Background Report Reference

AP-42 Section Number: 12.20

Background Chapter: 4

Reference Number: 34

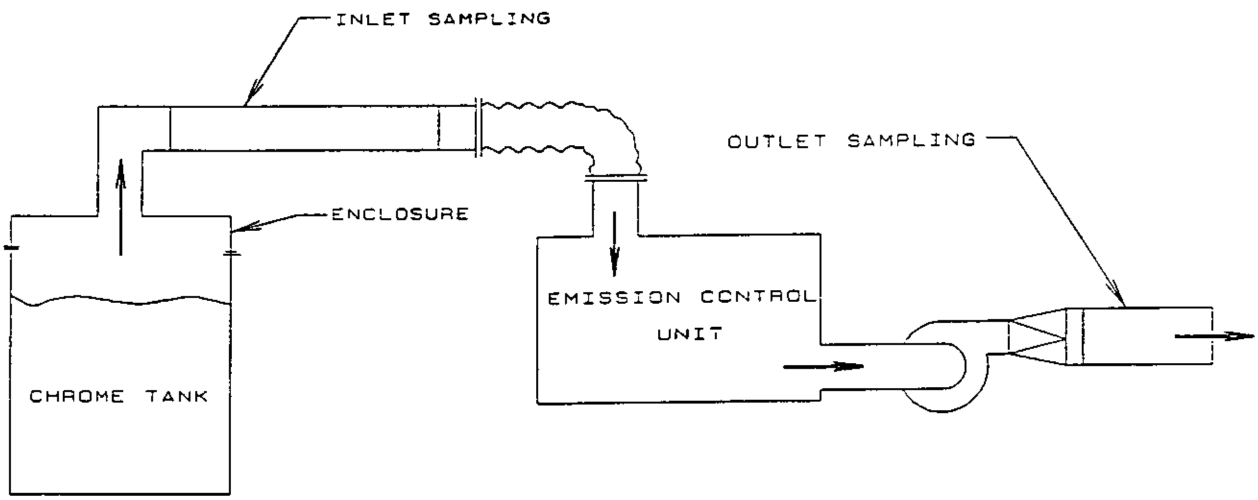
Title: Emissions Test Report. SVS/MECATM at a Chromic Anodizing Facility, Santa Ana, CA, on December 12, 1988 by Truesdart Laboratories, Inc., Tusti, CA

January 1989

ELECTROPLATING
REF. 4-34

EMISSIONS TEST REPORT

REID



SVS/MECA™

AT

A CHROME ANODIZING FACILITY
Santa Ana, California

ON

December 12, 1988

BY

TRUESDAIL LABORATORIES, INC.
Tustin, California

CM&E
INTERNATIONAL

REPORT

TRUESDAIL LABORATORIES, INC.

CHEMISTS - MICROBIOLOGISTS - ENGINEERS

RESEARCH - DEVELOPMENT - TESTING

14201 FRANKLIN AVENUE
TUSTIN, CALIFORNIA 92680
AREA CODE 714 • 730-6239
AREA CODE 213 • 225-1564
CABLE: TRUELABS

CLIENT **C M and E International**
18011-D Skypark Circle
Irvine, CA 92714
Attention: Dave Miller

DATE January 11, 1989

RECEIVED Dec. 12, 1988

LABORATORY NO. 26163

SAMPLE

Source tests for chromium on scrubber at Reid Metal Finishing

INVESTIGATION

Total and hexavalent chromium

RESULTS

On December 12, 1988 representatives of Truesdail Laboratories, Inc. conducted source tests for total and hexavalent chromium on the inlet and outlet of CM and E International VSV\MECA II scrubber serving a chrome plating tank at Reid Metal Finishing in Santa Ana, California.

A 360-minute isokinetic sample of the flue gas was collected at each sampling location by the wet impingement method (SCAQMD method 5.1). The sampling train consisted of a glass probe connected with Teflon tubing to a set of Greenburg-Smith impingers charged with 200 mls of 0.1N NaOH and followed by a Teflon filter on a glass fiber backing filter, a vacuum pump, and a dry gas meter. The inlet sampling location was 6 inches in diameter and the sample was collected at 2 sampling points on each of two diameters 90^{o} apart. The outlet sampling location was 6 inches in diameter and the sample was collected at 2 sampling points on each of the two diameters 90^{o} apart.

During the test period, a 30-minute integrated sample of the flue gas was collected at each sampling location simultaneously. The samples were collected with an evacuated 8-liter stainless steel cylinder and a stainless steel sampling line.

The flue gas flow rate was determined from in-line 6-inch orifice tubes at each sampling location. The flow was monitored throughout the entire test period by recording the velocity head and temperature at 15-minute intervals. The average temperature at each location was measured with a chromel-alumel thermocouple connected to a Micromite potentiometer.

Sampling trains were prepared by soaking all impingers for 12 hours in 50% nitric acid, then rinsing three times with distilled water and charging with 200 mls of 0.1N NaOH. All probes and Teflon tubing were rinsed on site with 50% nitric acid and washed three times with distilled water. Samples were recovered by measuring condensate gain and rinsing the probe, Teflon tubing, and impingers twice with 0.1N NaOH and once with 0.1N nitric acid. The Teflon filter was placed in the impinger catch and the sample refrigerated, and analyzed within 48 hours. A blank sampling train was taken to the job site, leak-checked, sealed and returned to the lab for analysis.

The total chrome was determined by atomic absorption and the hexavalent chrome by the diphenylcarbazide colorimetric method. The analyses included glassware prepped as above, calibration curves, spike recovery, and a blank sampling train.

The hydrogen, nitrogen, and oxygen content of the integrated samples was determined by gas chromatography utilizing thermal conductivity detection.

The results are as follows:

SAMPLING SUMMARY SHEET

PLANT Chrome Anodizing Facility LOCATION Santa Ana, Calif

SAMPLED SOURCE SVS/MECA Anodizing Facility

Run	Date	③ N_p	③ Y_m	④ ΔH	⑤ P Bar.	⑥ V_m	⑦ T_m	⑧ V_m Std.	⑨ %	⑩ P_{st}	17 P_s	⑱ T_s	⑲ VP	⑳ V_w	21 $V_{w_{gas}}$	22 %M	23 M_d
1	12DEC88	24	.997	.36	30.15	214.40	76	212.583	0.1	-.319	30.13	80		38.5	1.81	.85	.992
1	12DEC88	~~[illegible]~~	1.021 ~~[illegible]~~	.49	30.15	247.58	68			.31	30.17	78		93	4.38	1.69	.983

Run	㉔ CO_2	㉕ O_2	26 N_2	(27) CO	(28) H_2	29 MW_d	30 MW	㉛ C_p	㉜ $\sqrt{\Delta P_s(T_s + 460)}$	㉝ T_t	㉞ D_n	35 V_s	㊱ D_s	(37) Area	38 ACFM	㊴ DSCFM	40 %I
1	0.0	21.3	78.6		1000 ppm 2	28.83	28.73	.84	3.6227	360	.472	8.34	6"	0.20	104	102	93.1
1	0.0	21.0	78.9		1000 ppm	28.81	28.63	.84	3.90898	360	.5	9.55	6"	0.20	113	109	93.2

$$V_m\ \text{Std.} = Y_m \frac{17.64 \times V_m \left(\text{P Bar.} + \frac{\Delta H}{13.6}\right)}{(T_m + 460)}$$

$$\%M = \frac{100 \times V_{w_{gas}}}{V_m\ \text{Std.} + V_{w_{gas}}}$$

$$V_{w_{gas}} = 0.0471\ V_w$$

$$M_d = \frac{100 - \%M}{100}$$

$$MW_d = \%CO_2 \times .44 + (\%O_2 \times .32) + (\%CO + \%N_2) \times .28 + \left(\%\text{Other} \times \frac{\text{Mol. wt.}}{100}\right)$$

$$MW = MW_d \times M_d + 18(1 - M_d)$$

$$P_s = \text{P Bar.} \pm \frac{P_{st}}{13.6}$$

$$V_s = 85.49 \times C_p \sqrt{\Delta P_s (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

$$\%I = \frac{0.09450 \times (T_s + 460) \times V_m\ \text{Std.}}{V_s \times T_t \times P_s \times M_d \times A_n}$$

N_p = Total No. of Sampling points

Y_m = Meter Box Correction Factor

ΔH = Average Orifice Pressure Drop, inches H_2O

P Bar. = Barometric Pressure, Inches Hg, Absolute

V_m = Volume of Dry Gas at Meter Conditions, DCF

T_m = Average Meter Temperature, °F.

V_m Std. = Volume of Dry Gas at STP. DSCF[a]

% = Per Cent other gas removed before Dry Gas Meter

P_{st} = Static Pressure of Stack Gas, inches H_2O

P_s = Stack Gas Pressure, inches Hg.

T_s = Average Stack Temperature, °F

VP = Vapor Pressure of H_2O At Stack Temperature

V_w = Total H_2O Collected in Impingers and Silica Gel

$V_{w_{gas}}$ = Volumn of water vapor collected at STP, SCF[b]

%M = Per Cent Moisture by volume

M_d = Mole Fraction of Dry Gas

$\%CO_2$ = Volume % Dry

$\%O_2$ = Volume % Dry

$\%N_2$ = Volume % Dry

%CO = Volume % Dry

MW_d = Molecular Weight of Stack Gas Dry Basis

MW = Molecular Weight of Stack Gas, Wet Basis

C_p = Pitot Tube Coefficient

$\sqrt{\Delta P (T_s + 460)}$ Is determined by averaging the square root of the product of the velocity head (P) and the absolute stack temperature from each sampling point.

T_t = Net time of test in minutes

D_n = Sampling Nozzle Diameter, inches

A_n = Area of Nozzle opening, ft^2.

V_s = Stack Gas Velocity at Stack Conditions, Feet per second.

D_s = Diameter of Stack, inches

Area = Area of duct in ft^2

ACFM = Actual Cubic Feet per minute

DSCFM = Dry Standard Cubic Feet per minute

%I = Per Cent Isokinetic

[a]Dry Standard Cubic Feet @ 68°F, 29.92 in. Hg.

[b]Standard Conditions @ 68°F. 29.92 in. Hg.

TRUESDAIL LABORATORIES, INC.

C M AND E INTERNATIONAL
REID METAL FINISHING
12-12-88

	Scrubber Inlet	Scrubber Outlet
Flue Gas:		
Temperature, ^{o}F	80	78
Velocity, ft./sec*	26.9*	29.0*
Static Pressure, in H_2O	-0.32	+0.31
Duct Diameter, in.	6.0	6.0
Orifice Diameter, in.	3.44	3.44
Orifice Area, sq. ft.	0.065	0.065
Gas Volume: ACFM	105.	113.
SCFM	102.	110.
DSCFM	99.	107.
Moisture, % by Vol.	2.5	2.7

* Through orifice.

Chromium:	(10:53-17:02)	(10:52-16:58)
Sample Volume, DSCF	207.80	243.71
Concentration, ppmv		
Total Cr	7.1	0.00037
Cr^{+6}	1.8	0.00046
Concentration, mg/m^3		
Total Cr	15.6	0.00069
Cr^{+6}	3.9	0.00086
Emission Rate, mg/hr		
Total Cr	2,625 0.00579 lb/hr	0.13
Cr^{+6}	656 0.00145 lb/hr	0.16
Removal Efficiency, %		
Total Cr	99.995	
Cr^{+6}	99.98	

Intregrated Sample:	(15:00-15:35)	(14:48-15:18)
Concentration, %		
Hydrogen (H_2)	0.1	0.1
Oxygen (O_2)	21.3	21.0
Carbon Dioxide (CO_2)	<0.1	<0.1

Respectfully submitted,

TRUESDAIL LABORATORIES, INC.

S. Hugh Brown

S. Hugh Brown, Supervisor
Air Pollution Testing

APPENDIX

SVS/MECA™
FIELD TEST DATA

TEST Date : 12-12-88 TEST Supervisor : David Miller

TEST Site : Reid Metal Finishing TEST No. : Source Test CME-2080A

TEST READINGS										
TIME	AT (°F)	IT (°F)	OT (°F)	TT (°F)	ST (°C)	SR (GPM)	pH	SP (In)	RA (Amp)	RV (Volt)
10:52	72	71	73	90	17	27	7*	9.8	60	40.5
11:20	80			92						
11:23		72	73		19	26		9.8	95	40
12:03	78			94						
12:20		74	75		21	26		9.8	112	38.5
12:52		75	76		21	26		9.8	145	38.5
12:58	82	76	78	93	21	26			130	40
13:52	84			93					125	40
13:58		75	78		21	26		9.8		
14:38	84			94					130	40.5

TEST READING NOTES

1. Ambient Air Temperature, °F = AT
2. MECA Inlet Temperature, °F = IT
3. MECA Outlet Temperature, °F = OT
4. Tank Solution Temperature, ° F = TT
5. Scrubber Solution Temperature, °C = ST
6. Scrubber Solution Flow Rate, GPM = SR
7. Scrubber Solution pH = pH
8. Blower Static Pressure, inches W. G. = SP
9. Rectifier Amperage, amps = RA
10. Rectifier Voltage, volts = RV

SUPPLEMENTAL DATA & NOTES

1. Start of Test Hour Meter Reading 10.7 Hrs
2. End of Test Hour Meter Reading 17.1 Hrs
3. Blower Speed Control Setting 71 Hz
4. SVS/MECA™ Inlet Static Pressure 3.8 Inch
5. Tank CrO_3 Concentration 7 Oz/Gal
6. Liquid Collected Inlet Exhaust Duct 1 Lbs
7. Liquid Collected Mist Collection Undetected Gal
8. Liquid Collected Demist Section Undetected Gal
9. Scrubber Solution Level Change 0 Inch

* pH recorded at Test start and end only

Notes : 1. Ambient Air Temp (AT) taken adjacent to process tank.
2. Note rectifers shut down for loading of each workload rack into the process tank for an aveage of 3 to 5 minutes.
3. Workload racks were placed in the process tank for a 40 minute process time.
4. pH of scrubber solution read by using litmus paper.

SVS/MECA™
FIELD TEST DATA

TEST Date : 12-12-88 TEST Supervisor : David Miller

TEST Site : Reid Metal Finishing TEST No. : Source Test MECA-2080A

TEST READINGS										
TIME	AT (°F)	IT (°F)	OT (°F)	TT (°F)	ST (°C)	SR (GPM)	pH	SP (In)	RA (Amp)	RV (Volt)
14:45		74	77		22	26		9.8		40
15:25	84			95					135	40
15:30		74	78		22	26		9.75		
16:10	77			97					81	41
16:15		70.5	78		21	26		9.75		
16:58	74			94					120	39
17:00		71	76		21	26	7*	9.75		
:										
:										
:									Note 5	

TEST READING NOTES

1. Ambient Air Temperature, °F = AT
2. MECA Inlet Temperature, °F = IT
3. MECA Outlet Temperature, °F = OT
4. Tank Solution Temperature, ° F = TT
5. Scrubber Solution Temperature, °C = ST
6. Scrubber Solution Flow Rate, GPM = SR
7. Scrubber Solution pH = pH
8. Blower Static Pressure, inches W. G. = SP
9. Rectifier Amperage, amps = RA
10. Rectifier Voltage, volts = RV

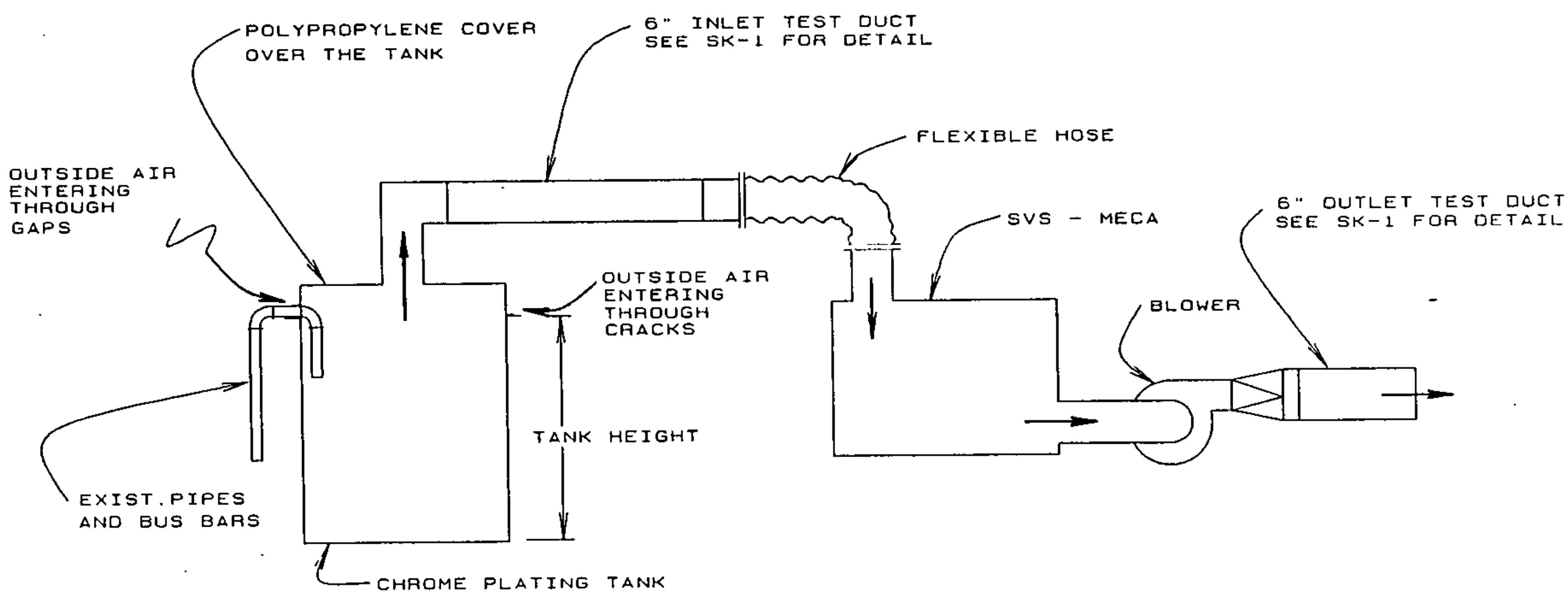
SUPPLEMENTAL DATA & NOTES

1. Start of Test Hour Meter Reading _______ Hrs
2. End of Test Hour Meter Reading _______ Hrs
3. Blower Speed Control Setting _______ Hz
4. SVS/MECA™ Inlet Static Pressure _______ Inch
5. Tank CrO_3 Concentration _______ Oz/Gal
6. Liquid Collected Inlet Exhaust Duct _______ Lbs
7. Liquid Collected Mist Collection _______ Gal
8. Liquid Collected Demist Section _______ Gal
9. Scrubber Solution Level Change _______ Inch

* pH recorded at Test start and end only

Notes : See Notes 1 thru 4 Pg 1

5. Summation of Amp-hrs for this source test **638.7 Amp-hr** from a total of 9 different workloads placed in the tank during the 6 hour test.



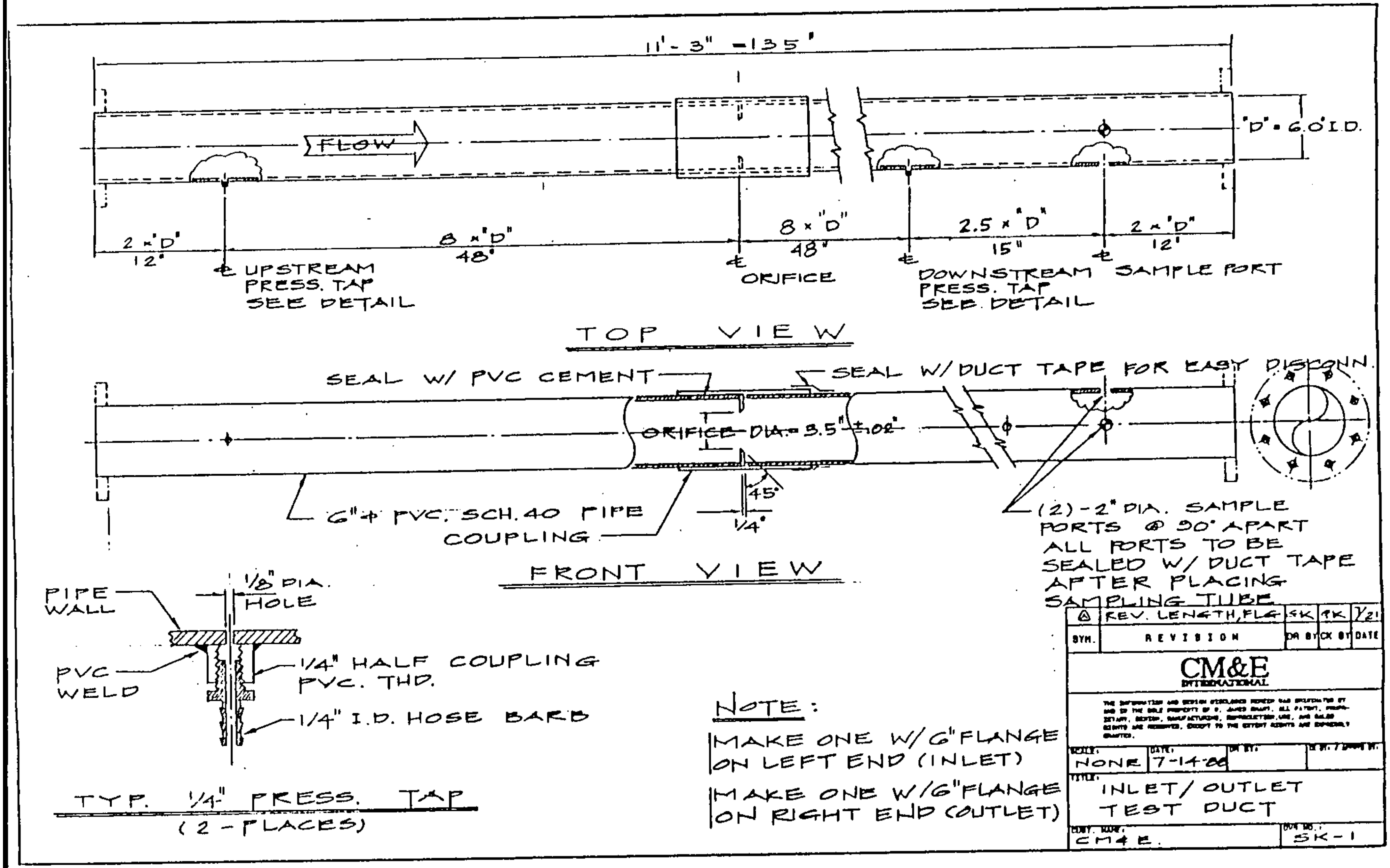
SYM.	REVISION	DR BY	CK BY	DATE

CM&E INTERNATIONAL

SCALE:	DATE:	DR BY:	CK BY. / APPRVD BY
NONE	6-23-88	H POPOV	

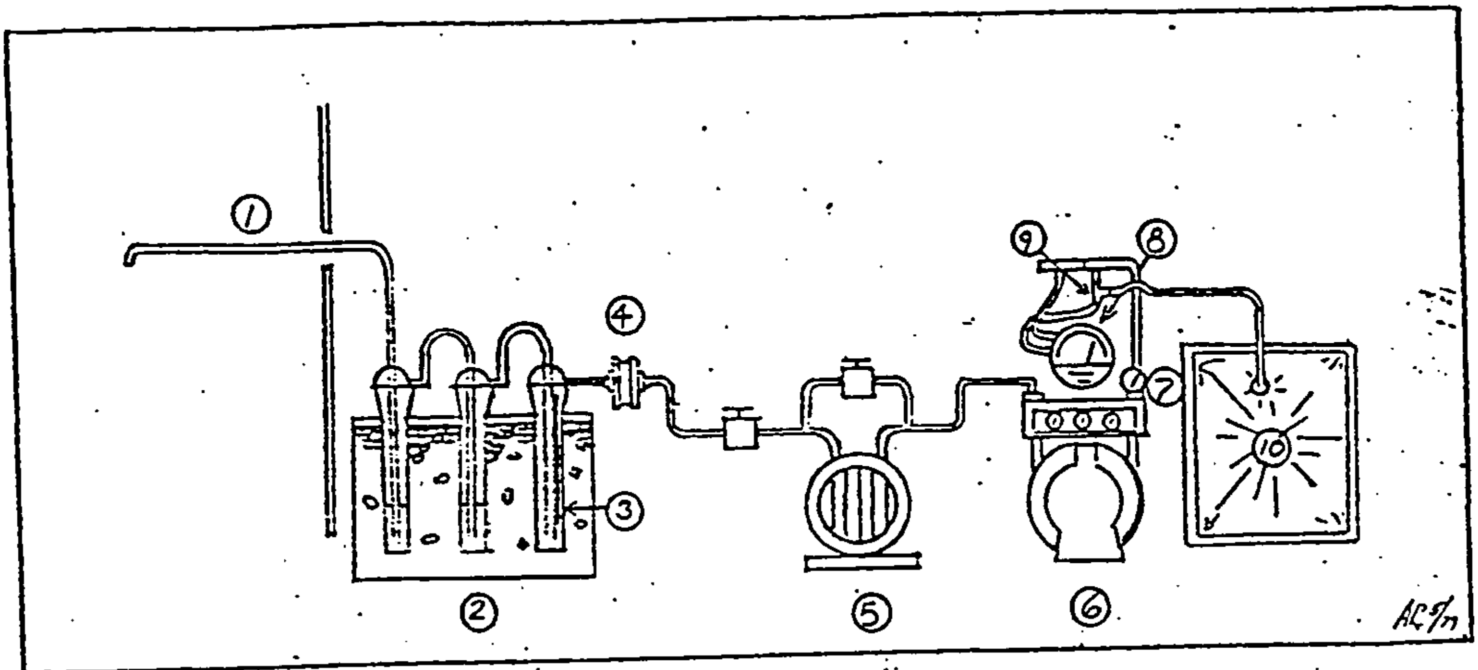
TITLE: TESTING DIAGRAM FOR SVS - MECA

CUST. NAME:	DWG NO.:
CM&E INTERNATIONAL	SKETCH - 1



11'-3" =135"
FLOW
"D" = 6.0" I.D.
2 x "D"
12"
8 x "D"
48"
8 x "D"
48"
2.5 x "D"
15"
2 x "D"
12"
℄ UPSTREAM PRESS. TAP SEE DETAIL
℄ ORIFICE
℄ DOWNSTREAM PRESS. TAP SEE DETAIL
℄ SAMPLE PORT
TOP VIEW
SEAL W/ PVC CEMENT
SEAL W/ DUCT TAPE FOR EASY DISCONN.
ORIFICE DIA. = 3.5" ±.02"
45°
1/4"
6" ϕ PVC, SCH. 40 PIPE
COUPLING
(2) - 2" DIA. SAMPLE PORTS @ 90° APART ALL PORTS TO BE SEALED W/ DUCT TAPE AFTER PLACING SAMPLING TUBE
FRONT VIEW
PIPE WALL
PVC WELD
1/8" DIA. HOLE
1/4" HALF COUPLING PVC. THD.
1/4" I.D. HOSE BARB
TYP. 1/4" PRESS. TAP
(2 - PLACES)
NOTE:
MAKE ONE W/ 6" FLANGE ON LEFT END (INLET)
MAKE ONE W/ 6" FLANGE ON RIGHT END (OUTLET)
△ REV. LENGTH, FLG SK TK 7/21
SYM. REVISION DR BY CK BY DATE
CM&E INTERNATIONAL
SCALE: NONE
DATE: 7-14-00
TITLE: INLET/ OUTLET TEST DUCT
CUST. NAME: CM4E.
DWG NO.: SK-1

FLUE GAS SAMPLING TRAIN



1. Glass Sampling Probe
2. Smith-Greenburgh Impingers in Ice Bath w/0.1 N NaOH
3. Thermometer
4. Back-up Filter, Gelman, Stainless Steel Filter Holder for 47 mm Filter - TEFLON + GLASS FIBER FILTER -
5. Leakless Vacuum Pump
6. Dry Gas Meter
7. Thermometer
8. Orifice Flow Rate Gauge
9. Dry Gas Sampling Outlet
10. Tedlar Gas Sampling Bag (optional)

TRUESDAIL LABORATORIES, INC.

Sampling Location: CM & E - INLET
Test No. [illegible]

Date: 12-12-88
Barometric Pressure: 30.15
Nozzle Diameter: .4725"

Time	Gas Meter Reading cu. ft. Vm	Gas Meter Press. in. H_2O Pm	Gas Meter Temp. °F Tm	Impinger Temp. °F Ti	Sample Point	CFM			
10:41	276.14	.36	73	—	1	60			
10:43	=	—	—	—	1				
10:53	—	—	—	—	1				
11:06	284.40	.36	73	42	2	60			
:21	292.85	.36	76	42	1	60			
:36	301.80	.36	79	44	2	60			
:51	310.75	.36	80	45	1	60			
12:06	319.80	.36	80	45	2	60			
:21	328.85	.36	80	45	1	60			
:36	337.85	.36	79	46	2	60			
:51	346.85	.36	79	46	1	60			
13:06	355.85	.36	79	47	2	60			
21	364.95	.36	78	47	1	60			
36	373.90	.36	78	47	2	60			
:51	382.68	—	—	44		—			

Weight Collected, grams

METER - 003
Leak check pre ✓
post ✓
mf: .95

A. Total Weight

B. Condensate Volume, ml.

C. Condensate Vapor Volume, $0.00267 \times \frac{460 + Tm}{B.P + Pm/13.6} \times B$, cu. ft.

D. Total Sample Volume, Vm + C, cu. ft.

E. Sample Volume, $D \times \frac{520}{460 + Tm} \times \frac{B.P. + Pm/13.6}{29.9} \times$ Moisture corr., DSCF

F. Concentration, 15.43 x A/E, grains/DSCF

G. Stack Gas Flow Rate, DSCFM

H. Emissions, 60 x G x F/7000, lbs/hr

TRUESDAIL LABORATORIES, INC.

Sampling Location: CM & E INLET
Test No.

Date: 12-12-88
Barometric Pressure: 30.15
Nozzle Diameter: (.472)

	Gas Meter			Impinger			
Time	Reading cu. ft. Vm	Press. in. H_2O Pm	Temp. °F Tm	Temp. °F Ti	Sample Point		
14:02	382.68	.36	75	—	1	60	
:17	391.80	.36	76	44	2	60	
:32	400.80	.36	76	45	1	60	
:47	409.80	.36	76	45	2	60	
15:02	418.80	.36	76	46	1	60	
:17	427.80	.36	76	44	2	60	
:32	436.80	.36	76	45	1	60	
:47	445.80	.36	76	44	2	60	
16:02	454.80	.36	76	44	1	60	
:17	463.80	.36	73	44	2	60	
:32	472.80	.36	72	44	1	60	
:47	481.80	.36	70	44	2	60	
17:02	490.54	—	—	43	1	—	
					2		
	214.40	.36	76	45			

Weight Collected, grams

M= 385 ml

GAS DIN
E
15:00
15:05
15:10
15:15
15:20

A. Total Weight

B. Condensate Volume, ml.

C. Condensate Vapor Volume, $0.00267 \times \frac{460 + Tm}{B.P + Pm/13.6} \times B$, cu. ft.

D. Total Sample Volume, Vm + C, cu. ft.

E. Sample Volume, $D \times \frac{520}{460 + Tm} \times \frac{B.P. + Pm/13.6}{29.9} \times$ Moisture corr., DSC .975

F. Concentration, 15.43 x A/E, grains/DSCF

G. Stack Gas Flow Rate, DSCFM

H. Emissions, 60 x G x F/7000, lbs/hr

Date: 12-15-88

Sampling Location: CMSE – INLET

Static Pressure, Ps: –.319

Test No.:

Barometric Pressure: 30.15

	Time ~~Point~~	Vel. Head H_2O"	Temp. °F	Velocity ft/sec	Point	STATIC ~~Vel. Head H_2O"~~	STATIC Temp. °F	Velocity ft/sec	Point	Vel. Head H_2O"	Temp. °F	Velocity ft/sec
1	10:41	.250	74	26.71		-.325	14:02	-.320	1	.245	80	26.59
2	11:06	.255	80	27.13		-.330	14:17	-.320	2	.245	80	26.59
1	21	.260	82	27.45		-.330	14:32	-.320	1	.245	80	26.59
2	36	.260	83	27.47		-.330	14:47	-.320	2	.245	80	26.59
1	51	.260	84	27.50		-.330	15:02	-.320	1	.245	80	26.59
2	12:06	.255	83	27.21		-.320	15:17	-.320	2	.245	80	26.59
1	21	.255	82	27.18		-.320	15:32	-.310	1	.240	80	26.32
2	36	.250	81	26.89		-.320	15:47	-.310	2	.245	80	26.59
1	51	.250	81	26.89		-.320	16:02	-.310	1	.240	79	26.30
2	13:06	.250	81	26.89		-.320	16:17	-.305	2	.235	78	26.00
1	21	.250	81	26.89		-.320	16:32	-.305	1	.240	77	26.25
2	36	.250	80	26.86		-.320	16:47	-.305	2	.240	76	26.22
1	51	–	–				17:02		1			

LEAK CHECK
PRE ✓ POST ✓

EQUIPMENT IDENTIFICATION
MAGNEHELIC A644 (0-½)"
MICROMITE B

A. AVERAGE VELOCITY (TRAVERSE) ft/sec 26.76 (8.70) (ε included)

B. REFERENCE POINT VELOCITY (TRAVERSE) ft/sec

C. AVERAGE VELOCITY (REFERENCE PT.) ft/sec

D. FLUE FACTOR C/B

E. PITOT TUBE CORRECTION FACTOR .80

F. GAS DENSITY CORRECTION FACTOR 1.004

G. CORRECTED VELOCITY, AxExF, ft/sec 26.87 (8.73)
or, AxDxExF, ft/sec

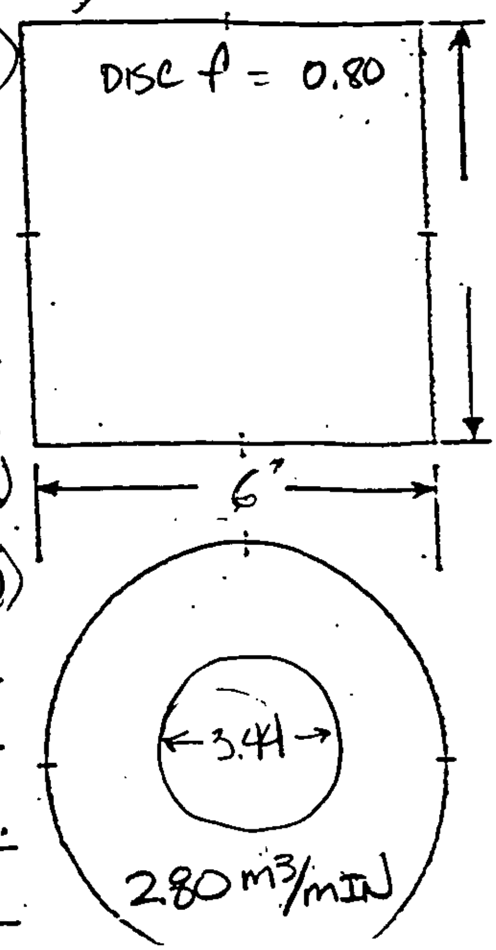
H. AREA OF ~~FLUE~~ ORIFICE, SQ. FT. 0.065 (0.20)

J. AVERAGE FLUE TEMPERATURE, °F 80

K. FLOW RATE, G x H x 60, CFM 105

L. FLOW RATE, $K \times \frac{520}{460 + J} \times \frac{BP + Ps/13.6}{29.9}$, SCFM 102.

M. FLOW RATE, L x MOISTURE CORR., DSCFM .975 99



TRUESDAIL LABORATORIES, INC.

Sampling Location: CM&E (REID)
Test No. OUTLET OF SCRUBBER PO. 1

Date: 12/12/88
Barometric Pressure: 30.15
Nozzle Diameter: 1/2"

Time	Gas Meter Reading cu. ft. Vm	Gas Meter Press. in. H_2O Pm	Gas Meter Temp. °F Tm	Impinger Temp. °F Ti	Sample Point	CFM	STACK TEMP °F		
1052	039.38	.43	67	—	1	.68	73		
1107	049.58	.46	66	42	2	.70	73		
1122	059.79	.43	66	42	1	.68	74		
1137	068.90	.42	67	43	2	.67	76		
1152	078.50	.41	68	45	1	.66	77		
1207	088.20	.47	68	46	2	.72	78		
1222	098.00	.51	69	44	1	.74	78		
1237	108.50	.51	69	45	2	.74	78		
1252	119.10	.51	69	46	1	.74	79		
1307	129.90	.51	69	46	2	.74	78		
1322	140.80	.51	69	46	1	.74	79		
1337	151.80	.33	69	45	2	.60	79		
1352	160.19	—	—	45			79		

MF - .95

Weight Collected, grams

LEAK CHECK - PRE ✓ POST ✓
METER # Ø09

A. Total Weight ____

B. Condensate Volume, ml. ____

C. Condensate Vapor Volume, $0.00267 \times \frac{460 + Tm}{B.P + Pm/13.6} \times B$, cu. ft. ____

D. Total Sample Volume, Vm + C, cu. ft. ____

E. Sample Volume, $D \times \frac{520}{460 + Tm} \times \frac{B.P. + Pm/13.6}{29.9} \times$ Moisture corr., DSCF ____

F. Concentration, 15.43 x A/E, grains/DSCF ____

G. Stack Gas Flow Rate, DSCFM ____

H. Emissions, 60 x G x F/7000, lbs/hr ____

TRUESDAIL LABORATORIES, INC.

Sampling Location: CM & E (Z.D) — Date: 12/12/89

Test No. OUTLET OF SCRUBBER PG. 2 — Barometric Pressure: 30.15

Nozzle Diameter: 1/2"

Time	Gas Meter Reading cu. ft. Vm	Gas Meter Press. in. H_2O Pm	Gas Meter Temp. °F Tm	Impinger Temp. °F Ti	Sample Point	CFM	STACK TEMP °F		CO TANK EW
1359	160.19	.51	68	—	1	.74	79	1448	20
1413	171.29	.48	68	45	2	.74	79	53	25
1428	182.70	.51	68	45	1	.74	79	58	20
1443	192.20	.51	68	45	2	.74	79	1503	15
1459	203.00	.52	68	46	1	.75	79	08	10
1513	213.30	.52	68	46	2	.75	79	13	5
1528	224.00	.52	68	45	1	.75	79	18	0
1543	235.00	.54	67	45	2	.76	78		
1558	245.90	.51	67	45	1	.74	78		
1613	256.50	.54	66	45	2	.76	78		
1628	267.00	.56	65	44	1	.79	77		
1643	277.40	.50	65	44	2	.72	77		
1658	286.96	—	—	44					
	247.58	.49	68	45					

SYSTEM RUNS AT 200 AMPS
40 MIN. RUN AT 40 VOLTS
TANK - 90°F

M= 395 mls

Weight Collected, grams

METER-009

A. Total Weight

B. Condensate Volume, ml. 93 ml

C. Condensate Vapor Volume, $0.00267 \times \frac{460 + Tm}{B.P + Pm/13.6} \times B$, cu. ft. 4.34

D. Total Sample Volume, Vm + C, cu. ft. 251.92

E. Sample Volume, $D \times \frac{520}{460 + Tm} \times \frac{B.P. + Pm/13.6}{29.9} \times$ Moisture corr., DSCF .973 243.71
6.90 m3

F. Concentration, 15.43 x A/E, grains/DSCF

G. Stack Gas Flow Rate, DSCFM

H. Emissions, 60 x G x F/7000, lbs/hr

TRUESDAIL LABORATORIES, INC.

Sampling Location: CM & E

Test No.: OUTLET

Date: 12/12/8?

Static Pressure, Ps: +.31

Barometric Pressure: 30.17 30.15

Ps	Point	Vel. Head H_2O"	Temp. °F	Velocity ft/sec	TIME ~~Point~~	Vel. Head H_2O"	TIME ~~Temp. °F~~	Ps ~~Velo-~~city ft/sec	Point	Vel. Head H_2O"	Temp. °F	Velocity ft/sec
.31	1	.26	73	27.19	10:52	,	13:58	.31	1	.32	79	30.33
.31	2	.28	73	28.21	11:07	--	14:13	.31	2	.30	79	29.37
.30	1	.26	74	27.21	11:22		14:28	.31	1	.30	79	29.37
.31	2	.25	76	26.74	11:37		14:43	.31	2	.30	79	29.37
.31	1	.24	77	26.22	11:52		14:58	.31	1	.31	79	29.85
.32	2	.29	78	28.85	2:07		15:13	.30	2	.32	79	30.33
.31	1	.30	78	29.34	2:22		15:28	.30	1	.32	78	30.30
.31	2	.30	78	29.34	12:37		15:43	.30	2	.30	78	29.34
.31	1	.31	79	29.85	12:52		15:58	.30	1	.32	79	30.30
.31	2	.31	78	29.83	13:07		16:13	.30	2	.34	77	31.27
	1	.20	79	23.98	13:22		16:28	.30	1	.31	77	29.80
	2				13:37		16:43		2			

LEAK CHECK
PRE ✓ POST ✓

EQUIPMENT IDENTIFICATION
MAGNEHELIC PM 283 (Circled)
MICROMITE A

A. AVERAGE VELOCITY (TRAVERSE) ft/sec 28.92 (9.40)

B. REFERENCE POINT VELOCITY (TRAVERSE) ft/sec —

C. AVERAGE VELOCITY (REFERENCE PT.) ft/sec —

D. FLUE FACTOR C/B —

E. PITOT TUBE CORRECTION FACTOR .80

F. GAS DENSITY CORRECTION FACTOR 1.004

G. CORRECTED VELOCITY, AxExF, ft/sec 29.04 9.44
or, AxDxExF, ft/sec

H. AREA OF ~~FLUE~~ ORIFICE, SQ. FT. 0.065 (0.2)

J. AVERAGE FLUE TEMPERATURE, °F 78

K. FLOW RATE, G x H x 60, CFM 113

L. FLOW RATE, K x $\frac{520}{460 + J}$ x $\frac{BP + Ps/13.6}{29.9}$, SCFM 110

M. FLOW RATE, L x MOISTURE CORR., DSCFM 107
.973

3.03 m^3/MIN

DISC f = 0.80

6

3.44

Date : 12-12-88
Client : CM&E INTERNATIONAL
Sampling Station : Scrubber Inlet and outlet

WATER VAPOR AND GAS DENSITY CALCULATIONS

PERCENT WATER VAPOR IN GASES :

	SCRUBBER INLET	SCRUBBER OUTLET
A. Gas pressure at meter, in. Hg (absolute)	30.18	30.19
B. Vapor pressure of water at impinger temp., in. Hg.	0.3004	0.3004
C. Volume of metered gas, cu.ft.	214.40	247.58
D. Volume of water vapor metered, B*C/A. cu.ft	2.13	2.46
E. Volume of water vapor condensed, cu.ft.	3.27	4.34
F. Total volume of water vapor in gas sample, D+E, cu.ft	5.40	6.80
G. Total volume of gas sample, C+E, cu.ft	217.67	251.92
H. Percent water vapor in sampled gas, 100*F/G	2.5	2.7
I. Density of gas referred to air*	0.992	0.9914
J. Gas density correction factor**	1.004	1.004

GAS DENSITY CORRECTION FACTOR :

Component	Volume fraction	Moisture correction	Mol. Wt.	Wt./mole (Wet basis)
SCRUBBER INLET				
Water	0.025	1.0	18.0	0.450
Oxygen	0.209	0.975	32.0	6.521
Nitrogen & inerts	0.791	0.975	28.2	21.749
Average Molecular Weight				**28.720**
SCRUBBER OUTLET				
Water	0.027	1.0	18.0	0.486
Oxygen	0.210	0.973	32.0	6.539
Nitrogen & inerts	0.790	0.973	28.2	21.676
Average Molecular Weight				**28.701**

Note:
* Density of gas referred to air = Average Mol. Wt./28.95
** Gas density correction factor = SQRT (1.00 / density of gas)

METHODS FOR DETERMINATION OF VELOCITY, VOLUME, DUST AND MIST CONTENT OF GASES

BULLETIN WP-50

SEVENTH EDITION

PREFACE

In order to determine the performance of an existing gas handling or gas cleaning system, to evaluate the necessity of installing a cleaning system, or to obtain information for the design of a cleaning system, it is necessary or desirable to obtain a measure of the concentration and character of the dust in the gas stream, and accurate data regarding the temperature, velocity, and volume of the gas stream itself.

The purpose of this bulletin is to outline a standard method of procedure for the study of gas streams contained in industrial flue systems, and of the suspended matter carried by these gases. In addition, various other methods are mentioned, as no one process is applicable to all situations. Many industrial processes are of such a specialized nature that it is necessary to start with some such standard procedure as described herein, and alter it to develop a procedure to suit the individual conditions.

HAROLD H. HAALAND
EDITOR

WESTERN PRECIPITATION DIVISION / JOY MANUFACTURING COMPANY
LOS ANGELES 90051 P.O. Box 2744, (213) 240-2300 / **PITTSBURGH** 15222 Oliver Building, (412) 471-2116 **NEW YORK** 10022 110 East 59th Street, (212) 836-2924 / **CHICAGO** 60162 4421 Harrison Street, Hillside, Ill., (312) 449-5700 / **ATLANTA** 30326 3445 Peachtree Road, N.E., (404) 266-1822 / **MONTREAL** 308 P.Q., Precipco Division, Joy Manufacturing Co. (Canada) Ltd., 8285 Mountain Sights Avenue, (514) 739-2781 / **ENGLAND** Capitol House, Church Street, Epsom, Surrey, Epsom 27661 / **AUSTRALIA** Joy Manufacturing Co. Pty., 78 Kent Road, Mascot, N.S.W., 67-5161 / **SOUTH AFRICA** Joy Manufacturing Co., (Africa) (Pty)., Ltd., 1 Steeldale, Johannesburg, 869-5241 / **FRANCE** Precipco de France, 30 Rue Chabrol, Paris X, France, 824-7560 **MEXICO** Joy Manufactuirng De Mexico S.A. de C.V., Apartado Postal M-9617, Mexico 1, D.F., 533-23-85

FORMULAS

(1) BASIC FLOW EQUATION

$$V_s = \sqrt{2gh}$$

(2) GAS VELOCITY IN FLUE—Using standard Pitot tube

Assume gas density equivalent to air, and flue pressure equal to one atmosphere.

For temperature in °F absolute

$$V_s = 2.90 \sqrt{HT_s}$$

For temperature in °C absolute

$$V_s = 3.90 \sqrt{HT_s}$$

(3) GAS VELOCITY IN FLUE—Using standard Pitot tube

For temperature in °F absolute

$$V_s = 2.90 \sqrt{\frac{29.92}{P_s} \times \frac{1.00}{G_d} \times HT_s}$$

For temperature in °C absolute

$$V_s = 3.90 \sqrt{\frac{29.92}{P_s} \times \frac{1.00}{G_d} \times HT_s}$$

(4) GAS VELOCITY IN FLUE—Using Type "S" Pitot tube

Assume gas specific gravity equivalent to air, and flue pressure equal to one atmosphere.

For temperature in °F absolute

$$V_s = 2.90\ F_s \sqrt{HT_s}$$

For temperature in °C absolute

$$V_s = 3.90\ F_s \sqrt{HT_s}$$

For Pitot tube as shown in Figure 5, $F_s = 0.83$

(5) GAS VELOCITY IN FLUE—Using orifice disc meter

Assume gas specific gravity equivalent to air, and flue pressure equal to one atmosphere.

For temperature in °F absolute

$$V_s = 2.90\ F_d \sqrt{HT_s}$$

For temperature in °C absolute

$$V_s = 3.90\ F_d \sqrt{HT_s}$$

For orifice as described in Figure 6, values of F_d can be obtained from Figure 7.

(6) GAS VOLUME IN FLUE

$$V_o = V_{s.avg} \times A \times 60$$

(7) CONVERSION OF FLUE GAS VOLUME TO STANDARD CONDITIONS OF 29.92 INCHES MERCURY PRESSURE AND 0° CENTIGRADE (32° FAHRENHEIT)

For temperature in °F absolute

$$V\ std = V_o \times \frac{P_s}{29.92} \times \frac{492}{T_s}$$

For temperature in °C absolute

$$V\ std = V_o \times \frac{P_s}{29.92} \times \frac{273}{T_s}$$

(8) METER RATE—Dry gas—Isokinetic sampling

$$R_m = 0.33 \times \frac{T_m}{T_s} \times V_s \times d^2 \times \frac{P_s}{P_b - P_m}$$

(9) CONVERTING CONDENSATE TO VAPOR VOLUME—Meter conditions

For temperature in °F absolute

$$V_v = 0.00267 \times \frac{V_w \times T_m}{P_b - P_m}$$

NOMENCLATURE

a —Area of nozzle in square inches.

A —Effective area of flue in square feet.

CF —Cubic feet.

CFM—Cubic feet per minute.

D —Diameter of flue in inches.

d —Diameter of sampling nozzle in inches.

F_d —Orifice disc factor.

F_s —Pitot tube correction factor.

g —Acceleration due to gravity in feet per second per second.

G_d —Specific gravity of gas referred to that of air.

h —Velocity head in equivalent feet of gas column in the flue.

H —Velocity head draft gauge reading in equivalent inches of water.

Hg —Mercury

M_c —Meter rate correction factor.

M_m —Volume of moisture remaining in metered gas at meter conditions in cubic feet.

P_a —Absolute pressure in inches mercury.

P_b —Barometric pressure in inches mercury.

P_m —Suction at meter in inches mercury.

P_s —Absolute pressure in flue in inches mercury.

R_m —Meter rate in CFM (dependent on gas velocity, nozzle size, and moisture content of gas).

T —Duration of test in hours.

T_m —Temperature at meter in degrees absolute.

T_s —Flue gas temperature in degrees absolute.

W_t —Weight of dust separated from gas sample in grams.

V_m —Volume of gas sample as measured by the gas meter in CF at meter conditions.

V_o —Volume of flue gas in CFM at flue conditions.

V.P. —Vapor pressure of water in inches of mercury.

V_s —Flue gas velocity at some given point in feet per second.

V_t —Total gas sampled converted to flue conditions in CF.

V_v —Volume of water vapor condensed in cubic feet converted to meter conditions (vapor state).

V_w —Volume of water condensed in cubic centimeters (liquid state).

CM&E / REID

ISOKINETICS

INLET: H_2O = 2.5 % MT = 76 °F ST = 80 °F

NOZZLE = 0.472" VEL = 8.7 FT/SEC

$$R_{ISO} = 0.975 \times 0.33 \times \frac{536\ °R}{540\ °R} \times (0.472)^2 \times 8.7\ \text{FT/SEC}$$

$$= 0.62\ \text{ACFM}$$

$$R_{ACTUAL} = 214.40\ \text{ACF} / 360\ \text{MIN} = 0.60\ \text{ACFM}$$

$$\frac{0.60}{0.62} \times 100 = \sim 97\%\ \text{ISOKINETIC}$$

OUTLET: H_2O = 2.7 % MT = 68°F ST = 78°F

NOZZLE = 0.50" VEL = 9.4 FT/SEC

$$R_{ISO} = 0.973 \times 0.33 \times \frac{528\ °R}{538\ °R} \times (0.5)^2 \times 9.4\ \text{FT/SEC}$$

$$= 0.74\ \text{ACFM}$$

$$R_{ACTUAL} = 243.71\ \text{ACF} / 360\ \text{MIN} = 0.68\ \text{ACFM}$$

$$\frac{0.68}{0.74} \times 100 = \sim 92\%\ \text{ISOKINETIC}$$

SHF

TRUESDAIL LABORATORIES, INC.

LABORATORY No. ______ DATE RECEIVED 8-31-88

CLIENT: C M & E DATE REPORTED ______

SAMPLE

CALIBRATION OF 2 ORIFICE TUBES

METHODS USED

DATA & CALCULATIONS:

BOTH INSIDE DIA. OF 6.00" $3.44/6 = 0.57$

BOTH ORIFICE RING DIA. OF 3.44" $0.57 = 0.90$ PITOT TUBE

0.57 = CORRECTION FAC.

TUBE '44'

	ORIFICE TUBE	STD. PITOT TUBE
HIGH SPEED	194 CFM	186 CFM
MED SPEED	140 CFM	137 CFM
LOW SPEED	80 CFM	79 CFM

TUBE '45'

	ORIFICE TUBE	STD. PITOT TUBE
HIGH SPEED	195 CFM	196 CFM
MED SPEED	140 CFM	137 CFM

SUMMARY OF RESULTS:

DATE	KM			
HRS.				

Signed ______

TRUESDAIL LABORATORIES, INC.

CHEMISTS - MICROBIOLOGISTS - ENGINEERS

14201 FRANKLIN AVENUE
TUSTIN, CALIFORNIA 92680
AREA CODE 714 • 730-6239
AREA CODE 213 • 225-1564
CABLE: TRUELABS

MICROMITE CALIBRATION

DATE: 11/1/88

	LOW		MED		HIGH	
MICRO	MICRO	THERM	MICRO	THERM	MICRO	THERM
A	31 F	32 F	73 F	73 F	212 F	212 F
B	32	32	75	75	211	212
C	32	32	76	75	212	212
D	32	32	75	75	212	212
	ICE WATER		AMBIENT AIR		BOILING WATER	

CALIBRATED WITH: THERMOMETERS #280-7 and #TL03146

TRUESDAIL LABORATORIES, INC.

MAGNEHELIC CALIBRATION

DATE: 11/01/88

	LOW		MED		HIGH	
MAGY. #	MAGY.	MICRO.	MAGY.	MICRO.	MAGY.	MICRO.
1/4" - GW92	0.045	0.044	0.133	0.134	0.233	0.232
1/2" - AM78	0.050	0.050	0.250	0.250	0.450	0.450
1/2" - AG44	0.050	0.048	0.250	0.248	0.450	0.442
1" - NH125	0.110	0.108	0.410	0.418	0.910	0.906
1" - PM283	0.100	0.100	0.400	0.402	0.900	0.986
1" - AM112	0.100	0.100	0.410	0.410	0.460	0.460
2" - PM9	0.250	0.250	0.900	0.900	1.800	1.800
2" - PM28	0.250	0.254	0.900	0.894	1.800	1.800

(CALIBRATED WITH DWYER MICROTECTOR)

TRUESDAIL LABORATORIES, INC.

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AREA CODE 213 • 225-1564
CABLE: TRUELABS

METER CALIBRATION

11/01/88 METER #003 RUN 1

CBP:	29.96	WET:	11.943
T in F:	74	DRY:	11.971
		dY:	0.998

WET TEST #1 DRY TEST #1

VOL	dP	T in F	CFM	VOL	dP	T in F
0.000	*********	*********	0.30	90.53	0.06	*********
1.000	0.35	73.0		91.52	0.06	64.0
2.000	0.35	72.5		92.50	0.06	64.0
3.000	0.35	72.5		93.48	0.06	64.0
4.000	0.34	72.5		94.47	0.06	64.0
4.000	*********	*********	0.50	94.47	0.24	*********
5.000	0.93	72.5		95.45	0.24	64.0
6.000	0.92	72.5		96.43	0.24	65.0
7.000	0.92	72.5		97.42	0.24	65.0
8.000	0.94	72.5		98.41	0.24	65.0
8.000	*********	*********	0.70	98.41	0.51	*********
9.000	1.65	72.5		99.40	0.51	65.0
10.000	1.65	72.5		100.40	0.51	65.0
11.000	1.65	72.5		101.40	0.51	65.0
12.000	1.65	72.5		102.40	0.51	65.0
0.000	*********	*********			*********	*********
12.000	0.97	72.5		11.870	0.27	64.6

CALCULATION:

WET, SCF: $$12.000 * \frac{528}{532.5} * \left(\frac{29.96 + 0.97 / 13.6}{29.92}\right) = 11.943$$

DRY, SCF: $$11.87 * \frac{528}{524.6} * \left(\frac{29.96 + 0.27 / 13.6}{29.92}\right) = 11.971$$

TRUESDAIL LABORATORIES, INC.

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METER CALIBRATION

11/01/88 METER #003 RUN 2

CBP: 29.92
T in F: 74

WET: 11.961
DRY: 12.025
dY: 0.995

WET TEST #2 DRY TEST #2

VOL	dP	T in F	CFM	VOL	dP	T in F
0.000	******************		0.30	102.40	0.06	*********
1.000	0.38	71.5		103.39	0.06	62.0
2.000	0.42	71.5		104.37	0.06	62.0
3.000	0.38	71.5		105.36	0.06	62.0
4.000	0.38	71.5		106.34	0.06	62.0
4.000	******************		0.50	106.34	0.24	*********
5.000	0.98	71.0		107.34	0.24	62.0
6.000	0.98	71.0		108.32	0.24	62.0
7.000	0.98	71.0		109.32	0.24	62.0
8.000	0.98	71.0		110.30	0.24	62.0
8.000	******************		0.70	110.30	0.51	*********
9.000	1.75	71.0		111.30	0.51	62.0
10.000	1.75	71.0		112.29	0.51	62.0
11.000	1.75	71.0		113.29	0.51	62.0
12.000	1.75	71.0		114.28	0.51	62.0
0.003	******************				******************	
12.003	1.04	71.2		11.880	0.27	62.0

CALCULATION:

WET, SCF: $$12.003 * \frac{528}{531.2} * \left(\frac{29.92 + 1.04 / 13.6}{29.92}\right) = 11.961$$

DRY, SCF: $$11.88 * \frac{528}{530} * \left(\frac{29.92 + 0.27 / 13.6}{29.92}\right) = 12.025$$

TRUESDAIL LABORATORIES, INC.

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AREA CODE 213 • 225-1564
CABLE: TRUELABS

METER CALIBRATION

11/01/88 METER #009 RUN 1

CBP:	29.86	WET, SCF:	11.915
T in F:	74	DRY, SCF:	11.666
		dY:	1.021

WET TEST #1 DRY TEST #1

VOL	dP	T in F	CFM	VOL	dP	T in F
0.000	******************		0.30	381.36	0.11	*********
1.000	0.54	72.0		382.33	0.10	65.0
2.000	0.48	72.0		383.30	0.10	66.0
3.000	0.48	72.0		384.27	0.10	66.0
4.000	0.48	72.0		385.21		66.0
4.000	******************		0.50	385.21	0.23	*********
5.000	0.88	72.0		386.19	0.23	66.0
6.000	0.88	72.0		387.16	0.23	66.0
7.000	0.88	72.0		388.14	0.23	66.0
8.000	0.88	72.0		389.10		66.0
8.000	******************		0.70	389.10	0.46	*********
9.000	1.50	72.0		390.07	0.46	66.5
10.000	1.50	72.0		391.05	0.46	66.5
11.000	1.55	72.0		392.03	0.46	66.5
12.000	1.55	72.0		393.00		67.0
0.001	******************				******************	
12.001	0.97	72.0		11.640	0.26	66.1

CALCULATION:

$$\text{WET, SCF:}\quad 12.001 * \frac{528}{532} * \left(\frac{29.86 + 0.97 / 13.6}{29.92}\right) = 11.915$$

$$\text{DRY, SCF:}\quad 11.640 * \frac{528}{526.1} * \left(\frac{29.86 + 0.26 / 13.6}{29.92}\right) = 11.666$$

TRUESDAIL LABORATORIES, INC.

CHEMISTS - MICROBIOLOGISTS - ENGINEERS

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AREA CODE 714 • 730-6239
AREA CODE 213 • 225-1564

METER CALIBRATION

11/01/88 METER #009 RUN 2

CBP:	29.92	WET, SCF:	11.953
T in F:	74	DRY, SCF:	11.710
		dY:	1.021

WET TEST #2 DRY TEST #2

VOL	dP	T in F	CFM	VOL	dP	T in F
0.000	*******************		0.30	86.98	0.10	*********
1.000	0.48	71.5		87.96	0.10	67.0
2.000	0.48	71.5		88.95	0.10	67.0
3.000	0.50	71.5		89.93	0.10	67.0
4.000	0.50	71.5		90.91	0.10	67.0
4.000	*******************		0.50	90.91	0.23	*********
5.000	0.90	71.5		91.89	0.23	67.0
6.000	0.90	71.5		92.88	0.23	67.0
7.000	0.89	71.5		93.86	0.23	67.0
8.000	0.90	71.5		94.84	0.23	67.0
8.000	*******************		0.70	94.84	0.51	*********
9.000	1.65	71.5		95.83	0.51	67.0
10.000	1.70	71.5		96.82	0.51	67.0
11.000	1.65	71.5		97.81	0.51	67.0
12.000	1.70	71.5		98.80	0.51	67.0
0.002	*******************				*******************	
12.002	1.02	71.5		11.68	0.28	67.0

CALCULATION:

$$\text{WET, SCF:} \quad 12.002 * \frac{528}{531.5} * \left(\frac{29.92 + 1.02 / 13.6}{29.92}\right) = 11.953$$

$$\text{DRY, SCF:} \quad 11.680 * \frac{528}{527} * \left(\frac{29.92 + 0.28 / 13.6}{29.92}\right) = 11.710$$

Date : 12-12-88
Client : CM&E INTERNATIONAL

CALCULATION OF CONCENTRATION

SCRUBBER INLET :

1. Concentration (ppm)

(a) Cr (total) concentration = $239 \frac{\mu g}{ml}$

$$= 239 \frac{\mu g}{ml} \cdot 385 ml \cdot \frac{1 \mu m}{52 \mu g} \cdot \frac{23.7 \mu l}{1 \mu m} \cdot \frac{1 DSCF}{28.3 l} \cdot \frac{1}{207.80 DSCF}$$

= 7.1 ppm

(b) Cr^{+6} concentration = $60 \frac{\mu g}{ml}$

$$= 60 \frac{\mu g}{ml} \cdot 385 ml \cdot \frac{1 \mu m}{52 \mu g} \cdot \frac{23.7 \mu l}{1 \mu m} \cdot \frac{1 DSCF}{28.3 l} \cdot \frac{1}{207.80 DSCF}$$

= 1.8 ppm

2. Concentration (mg/m^3)

(a) Cr (total) concentration = $239 \frac{\mu g}{ml} \cdot 385 ml \cdot \frac{1}{5.89 m^3}$

$$= 15.6 \frac{mg}{m^3}$$

(b) Cr^{+6} concentration = $60 \frac{\mu g}{ml} \cdot 385 ml \cdot \frac{1}{5.89 m^3}$

$$= 3.9 \frac{mg}{m^3}$$

3. Emission rate

(a) Cr (total) emission rate = $\frac{15.6 mg}{m^3} \cdot \frac{99 DSCF}{min} \cdot \frac{1 m^3}{35.3 ft^3} \cdot \frac{60 min}{1 hr}$

= 2,625 mg/hr

(b) Cr^{+6} emission rate = $\frac{3.9 mg}{m^3} \cdot \frac{99 DSCF}{min} \cdot \frac{1 m^3}{35.3 ft^3} \cdot \frac{60 min}{1 hr}$

= 656 mg/hr

Date: 9-15-88
Client : CM&E INTERNATIONAL

SCRUBBER OUTLET :

1. Concentration (ppm)

(a) Cr (total) concentration = $0.012\frac{\mu g}{ml}$

$$= 0.012\frac{\mu g}{ml} \cdot 395ml \cdot \frac{1\mu m}{52\mu g} \cdot \frac{23.7\mu l}{1\mu m} \cdot \frac{1DSCF}{28.3l} \cdot \frac{1}{207.80DSCF}$$

= 0.00037 ppm

(b) Cr^{+6} concentration = $0.015\frac{\mu g}{ml}$

$$= 0.015\frac{\mu g}{ml} \cdot 395ml \cdot \frac{1\mu m}{52\mu g} \cdot \frac{23.7\mu l}{1\mu m} \cdot \frac{1DSCF}{28.3l} \cdot \frac{1}{207.80DSCF}$$

= 0.00046 ppm

2. Concentration (mg/m^3)

(a) Cr (total) Concentration = $0.012\frac{\mu g}{ml} \cdot 395ml \cdot \frac{1}{6.90m^3}$

$$=0.00069\frac{mg}{m^3}$$

(b) Cr^{+6} Concentration = $0.015\frac{\mu g}{ml} \cdot 395ml \cdot \frac{1}{6.90m^3}$

$$=0.00086\frac{mg}{m^3}$$

3. Emission rate

(a) Cr (total) emission rate = $\frac{0.00069mg}{m^3} \cdot \frac{107DSCF}{\min} \cdot \frac{1m^3}{35.3ft^3} \cdot \frac{60\min}{1hr}$

= 0.13 mg/hr

(b) Cr^{+6} emission rate = $\frac{0.00086mg}{m^3} \cdot \frac{107DSCF}{\min} \cdot \frac{1m^3}{35.3ft^3} \cdot \frac{60\min}{1hr}$

= 0.16 mg/hr

Date: 9-15-88
Client: CM&E INTERNATIONAL

EFFICIENCY:

$$\text{Cr (total)} = \frac{2,625\frac{mg}{hr} - 0.13\frac{mg}{hr}}{2,625\frac{mg}{hr}} \cdot 100$$

$$= 99.995\ \%$$

$$Cr^{+6} = \frac{656\frac{mg}{hr} - 0.16\frac{mg}{hr}}{656\frac{mg}{hr}} \cdot 100$$

$$= 99.98\ \%$$

TRUESDAIL LABORATORIES, INC.

CM&E, #26163

CHAIN OF CUSTODY

SAMPLING EQUIPMENT PREPARED BY:

12/13/88 Kurt Bonfanti
DATE NAME

DATE NAME

DATE NAME

FIELD CREW:

12/12/88 Chuck M. Figueroa
DATE NAME

12/13/88 Kurt Bonfanti
DATE NAME

DATE NAME

DATE NAME

SAMPLE RECOVERY:

12/13/88 Gary P. Mata
DATE NAME

DATE NAME

ANALYSIS:

RELINQUISHED BY:

12/13/88 Andrew Keller
DATE NAME

FOR (ANALYSIS)

Cr, Cr^{+6}

RECEIVED BY:

12-13-88 haýher
DATE NAME

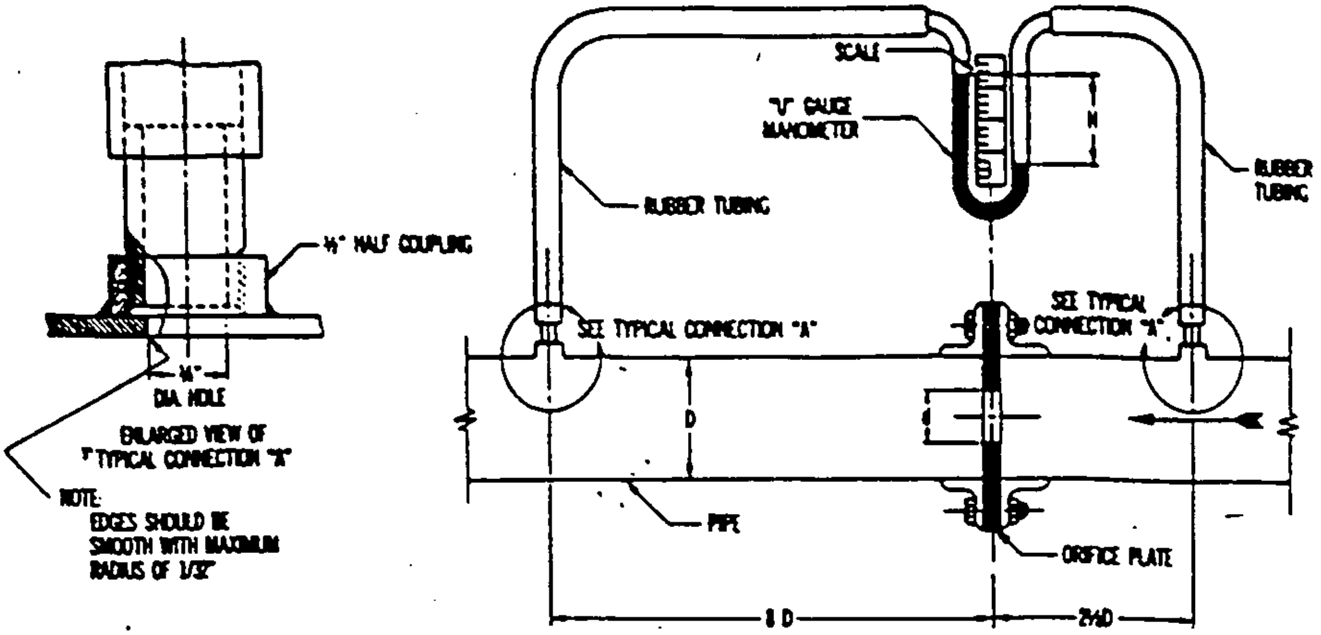

Fig. 6 ORIFICE DISC METER

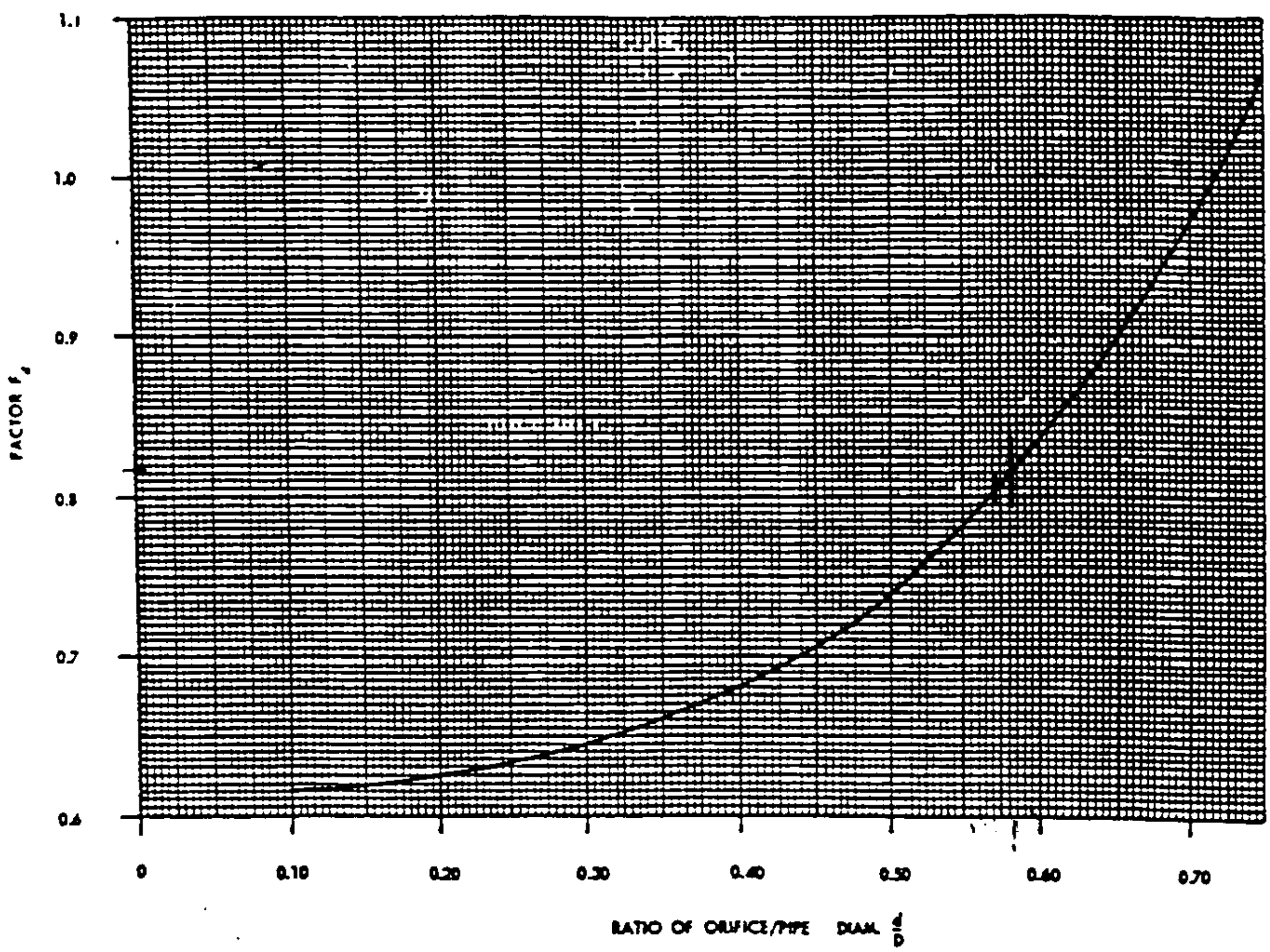

Fig. 7 ORIFICE DISC FACTOR

In the discussion above, it has been assumed that the Standard Pitot Tube or one of similar construction, was employed. Where the gases are nearly saturated with some condensable constituent or carry heavy dust loads, this tube tends to stop up. Here, the Special Pitot Tube (Type S) may be used. (Fig. 5)

This Type S Pitot tube does not give the true static pressure, and a correction factor F_s must therefore be added to the formula (2), which then becomes

(4) $V_s = 2.90\ F_s \sqrt{HT_s}$ (for temperatures in °F absolute)

$V_s = 3.90\ F_s \sqrt{HT_s}$ (for temperatures in °C absolute)

The value of the factor F_s must be determined from comparison with a Standard Pitot tube. For the type Pitot tube illustrated, F_s averages 0.83 for velocities up to 50 feet per second. For accurate work the individual Pitot tube should be calibrated at the velocity range being measured.

ORIFICE DISC METER

When determining the velocity of gas flowing through relatively small pipes or ducts, an orifice disc may be more convenient than the Pitot tube for obtaining the velocity pressure. Such an arrangement is outlined in Figure 6.

One arrangement of an orifice disc would be a plate of thickness not in excess of 1/50 of the pipe diameter having an accurately cut central, circular opening and may conveniently be located in an existing flanged joint. The gauge connections should be located so that the distance from the orifice disc on the upstream side is 2½ times the pipe diameter D and 8 times the pipe diameter on the downstream side. For other types see the standard references on the subject.

The orifice diameter should be such as to give a suitable gauge reading. They shall not be used with a diameter ratio greater than 0.7. The throat diameter shall not be less than 0.75 inches.

The basic formula expressing the relation between gas velocity through the orifice and the pressure differential is the same as with the Pitot tube

(1) $V_s = \sqrt{2gh}$

With orifice discs, however, a factor must be introduced, the value of which depends only on the ratio of the pipe or duct diameter D to the orifice diameter d; hence, where the gas pressure is at standard atmospheric pressure, or 29.92 inches of mercury, and the gas density is equal to that of air, then the formulae for temperatures in °F and °C become

(5) $V_s = 2.90\ F_d \sqrt{HT_s}$ (for temperatures in °F absolute)

$V_s = 3.90\ F_d \sqrt{HT_s}$ (for temperatures in °C absolute)

Here, as with the Pitot tube, H is the gauge reading in inches of water.

The numerical constants 2.90 and 3.90 may be corrected for other pressures and densities as in equation (3).

Values of the factor "F_d" for gauge connections located as indicated above, and for the different ratios d/D of the orifice and pipe diameters are given in Figure 7.*

USE OF THE ANEMOMETER

Where the gas velocity is much less than 10 feet per second, the differential gauge reading resulting from the Pitot tube pressures is ordinarily too small to permit accurate measurement. In such cases, an anemometer can be used to advantage. The instrument is usually calibrated to read directly in feet per minute of gas flow. It is, therefore, only necessary to insert the anemometer in the proper position at the point for measurement for some definite time (preferably measured by a stop watch). The difference in the anemometer reading for one minute represents the velocity of the gas at that point in feet per minute. The instrument is hard to keep in adjustment under field conditions and should be carefully calibrated before each use. It should not be used in hot, dirty, or corrosive gas.

*NOTE: For extreme accuracy, all orifice meters should be carefully calibrated.

The sampling trains will be prepared beforehand by soaking all impingers overnight in 50% nitric acid, then rinsing three times with distilled water and charging with 200 mls of 0.1N NaOH. All probes and Teflon tubing will be rinsed on site with 50% nitric acid and washed three times with distilled water. Samples will be recovered by measuring condensate gain and rinsing the probe, Teflon tubing, and impingers twice with 0.1N NaOH and once with 0.1N nitric acid. The Teflon filter will be placed in the impinger collection.

The flue gas flow rate will be determined by the inline orifice tubes on the inlet and outlet test locations. The flow will be monitored throughout the entire test period by recording the velocity head and temperature at 30-minute intervals. The average temperature at each location will be measured with a chromel-alumel thermocouple connected to a Micromite potentiometer. The sampling trains and flow measurement equipment will be leak-checked before and after use.

The total chrome will be determined by atomic absorption spectroscopy and the hexavalent chrome by the diphenylcarbazide colormetric method. The analyses will include calibration curves, spike recovery, and a blank sampling train.

The hydrogen, nitrogen and oxygen content of the integrated samples will be determined by gas chromatography utilizing thermal conductivity detection.

The test report will include a copy of this test plan, the field data, chain of custody, calculations, and recent calibrations of the flow measuring devices.

The test is currently scheduled for December 12, 1988 at 8:00 AM.

Please contact me at (714) 730-6239 if you need more information.

Sincerely,

TRUESDAIL LABORATORIES, INC.

S. Hugh Brown, Supervisor
Air Pollution Testing

cc: Dave Miller - CM and E

TRUESDAIL LABORATORIES, INC.

PLEASE REPLY TO

CHEMISTS - MICROBIOLOGISTS - ENGINEERS

RESEARCH - DEVELOPMENT - TESTING

ESTABLISHED 1931

14201 FRANKLIN AVENUE
TUSTIN, CALIF. 92680
AREA CODE 714 • 730-6239
AREA CODE 213 • 225-1564
FAX 714 • 730-6462

December 1, 1988

SCAQMD
9150 Flair Drive
El Monte, CA 91731
Attention: Andrew Lee

Dear Andrew:

This letter is to serve as our test plan for conducting source tests for total and hexavalent chromium on a VSV/MECA II control device installed on the plating operation at Reid Metal Finishing in Santa Ana, California. The control device will be tested for a 6-hour period at the inlet and outlet simultaneously. Each sampling location will consist of a 6-inch orifice disc tube 11 feet long and installed in-line on the control device.

The chromium will be determined by a modified version of the wet impingement method (SCAQMD method 5.1). The sampling train will consist of a glass probe connected with Teflon tubing to a set of Greenburg-Smith impingers charged with 200 mls of 0.1N NaOH and followed by a Teflon filter on a glass fiber backing filter, a vacuum pump, and a dry gas meter. Each sample will be collected isokinetically at 4 points on each of two diameters, 90° apart. The isokinetic sampling rates will be determined either from a preliminary traverse will a mini-Standard Pitot tube and Magnehelic differential pressure gage, or by back calculation from the observed orifice velocity during the test period. Near the end of the test a 60-minute integrated sample of the flue gas will be taken at each location with an evacuated 7-liter aluminum cylinder.

Date : 12-12-88
Client : CM&E INTERNATIONAL

SUMMARY OF REPORT

	SCRUBBER INLET	SCRUBBER OUTLET
FLUE GAS :		
Temperature, °F	80	78
Velocity, ft/sec (Thro orifice)	26.9	29.0
Static pressure, in. H_2O	-0.32	+0.31
Duct diameter, in.	6.0	6.0
Orifice diameter, in.	3.44	3.44
Orifice area, sq.ft	0.065	0.065
Gas volume: ACFM	105	113
SCFM	102	110
DSCFM	99	107
Moisture, % by volume	2.5	2.7
CHROMIUM :		
Sample volume, DSCF	207.80	243.71
Concentration, ppmv:		
Total Cr	7.1	0.00037
Cr^{+6}	1.8	0.00046
Concentration, mg/m^3:		
Total Cr	15.6	0.00069
Cr^{+6}	3.9	0.00086
Emission rate, mg/hr:		
Total Cr	2,625	0.13
Cr^{+6}	656	0.16
Removal Efficiency, %:		
Total Cr	-	99.995
Cr^{+6}	-	99.98
INTEGRATED SAMPLE :		
Concentration, %		
Hydrogen (H_2)	0.1	0.1
Oxygen, (O_2)	21.3	21.0
Carbon dioxide (CO_2)	<0.1	<0.1

Respectfully submitted,
TRUESDAIL LABORATORIES, INC.

S. Hugh Brown, Supervisor
Air Pollution Testing