s}{P_s M_s}\right]^{1/2} \left[\Delta P\right]^{1/2}$$

$\bar{V}_s$ = 85.48 ft./sec. $\left[\frac{\text{lB/lB-mole(in.Hg)}}{°\text{R(in.}H_2O)}\right]^{1/2}$ .84 $\left[\frac{(\ 578)°R}{(\_\_\text{in.Hg})(29.88\ \text{lB/lB-mole}}\right.$ 29.15

$\left[\ .54\ \right]\left[\text{in } H_2O\right]^{1/2}$ = 31.6 ft./sec

WR GRACE, ENOREE,
BAGHOUSE
RUN #2
8/8/89

E. Average Stack Gas Volumetric Flow Rate

$$\bar{Q}_s = (3600\ \text{sec/hr})(\bar{V}_s)(A_s)(1-B_{ws})\ \frac{T_{std}}{P_{std}}\ \frac{P_s}{T_s}$$

$$\bar{Q}_s = (3600\ \text{sec/hr})(\underline{31.6}\ \text{ft./sec})(\underline{1.58}\ \text{ft.}^2)(1-\underline{.01})\ \frac{528°\text{R}}{29.92\text{in.Hg}}$$

$$\left[\frac{\underline{29.15}\ \text{in.Hg}}{\underline{578}\ °\text{R}}\right] = 158{,}000\ \text{dscf/hr}$$

F. Pollutant Mass Rate

$$\text{PMR} = \left[\frac{M_n}{V_{m(std)}}\right] X\ \ Q_s$$

$$\text{PRM} = \frac{(\underline{.0401})\text{gm}}{\underline{34.8}\text{dscf}}\ X\ \underline{\qquad}\text{dscf/HR}\ \ X\ \frac{1}{454\text{gm/1B}} = \underline{.401}\ \text{1B/HR}$$

G. % Isokinetic Variation (Intermediate Data)

$$\%I = \frac{T_s\ V_{m(std)}\ P_{std}\ \ 100}{\Theta\ \bar{V}_s A_n P_s\ T_{std}(60)(1-B_{ws})}$$

$$\%I = \frac{(\underline{578}\ °\text{R})(\underline{34.8}\ \text{dscf})(29.92\ \text{in.Hg})(100)}{(\underline{\qquad}\ \text{ft}^2)(\underline{60}\ \text{min.})(\underline{31.6}\ \text{ft./sec.})(\underline{29.15}\ \text{in.Hg})(528°\text{R})(60\ \text{sec./min.})(1-\underline{.01})}$$

3.49×10^{-4}

$\%I = 99.5$

$$\text{Emmisions} = \left(\frac{m_n\ \text{gm}}{V_{m(std)}\ \text{dscf}}\right)\left(\frac{7000\ \text{gr/lb}}{454\ \text{gm/lb}}\right)$$

$$= \left(\frac{.0401\ \text{gm}}{34.8\ \text{dscf}}\right)\ \frac{7000\ \text{gr/lb}}{454\ \text{gm/lb}}$$

$$\text{Emmisions} = .0178\ \text{gr/dscf}$$

Lf @ 4" - 60 sec .086 .086 1000

Plant	W R Grace	Meter Calibration (Y)	.990	Sheet	1 of 1
City	Enoree	Pitot Tube (C_p)	.84	Nozzle Identification No.	1/4
Location	Baghouse	Probe Length	5' B	Nozzle Diameter	0.253 ~~mm~~ (in.)
Operator	Reiver	Probe Liner Material	SS	Therm. No.	1
Date	8/8/89	Probe Heater Setting	20%	Final Leak Rate	.000 ~~m^3/min.~~ (cfm)
Run No.	3	Ambient Temperature	77	Vacuum During Leak Check	4 ~~mm Hg~~ (in. Hg)
Stack diam. ~~mm~~ (in.)	17	Barometric Pressure (P_b)	29.12 ~~mm Hg~~ (in. Hg)	Filter No.	305, 314, 315, 316
Sample Box No.	3	Assumed Moisture	4%	Remarks:	
Meter Box No.	RAC S-1343	Static Pressure (P_s)	+.10 ~~mm H_2O~~ (in. H_2O)		
Meter ΔH@	1.96	C Factor	1.1		
		Reference ΔP	.45 ~~mm H_2O~~ (in. H_2O)		

SGi = 744.4, 721.5, 654.4
silica gel wgt

RB

Traverse point number	Sampling time, (θ), min.	Clock time, (24 hr)	Vacuum mm Hg (in. Hg)	Stack temperature (T_s), °C (°F)	Velocity head (ΔP_s), mm H_2O (in. H_2O)	Pressure differential across orifice meter (ΔH) mm H_2O (in. H_2O)	Gas sample volume (V_m) m^3 (ft^3)	Gas sample temperature at dry gas meter: Inlet, °C (°F)	Gas sample temperature at dry gas meter: Outlet, °C (°F)	Temperature of gas leaving condenser or last impinger, °C (°F)	Filter temp., °C (°F)
1	0-5	1143	0	119	.30	1.2	019.362	83	87	66	270
2		1148	0	124	.30	1.2	022.3	88	84	58	272
3		1153	0	124	.30	1.2	025.2	93	85	56	250
4		1158	0	125	.30	1.2	028.3	94	85	55	260
5		1203	0	121	.27	1.1	031.8	95	86	53	270
6		1208	0	110	.26	1.1	034.6	96	86	58	270
	STOP	1213	Chg	Port			037.730	~~94~~	~~87~~	56	240
7		1217	0	126	.31	1.3		94	87	56	240
8		1220	0	124	.33	1.4	040.9	97	87	52	255
9		1226	0	127	.31	1.3	044.1	98	88	52	265
10		1230	0	126	.26	1.1	047.3	99	89	52	260
11	50.10	1235	0	124	.25	1.0	050.5	98	89	51	245
12		1240	0	108	.21	.86	053.3	97	89	51	245
	STOP	1245									
	Total		Max. 0	Avg. 122	AVG .21 √.53	1.16	055.738 Total	Avg.	Avg.	Max. 66	

122 0.53 1.16 36.376 36.376 90 90

H_2O = 4.4

Dpot = 44.3

METHOD 5

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant: W R GRACE, ENOREE, SC Sample date: 8/8/89
Sample location: BAG HOUSE Run no.: 3
Sample recovery person: RAINEY Recovery date: 8/8/89
Filter(s) no.: 316

MOISTURE

Impingers			Silica gel	
Final volume (wt)	201	ml(gm)	Final wt.	747.8 g
Initial volume (wt)	200	ml(gm)	Initial wt.	744.4 g
Net volume (wt)	01	ml(gm)	Net wt.	3.4 g

Total moisture ______ g

Color of silica gel PINKISH

Description of impinger water CLEAR

RECOVERED SAMPLE

Filter container no. 316 sealed YES

Description of particulate on filter ______

Acetone rinse container no. 3 Liquid level marked YES

Acetone blank container no. BLANK Liquid level marked YES

Samples stored and locked ______

Remarks: ______

Date of laboratory custody 8/9/89

Laboratory personnel taking custody [signature]

Remarks: ______

METHOD 5 TRAIN ANALYTICAL PARTICULATE DATA

8/8/89

Plant W R GRACE, ENOREE, S C Run No. 3

Sample location BAG HOUSE

Relative humidity

Density of acetone (ρa) 0.784 g/ml

Sample type	Sample identifiable	Liquid level marked and/or container sealed
Acetone rinse	1	YES
filter(s)	316	YES

Acetone rinse container no. 3

Acetone rinse volume (Vaw) 102 ml

Acetone blank residue concentration (Ca) 7.65×10^{-6} mg/g

Wa = Ca Vaw ρa = (7.65×10^{-6}) (102) (0.784) = .0006 mg

Date and time of wt 8/15/89 0915 Gross wt 67.9022 mg

Date and time of wt " " 1515 Gross wt 67.9026 mg

Average gross wt 67.9024 mg

Tare wt 67.8824 mg

Less acetone blank wt (Wa) .0006 mg

Weight of particulate in acetone rinse .0194 mg ✓

Filter(s) container no. 316

Date and time of wt 8/15/89 0915 Gross wt .3001 mg

Date and time of wt " " 1515 Gross wt .3003 mg

Average gross wt .3002 mg

Tare wt .2753 mg

Weight of particulate on filter(s) .0249 mg ✓

Weight of particulate in acetone rinse .0194 mg

Total weight of particulate .0443 mg ✓

Note: In no case shall a blank residue greater than (.01 mg/g) or .001% of the weight of acetone used be subtracted from the sample weight.

Remarks:

Signature of analyst [signature]

Signature of reviewer Ed Orr

WR GRACE, ENOREE, SC
BAG HOUSE
RUN #3
8/8/89

Method 5 Particulate Test

Calculation Form

I. Necessary Data

A. No. of Traverse Points 12

B. Total Test Time (θ) 60 minutes

C. Water Collected

1. Impinger H_2O 01 ml

2. Silica Gel 3.4 gm

D. Particulate Weight (m_n) .0443 gm

E. Volume Metered

V_m = 36.376 CF X DGMCF* = .990 36.0 CF

F. Average $\sqrt{\Delta P}$ = .53 $\sqrt{\text{in } H_2O}$

G. Average ΔH = 1.16 in H_2O

H. Average Meter Temperature T_m 90 °F + 460 = 550 °R

I. Average Stack Temperature T_s 122 °F + 460 = 582 °R

J. Stack Absolute Pressure 29.13 in. Hg

K. Barometric Pressure 29.12 in. Hg

L. $\%CO_2$ —; $\%O_2$ —; %CO —; $\%N_2$ —;

M. Area of Stack 1.58 ft.² D = 17"

N. Area of Nozzle 3.49×10^{-4} ft.² d = .253

II. Calculations

A. Standard Volume Metered

*DGMCF = Dry Gas meter calibration factor

$$V_{m(std)} = V_m \frac{T_{std}}{P_{std}} \frac{P_b + \frac{\Delta H}{13.6}}{T_m}$$

29.20

$$V_{m(std)} = (36.0 \text{ CF}) \left(\frac{528°R}{29.92 \text{ in.Hg}}\right) \left(\frac{29.12 + \frac{1.16}{13.6} \text{ in.Hg}}{550 \text{ °R}}\right) = 33.7 \text{ dscf}$$ ✓

W R GRACE, ENOREE, SC
BAGHOUSE
RUN # 3
8/8/89

B. Moisture Content of Stack Gas

1. H_2O collected in impingers in standard cubic feet

$$V_{wc(std)} = K\ (V_f - V_i)$$

$$V_{wc(std)} = 0.04707\ ft.^3/ml\ (\underline{\ 01\ }\ ml) = \underline{\ 0.05\ }\ scf$$

2. H_2O collected in Silica Gel in standard cubic feet

$$V_{wsg(std)} = K\ (W_f - W_i)$$

$$V_{wsg(std)} = 0.04715\ ft.^3/gm.\ (\underline{\ 3.4\ }\ gm) = \underline{\ .16\ }\ scf$$

3. Moisture Content of Stack Gas (B_{ws})

$$B_{ws} = \frac{V_{wc(std)} + V_{wsg(std)}}{V_{wc(std)} + V_{wsg(std)} + V_{m(std)}}$$

.165

$$B_{ws} = \frac{(\underline{\ 0.05\ }\ scf) + (\underline{\ .16\ }\ scf)}{(\underline{\ 0.05\ }\ scf) + (\underline{\ .16\ }\ scf) + (\underline{\ 33.7\ }\ scf)} = \underline{\ .01\ }$$

C. Molecular Weight of Stack Gas (1B/1B-mole)

1. M_d (Dry Molecular Weight) = $\Sigma\ M_x\ B_x$

M_d = (44) — %CO_2 + (32) — %O_2 + (28) — %CO + (.28) — %N_2 = 30 1B/1B-mole

2. M_s (Wet Molecular Weight) = $M_d\ (1-B_{ws}) + 18\ B_{ws}$

M_s = 30 (1- .01) + 18(.01) = 29.9 1B/1B-mole

D. Average Stack Gas Velocity

$$\bar{V}_s = K_p C_p \left[\frac{T_s}{P_s M_s}\right]^{1/2} \left[\Delta P\right]^{1/2}$$

$$\bar{V}_s = 85.48\ ft./sec. \left[\frac{1B/1B\text{-}mole(in.Hg)}{°R(in.H_2O)}\right]^{1/2} \underline{\ .84\ } \left[\frac{(\ 582\ )°R}{(\_\_in.Hg)(\ 29.9\ \ 1B/1B\text{-}mole}\right.$$

$$\left[\underline{\ .53\ }\right]\left[in\ H_2O\right]^{1/2} = \underline{\ 31.1\ }\ ft./sec$$

29.13

WR GRACE, ENOREE, SC
BAGHOUSE
RUN #3
8/8/89

E. Average Stack Gas Volumetric Flow Rate

$$\bar{Q}_s = (3600\ \text{sec/hr})(\bar{V}_s)(A_s)(1-B_{ws})\ \frac{T_{std}}{P_{std}}\ \frac{P_s}{T_s}$$

$$\bar{Q}_s = (3600\ \text{sec/hr})(31.1\ \text{ft./sec})(1.58\ \text{ft.}^2)(1-.01)\ \frac{528°R}{29.92\ \text{in.Hg}}\left[\frac{29.13\ \text{in.Hg}}{582\ °R}\right] = 155{,}000\ \text{dscf/hr}$$

F. Pollutant Mass Rate

$$PMR = \left[\frac{M_n}{V_{m(std)}}\right] X\ Q_s$$

$$PRM = \frac{(.0443)\text{gm}}{33.7\ \text{dscf}}\ X\ \underline{\quad}\ \text{dscf/HR}\ X\ \frac{1}{454\text{gm/1B}} = 0.449\ \text{1B/HR}$$

G. % Isokinetic Variation (Intermediate Data)

$$\%I = \frac{T_s\ V_{m(std)}\ P_{std}\ 100}{\theta\ V_s A_n P_s\ T_{std}(60)(1-B_{ws})}$$

$$\%I = \frac{(582\ °R)(33.7\ \text{dscf})(29.92\ \text{in.Hg})(100)}{(3.49\times10^{-4}\ \text{ft}^2)(60\ \text{min.})(31.1\ \text{ft./sec.})(29.13\ \text{in.Hg})(528°R)(60\ \text{sec./min.})(1-.01)}$$

$\%I = 98.6$

$$\text{EMMISIONS} = \left(\frac{m_n\ \text{gr}}{V_{m(std)}\ \text{dscf}}\right)\left(\frac{7000\ \text{gr/lb}}{454\ \text{gm/lb}}\right)$$

$$= \left(\frac{.0443\ \cancel{\text{gm}}}{33.7\ \text{dscf}}\right)\frac{7000\ \text{gr}/\cancel{\text{lb}}}{454\ \cancel{\text{gm}}/\cancel{\text{lb}}}$$

$$= .0203\ \text{gr/dscf}$$

NOZZLE CALIBRATION

WR GRACE
ENOREE, SC

DATE 2/10/89 CALIBRATED BY [illegible]

NOZZLE IDENTIFICATION	D_1, in.	D_2, in.	D_3, in.	D_4, in.	D_5, in	D_{avg}
1/4" - RUN #1	.251	.249	.248	.249	.250	.24
1/4" - RUN # 2	.253	.254	.255	.253	.252	.25
1/4" - RUN # 3	.252	.253	.253	.254	.253	.25

Where:

D = nozzle diameter measured on a different diameter, in.
Tolerance = measure within 0.001 in.

Δ D = maximum difference in any two measurements, in.
Tolerance = 0.004 in.

D_{avg} = average of D_1 through D_5.

CALIBRATION

DRY GAS METER & ORIFICE

DATE 12/14/88 METER BOX NO. RAC·5·1343

BAROMETRIC PRESSURE, P_b = 29.16 in. Hg. DRY GAS METER NO. ____________

PSI Std

Orifice manometer setting ΔH in. H_2O	Gas volume wet test meter V_w, ft³ ($Y = 0.985$)	Gas volume dry gas meter V_d, ft³	Wet test Meter t_w, °F	Dry gas meter Inlet t_{di}, °F	Dry gas meter Outlet t_{do}, °F	Dry gas meter Average t_d, °F	Time θ, min.	Y	ΔH@
0.5	352.003 353.925 } 1.922	11.331 13.271 } 1.940	74 = 534°R	84	70	77 = 537°R	5		
1.0	354.405 357.127 } 2.722	13.702 16.443 } 2.741		87	71	79 = 539°R			
1.5	357.602 360.936 } 3.334	16.905 20.259 } 3.354		91	73	82 = 542°R			
2.0	361.403 365.215 } 3.812	20.705 24.545 } 3.840		95	75	85 = 545°R			
2.5	365.801 370.025 } 4.224	25.103 29.367 } 4.264		98	78	88 = 548°R			
3.0	370.703 375.289 } 4.586	29.905 34.538 } 4.633		101	79	90 = 550°R	5		
							Average	0.990	1.96

ΔH	$\frac{\Delta H}{13.6}$	Y: $\frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w + 460)}$	ΔH@: $\frac{0.0317\,\Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\,\theta}{V_w}\right]^2$
0.5		$\frac{1.922(0.985)(29.16)(537)}{1.940(29.20)(534)} = 0.980$	$\frac{0.0317(0.5)}{29.16(537)}\left[\frac{534(5)}{1.922}\right]^2 = 1.95$
1.0		$\frac{2.722(.985)(29.16)(539)}{2.741(29.23)(534)} = 0.985$	$\frac{0.0317(1.0)}{29.16(539)}\left[\frac{534(5)}{2.722}\right]^2 = 1.94$
1.5		$\frac{3.334(.785)(29.16)(542)}{3.354(29.27)(534)} = 0.990$	$\frac{0.0317(1.5)}{29.16(542)}\left[\frac{534(5)}{3.334}\right]^2 = 1.93$
2.0		$\frac{3.812(.985)(29.16)(545)}{3.840(29.31)(534)} = 0.993$	$\frac{0.0317(2.0)}{29.16(545)}\left[\frac{534(5)}{3.812}\right]^2 = 1.96$
2.5		$\frac{4.224(.985)(29.16)(548)}{4.264(29.34)(534)} = 0.995$	$\frac{0.0317(2.5)}{29.16(548)}\left[\frac{534(5)}{4.224}\right]^2 = 1.98$
3.0		$\frac{4.586(.985)(29.16)(550)}{4.633(29.38)(534)} = 0.997$	$\frac{0.0317(3.0)}{29.16(550)}\left[\frac{534(5)}{4.586}\right]^2 = 2.01$

Y = Ratio of accuracy of wet test meter to dry test meter.

ΔH@ = Orifice pressure differential that gives 0.75 cfm of air at 68°F and 29.92 inches of mercury, in. H_2O.

$\gamma_{max} - \gamma_{min} \leq 0.02$ ✓

$0.98 \leq \Gamma_{avg} \leq 1.02$ ✓

CALIBRATION

DRY GAS METER & ORIFICE

DATE 9/2/88 METER BOX NO. PSI Std

BAROMETRIC PRESSURE, P_b = 29.95 in. Hg. DRY GAS METER NO. ______

$\Delta H'$	Orifice manometer setting ΔH in. H_2O	Gas volume wet test meter V_w, ft^3	Gas volume dry gas meter V_d, ft^3	Wet test Meter t_w, °F	Dry gas meter Inlet t_{di}, °F	Dry gas meter Outlet t_{do}, °F	Dry gas meter Average t_d, °F	Time θ, min.	Υ	$\Delta H@$
−0.98	0.5	2.033	230.103 } 2.058 232.161 } ✓	75 = 535°R	75	75	75 = 535°R	5		NA
−1.43	1.0	2.714	232.703 } 2.769 235.472 } ✓							
−1.88	1.5	3.362	235.804 } 3.428 239.232 } ✓							
−2.33	2.0	3.840	239.903 } 3.931 243.816 } ✓							
−2.73	2.5	4.300	244.103 } 4.392 248.495 } ✓							
−3.13	3.0	4.631	248.804 } 4.747 253.551 } ✓							

Average 0.985

ΔH	$\frac{\Delta H}{13.6}$	Υ = $\frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H'}{13.6})(t_w + 460)}$	$\Delta H@$ = $\frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\theta}{V_w}\right]^2$
✓ 0.5	0.0368	$\frac{2.033(29.95)}{2.058(29.88)} = 0.9902$	NA
✓ 1.0	0.0735	$\frac{2.714(29.95)}{2.769(29.84)} = 0.9838$	
✓ 1.5	0.110	$\frac{3.362(29.95)}{3.428(29.81)} = 0.9853$	
✓ 2.0	0.147	$\frac{3.840(29.95)}{3.931(29.78)} = 0.9824$	
✓ 2.5	0.184	$\frac{4.300(29.95)}{4.392(29.75)} = 0.9856$	
✓ 3.0	0.221	$\frac{4.631(29.95)}{4.747(29.72)} = 0.9831$	

Υ = Ratio of accuracy of wet test meter to dry test meter.

$\Delta H@$ = Orifice pressure differential that gives 0.75 cfm of air at 68°F and 29.92 inches of mercury, in. H_2O.

$\gamma_{max} - \gamma_{min} \leq 0.02 > 0.0077$ ✓

[illegible] adj [illegible] for Δp across [illegible]

CRITICAL ORFICE CALIBRATION

Date 7/7/89 P_b = 29.94 in Hg

Meter SC DHEC Std. γ = 1.0

$V_{std} = (V_f - V_i)(\gamma)(528/T_m)(P_b/29.92)$

$K = V_{std}(T_m)^{1/2}/(P_o)(\theta)$

---

1. T_m = 73 °F = 533 °R

T_b = 73 °F = " °R

ΔP = 0.78 in H_2O

V_f = 2.851 cf } 2.851 cf

V_i = 0 cf

P_o = 29.94 - 1.9 /13.6 = 29.80 in Hg

θ = 5 min 1048 → 1053

V_{std} = (2.851 cf)(1.0)(528/533)(29.94/29.92) .9913

= 2.826 scf

K_1 = (2.826 scf)(533 °R)$^{1/2}$/[(29.80 in Hg)(5 min)]

= 0.4379 scf (°R)$^{1/2}$/[(in Hg)(min)]

---

2. T_m = 53 °F = 533 °R

T_b = 53 °F = 533 °R

ΔP = 1.9 in H_2O

V_f = 2.852 cf } 2.852 cf

V_i = 0 cf

P_o = 29.94 - 1.9 /13.6 = 29.80 in Hg

θ = 5 min 1054 → 1059

V_{std} = (2.852 cf)(1.0)(528/533)(29.94/29.92)

= 2.827 scf

K_2 = (2.827 scf)(533 °R)$^{1/2}$/[(29.80 in Hg)(5 min)]

= 0.4380 scf (°R)$^{1/2}$/[(in Hg)(min)]

3. T_m = 73 °F = 533 °R

T_b = " °F = " °R

ΔP = .78 in H_2O

V_f = 2.848 cf

V_i = 0 cf

2.848 cf

P_o = 29.94 - 1.9 /13.6 = 29.80 in Hg

θ = 5 min 1100 → 1105

V_{std} = (2.848 cf)(1.0)(528/533)(29.94/29.92)

= 2.823 scf

K_3 = (2.823 scf)(533 °R)$^{1/2}$/[(29.80 in Hg)(5 min)]

= 0.4374 scf (°R)$^{1/2}$/[(in Hg)(min)]

K_{avg} = $(K_1 + K_2 + K_3)/3$

= (0.4379 + 0.4380 + 0.4374)/3

= 0.4378 scf (°R)$^{1/2}$/[(in Hg)(min)]

CALIBRATION USING EPA CRITICAL ORFICE PROCEDURE

DRY GAS METER & ORIFICE

DATE 8/15/89

METER BOX NO. 1343

BAROMETRIC PRESSURE, P_b = 28.88 in. Hg.

CRITICAL ORFICE K = 0.4378 $sft^3(^oR)^{1/2}(in\ Hg)^{-1}(min)^{-1}$ @ 19 in. Hg (by mercury manometer)

TEMPERATURE, T_b = 79 ^oF

INITIAL METER READING, CF_i = 59.004 ft^3

FINAL METER READING, CF_f = 61.887 ft^3

2.883 ft^3

DRY GAS METER TEMPERATURE, T_{in} = 84 ^oF, T_{out} = 78 ^oF; $T_{m_{avg}}$ = 81 ^oF

ORFICE ΔH = 1.1 in H_2O

TIME, θ = 5 minutes

CALCULATIONS:

$$V_{std} = K \times P_b \times \theta / \sqrt{T_b}$$

$$= \frac{[0.4378\ ft^3(^oR)^{1/2}(in.Hg)^{-1}(min)^{-1}](28.88\ in.Hg)(5\ min)}{\sqrt{539\ ^oR}}$$

$$= 2.723\ sft^3$$

$$V_m = (CF_f - CF_i) \times (528/T_m)\left(\frac{P_b + \Delta H / 13.6}{29.92}\right)$$

$$= \frac{(2.883\ ft^3)(528^oR)(28.88\ in\ Hg + 1.1\ in.H_2O/13.6)}{(541\ ^oR)(29.92\ in\ Hg)}$$

$$= 2.716\ sft^3$$

$$\gamma = V_{std} / V_m = \frac{2.723\ ft^3}{2.716\ ft^3} = 1.003$$

Thermometer Field Calibration

Plant: W R Grace

City: Enoree SC

Location: Baghouse

Date: 8/8/89

Analyst: Rainey

Thermometer #	Thermometer Application	Test Thermometer Ambient	Standard Thermomet Ambient
1	stack	68	68 °F
3	meter in	69	
4	meter out	68	
5	impinger	68	
6	filter box	69	68 °F

Date: 10/1/88 Thermocouple No.: 1 (stack)

Ambient Temperature: 21.5 °C Barometric pressure: 29.95 " Hg

Calibrator: Ed P Reference: Mercury-in-glass: Fisher

Other: ________

Reference point No.[a]	Source[b] (specify)	Reference thermometer temperature, ~~°C~~ °F	Thermocouple potentiometer temperature, ~~°C~~ °F	Difference,[c] %
1	ice bath	32.	32	0
2	boiling water	211	211	0
3	muffle furnace	617	612	0.5
4	"	1071	1067	0.3

Date: 10/1/88 Thermocouple No.: 2 (stack)

Ambient Temperature: 21.5 °C Barometric pressure: 29.95 " Hg

Calibrator: Ed P Reference: Mercury-in-glass: Fisher

Other: ________

Reference point No.[a]	Source[b] (specify)	Reference thermometer temperature, ~~°C~~ °F	Thermocouple potentiometer temperature, ~~°C~~ °F	Difference,[c] %
1	ice bath	32	32	0
2	boiling water	210	211	0.1
3	muffle furnace	617	610	0.7
4	"	1071	1065	0.3

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

[b] Type of Calibration system used

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

Stack Temperature Sensor Calibration Data Sheet

RAC-S-1343

Date: 10/1/88 Thermocouple No.: 3 (meter in)

Ambient Temperature: 21.5 °C Barometric pressure: 29.95 " Hg

Calibrator: Ed P Reference: Mercury-in-glass: Fisher

Other:

Reference point No.[a]	Source[b] (specify)	Reference thermometer temperature, ~~°C~~ °F	Thermocouple potentiometer temperature, ~~°C~~ °F	Difference,[c] %
1	ice bath	32	32	0
2	water bath	94	95	0.2
3	"	110	111	0.2

Date: 10/1/88 Thermocouple No.: 4 (meter out)

Ambient Temperature: 21.5 °C Barometric pressure: 29.95 " Hg

Calibrator: Ed P Reference: Mercury-in-glass: Fisher

Other:

Reference point No.[a]	Source[b] (specify)	Reference thermometer temperature, ~~°C~~ °F	Thermocouple potentiometer temperature, ~~°C~~ °F	Difference,[c] %
1	ice bath	32	32	0
2	water bath	94	93	0.2
3	"	110	110	0

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

b Type of Calibration system used

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

Stack Temperature Sensor Calibration Data Sheet

Date: 10/1/88 Thermocouple No.: 5 (impinger)

Ambient Temperature: 21.5 °C Barometric pressure: 29.95 " Hg

Calibrator: Ed P Reference: Mercury-in-glass: Fisher

Other: ________

Reference point No.[a]	Source[b] (specify)	Reference thermometer temperature, ~~°C~~ °F	Thermocouple potentiometer temperature, ~~°C~~ °F	Difference,[c] %
1	ice bath	32	32	0
2	water bath	94	93	0.2
3	"	68	68	0

Date: 10/1/88 Thermocouple No.: 6 (filter box)

Ambient Temperature: 21.5 °C Barometric pressure: 29.95 " Hg

Calibrator: Ed P Reference: Mercury-in-glass: Fisher

Other: ________

Reference point No.[a]	Source[b] (specify)	Reference thermometer temperature, ~~°C~~ °F	Thermocouple potentiometer temperature, ~~°C~~ °F	Difference,[c] %
1	oil bath	204	206	0.3
2	"	261	262	0.1
3	"	283	284	0.1

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

[b] Type of Calibration system used

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

Stack Temperature Sensor Calibration Data Sheet

BLANK ANALYTICAL DATA

Plant: Fisher Acetone #6

Sample location: Lab Grade

Relative humidity: ______

Type of blank: acetone

Liquid level at mark and container sealed: yes

Density of blank (ρa): 0.784 g/ml

Blank volume (Va): 100. ml

Date and time of wt. 10/1/88, 10 AM — Gross wt. 67.5243 ~~m~~g

Date and time of wt. 10/1/88, 3 PM — Gross wt. 67.5245 ~~m~~g

Average gross wt. 67.5244 ~~m~~g

Tare wt. 67.5238 ~~m~~g

Weight of blank (ma) 0.0006 ~~m~~g

$$Ca = \frac{ma}{Va\ \rho a} = \frac{(0.6)}{(100)(0.784)} = 0.00765 \text{ mg/g}$$

Note: In no case shall a blank residue greater than (0.01 mg/g) or 0.001% of the weight of blank used be subtracted from the sample weight.

Remarks: beaker '10'

______

Signature of analyst: Ed P

Signature of reviewer: Carroll J Rainey

ANALYTICAL BALANCE CALIBRATION FORM

Balance name Triple Beam Balance Number

Classification of standard weights NBS Class-S

Date	295.0 g	1.0000 g	10.0000 g	50.0000 g	100.0000 g	Analyst
10/1/88	295.0			50.0	100.0	Ed P

ANALYTICAL BALANCE CALIBRATION FORM

Balance name Mettler H-80 Number

Classification of standard weights NBS Class-S

Date	0.500 g	1.0000 g	10.0000 g	50.0000 g	100.0000 g	Analyst
10/1/88	0.4998			50.0002	100.0004	Ed P

TYPE S PITOT TUBE INSPECTION DATA FORM

Pitot tube assembly level? ✓ yes ______ no

Pitot tube openings damaged? ______ yes (explain below) ✓ no

α_1 = 1.0 ° (<10°), α_2 = 2.0 ° (<10°), β_1 = 2.0 ° (<5°), β_2 = 3.0 ° (<5°)

γ = 3.0 °, θ = 2.0 °, A = 0.9 cm (in.)

z = A sin γ = 0.047 cm (in.); <0.32 cm (<1/8 in.),

w = A sin θ = 0.021 cm (in.); <.08 cm (<1/32 in.)

P_A 0.48 cm (in.) P_b 0.48 cm (in.)

D_t = 0.38 cm (in.)

Comments: 3' PROBE, stainless steel Liner

Calibration required? ______ yes ✓ no

TYPE S PITOT TUBE INSPECTION DATA FORM

Pitot tube assembly level? ✓ yes ______ no

Pitot tube openings damaged? ______ yes (explain below) ✓ no

α_1 = 1.0 ° (<10°), α_2 = 1.0 ° (<10°), β_1 = 1.0 ° (<5°),

β_2 = 2.0 ° (<5°)

γ = 2.0 °, θ = 3.0 °, A = .8 cm (in.)

$z = A \sin \gamma$ = .03 cm (in.); <0.32 cm (<1/8 in.),

$w = A \sin \theta$ = .04 cm (in.); <.08 cm (<1/32 in.)

P_A .5 cm (in.) P_b .47 cm (in.)

D_t = .4 cm (in.)

Comments: A-5' probe, stainless steel liner

Calibration required? ______ yes ✓ no

TYPE S PITOT TUBE INSPECTION DATA FORM

Pitot tube assembly level? ✓ yes ______ no

Pitot tube openings damaged? ______ yes (explain below) ✓ no

α_1 = 2.0 ° (<10°), α_2 = 1.0 ° (<10°), β_1 = ______ ° (<5°),

β_2 = ______ ° (<5°)

γ = 1.0 °, θ = 2.0 °, A = .9 cm (~~in.~~)

$z = A \sin \gamma$ = .02 cm (~~in.~~); <0.32 cm (<1/8 in.),

$w = A \sin \theta$ = 0.03 cm (~~in.~~); <.08 cm (<1/32 in.)

P_A .52 cm (~~in.~~) P_b .48 cm (~~in.~~)

D_t = .43 cm (~~in.~~)

Comments: B-5' probe, stainless steel liner

Calibration required? ______ yes ✓ no