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.

AP42 Section:	11.3
Reference:	12
Title:	Source Emission Test At Belden Brick, Inc., Sugarcreek, OH, No. 1 Kiln, Plant 3, CSA Company, Alliance, OH, March 3, 1992.

AP-42 Section 11.3
Reference 12

CSA COMPANY

(Custom Stack Analysis)

ENGINEERING REPORT

SOURCE EMISSION TEST
AT
BELDEN BRICK, INC.
SUGARCREEK, OHIO
NO.1 KILN, PLANT 3
MARCH 3, 1992

TECHNICAL SERVICES FOR POLLUTION CONTROL

SOURCE TESTING - LAB SERVICE - BOILER CONSULTING

BELDEN BRICK,INC.,SUGARCREEK,OH,NO.1KILN,PLANT 3,MARCH 3,1992

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CSA CO., PO BOX 3750, ALLIANCE, OH 44601 PH (216)525-5119

FAX (216)525-7908

Permit limits

PM 4.20 #/hr

SO_2 6.60

NO_x 6.00

SOURCE EMISSION TESTS

AT

BELDEN BRICK INC.

SUGARCREEK, OHIO

NO.1 KILN,PLANT 3

MARCH 3,1992

Brief of Tests

Particulate emission tests were performed on the stack of the brick kiln as per EPA Federal Register methods 1 through 5,6 and 7 as set forth in the Appendix to Part 60, "Standards of Performance for stationary sources", Subchapter C, Chapter 1,Title 40, Volume 42, No.160, July 1,1988 as amended from the original Federal Register, Volume 36, No. 247, December 23, 1971.

The tunnel kiln is a continuos operation where the green product is loaded on cars that travel through the various heat zones and discharge as a finished product at the other end. The kiln is heated with natural gas with the proudcts of combustion and the emissions from the curring process discharging to a stack via induced draft fan.

Results

A) The particulate emission rate was 2.50 pounds per hour.

B) The sulfur dioxide emission rate was ~~2.29~~ 2.77 pounds per hour.

C) The nitrogen oxides emission rate was 2.29 pounds per hour.

D) The process weight rate was 15,660 pounds per hour.

Test Methods

A twelve point traverse was selected for the ~~thirty five~~ 44 inch square brick stack as per method 1. Each point was sampled for five minutes for a total test time of 60 minutes (See figure 1). The CO_2 and O_2 analysis were conducted by an orsat flue gas analyzer from an integrated sample taken at the test ports to provide data for method 3.

Method 5 was used to determine the particulate quantity, moisture determination by method 4 and gas velocity by method 2 using a Research Appliance Corp. "Stacksamplr".

The sulfur dioxide tests were performed by method 6.

The nitrogen oxides were determined by EPA method 7.

Particulate Test Apparatus

A schematic of the apparatus is shown in figure 2.

The dust laden gases were passed through a pyrex lined probe and heated glass cyclone separator bypass followed by a four inch filter holder containing Gelman Type A-E fiberglass filter media. The gases leaving the filter were cooled in a series of three impingers packed in ice. The first and third impinger were the modified Greenburg-Smith type and the second one was a standard Greenburg-Smith. The First and second impingers were filled with 100 ml of distilled water with the third one used as a dry trap. After leaving the dry trap, the gases passed through a "Drierite" column containing about 500 grams of calcium sulfate (CaS04) desicant to remove the remaining water vapor. The dry gas passed through the hose portion of the umbilical cord to a Research Appliance Corp. model 2343 "Stacksamplr" module. In the module the gas was moved through the system by a leakless air pump to a Rockwell 175-S dry test meter. The dry test meter exhausted to a calibrated orifice to measure the flow rate of the gases passing through the sampling apparatus. A type "S" pitot tube was attached to the sheath of the heated probe to measure the velocity head of the flue gases near the tip of the probe nozzle. The orifice pressure taps and the pitot tube were connected to a Dwyer dual 10 inch combination inclined well type manometer. One half of the manometer measured the orifice differential (Δ H) and the other half measured the flue gas velocity head (Δ P).

The temperature of the flue gas was measured by a type "K" thermocouple connected to a PyroMation digital temperature indicator.

The CO_2 and 0_2 were measured with a Burrell "Industro" Model B orsat from an integrated sample taken by withdrawing a constant flow rate of gas from the stack and injecting it into a Tedlar bag. This was done by drawing the gas through an in-stack filter via neoprene tubing to a condenser and condensate collector ahead of a leakless diaphragm vacuum-pressure pump. The pump discharged to the rotometer and the Tedlar bag. The apparatus is equipped with valves to by-pass the rotometer and bag when clearing the sample line as shown in figure 3.

Particulate Test Procedures

The probe, filter and glassware was assembled and leak tested in our lab before transporting to the job site. Three sets of equipment

were used. At the job site a preliminary pitot traverse was performed to select the proper nozzle size. The nozzles were measured with an inside vernier caliper and micrometer calibrated with a one inch micrometer standard.

The first and second impingers were filled with 100 ml of distilled water and the "Drierite" columns were connected just prior to elevating the probe into position.

After leak testing the apparatus at 10 inches of mercury the probe was inserted at the first sample point to start the test.

The isokinetic sampling rates were determined using a portable desk top computer programmed to calculate the proper ΔH setting at the flue gas temperature, pressure, density and the assumed moisture along with the temperature, ΔP and an assumed ΔH of the test module. The sampling rate (ΔH) can be determined in less than 5 seconds using this technique.

The apparatus was leak tested after the test was completed at a vacuum exceeding that encountered during the test.

The moisture content was determined from the amount of condensate collected in the impingers and the difference of the tare and gross weight of the "Drierite" desicant column. The desicant column was weighed on an Ohaus 5 Kg industrial lab balance to the nearest half gram.

The filter media was dried in a desicator at room temperature to dryness before tare and gross weighing on a Stanton CL4D analytical balance.

The probe liner, nozzle, cyclone bypass and front half of the filter holder were washed with acetone and brush after testing and evaporated to dryness at room temperature in 500 ml beakers. The beakers were dried and tare weighed prior to sample evaporation and gross weighed after allowing the samples to desicate to dryness. These weights were accomplished with the Stanton Balance.

The integrated gas sampler was started at the beginning of the method 5 test with about two cubic foot of gas collected in the tedlar bag at the end of the test. The sampling rate was maintained constant during the test by maintaining a constant reading on the rotometer.

The orsat analysis was performed on the gases contained in the

bag shortly after the test was completed.

Sulfur dioxide test apparatus and procedures.

A schematic of the test apparatus is shown in figure 4. The gases were drawn through a heated pyrex probe with a fiberglass wad attached to the sampling end of the probe. The probe was connected to the impinger train where it first passed through a midget bubbler containing 15 ml of 80% isopropyl alcohol. A wad of glass wool was packed in the top of the bubbler to collect any acid mist carryover. The gases then passed through two midget impingers,each containing 15 ml of 3% hydrogen peroxide solution followed by an empty midget impinger to collect the carryover from the preceeding impingers. The midget bubbler and impingers were contained in an ice bath to condense acid and water vapor. After leaving the dry trap the gases passed through a "Drierite" column containing about 500 grams of "Drierite" via rubber hose to remove the remaining water vapor. The dry gas was transmitted to the module through a "polyflow" tubing. In the module the gas was moved through the system by a leakless air pump connected to the rotometer to measure the gas flow rate and a Rockwell type "S" dry test meter to measure the gas volume. The dry test meter was equipped with a thermometer located in the top half of the gas meter to measure the temperature of the meter. The gas from the meter was discharged to the atmosphere.

Class "A" burrettes and pipets were used for the titrations in the lab analysis of the contents of the impingers.

The run was started shortly after the method 5 test was started and ran for twenty minutes. Two runs comprised one test.

The calculations are shown in Appendix I.

NOx Apparatus & Procedure

The NOx sampling apparatus is shown in figure 4. Prior to testing the absorbing solution was made by adding 2-8 ml of concentrated H_2SO_4 to 1 liter of deionized, distilled water. After mixing, 6 ml of 3 per cent H_2O_2 was added. This solution was made just prior to testing and was stored in a dark glass bottle away from sunlight. 25 ml of this solution was used for each test. Four tests were performed during of the three method 5 tests. The raw data and calculations are shown in Appendix II.

Before taking a sample the system was leak checked by evacuating the flask to the maximum vacuum and closing the valve to the pump with the three way stopcock left in the evacuate position and the one way stopcock open. The system was considered leak-free if the vacuum remained the same for a period of one minute. The reading indicated on the manometer was recorded along with the temperature of the flask.

The contents in the flask were shaken for at least five minutes after collecting the sample. The samples were contained in the flask for at least sixteen hours before transferring to plastic bottles. The flasks were rinsed twice with about five ml portions of distilled water that was added to the plastic bottle. The pH of the contents of the plastic bottle was adjusted to about ten with one normal sodium hydroxide. The bottles were marked and sealed for transport. The barometric pressures were obtained from the local airport and corrected for elevation.

NOx Lab Analysis

1) Spectrophotometer Calibration

The spectrophotometer was turned on and allowed to warm up for about one hour prior to calibrating with a didymium calibrating standard along with the procedures of standard practice for the Perkin-Elmer model 44 linear absorbance spectrophotometer.

A KNO_3 standard solution was made by dissolving 2.198 grams of KNO_3 in one liter of distilled deionized water in a 1,000 ml volumetric flask. Ten ml of this solution was dilluted to 100 ml in a 100 ml volumetric flask to use as a working standard where one ml is equal to 100 m-grams NO_2.

The spectrophotometer calibration factor was made by adding 0, 1,2,3 & 4 ml of the standard working solution to a series of five porcelain evaporating dishes along with 25 ml of the absorbing solution and 10 ml of distilled water. The pH of this solution was adjusted to about 10 by adding NaOH (1N) before evaporating to dryness on a steam bath. After drying and cooling 2 ml of phenoldisulfonic acid was added to the residue. One ml of distilled water and four drops of concentrated sulfuric acid was added and titurated throughly with a polyethylene policeman. This solution was stirred while being heated for about 3 minutes on the steam

bath. After cooling, 20 ml of distilled water was added and mixed well. Concentrated NH_4OH was added dropwise with constant stirring until the pH was 10 by pH paper. This solution was added to 100 ml volumetric flasks and dilluted to the mark with distilled water. The contents were mixed throughly before transferring a portion to the 25 x 105 mm round spectrophotometer cuvettes. The absorbance of each of the solutions was measured and recorded at 410 nm wave length using the O ml sample as the blank. The blank sample showed the same absorbance as the distilled water. The absorbance for each standard is shown on the data sheetin Appendix II.

2) Sample Analysis

All samples were returned with none of the liquid lost in transit. The contents of the plastic bottles were transfered to 50 ml volumetric flasks and rinsed twice with 5 mlportions of distilled water, then dilluted to the mark with distilled water and mixed throughly. A 25 ml aliquot was piped into the 250 ml porcelain evaporating dish and evaporated to dryness on the steam bath. Since there were no solids in the solution the remaining procedures were performed the same as the calibration standards.

The volume of the 2 liter sample flask was determined by filling the flask to the one way stopcock bore and emptying it into a graduated cyclinder for measurement. This was done with water at room temperature.

Miscellaneous

All raw data and calculations are shown in Appendix I.

The Intent to test notification is included in Appendix II.

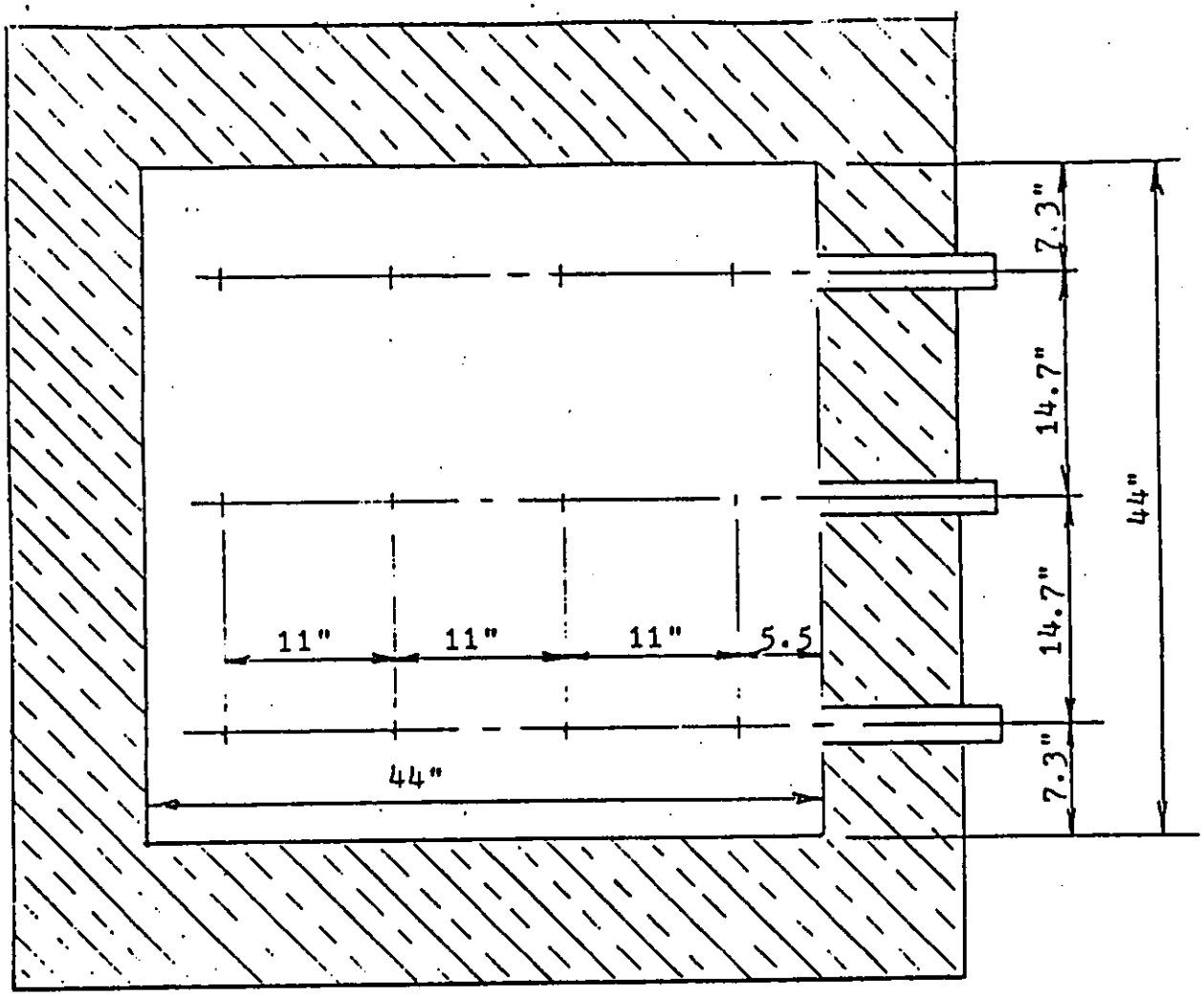
Submitted by

Ernest L.Kolm

Test	1	2	3	Average
Date	3/3/92	3/3/92	3/3/92	
Time	9:57/11:00	11:12/12:15	12:33/13:25	
PARTICULATE QUANTITY				
Grains/f3 Dry STP	0.0198	0.0153	0.0190	0.0180
Pounds/Hr.	2.8331	2.1060	2.5511	2.4967
GASEOUS EMISSIONS				
SO2 Pounds/Hr	2.79	2.87	2.48	2.71
SO2 Parts/Million	17.0	18.0	16.0	17.0
NOx Pounds/Hr	2.47	2.42	1.97	2.29
STACK GAS CONDITIONS				
Temperature -dg. F	402.0	429.0	397.0	409.3
Static Pressure-in H2O	0.00	0.00	0.00	0.00
CO2 - %	3.2	3.1	3.0	3.1
O2 - %	16.4	16.5	16.9	16.6
H2O - %	5.5	5.4	5.7	5.6
Velocity - FPS	36.62	36.40	34.34	35.79
Stack Area - sqr. ft.	13.40	13.40	13.40	13.40
Gas Flow - ACFM	29445	29266	27610	28774
Gas Flow (DSTP) CFH	998281	962687	939679	966882
SAMPLE TRAIN CONDITIONS				
Pitot Delta P in H2O	0.2510	0.2400	0.2220	
Orifice Delta P in H2O	1.51	1.61	1.44	
Temp. Meter - dg. F	78	95	98	
Gas Volume - CF Dry STP	39.24	39.61	38.66	
Barometer - in Hg	29.10	29.10	29.10	
Probe Tip Dia. - in.	.313	.313	.313	
Isokinetic Var. - %	99.0	103.6	103.6	

BELDEN BRICK,INC.
SUGARCREEK,OHIO
NO.1 KILN,PLANT 3
COMPILED DATA

Table 1

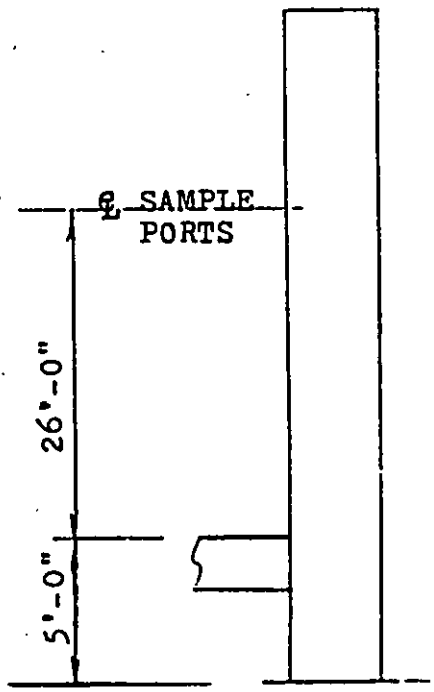


AREA = 13.4 f^2

EQUIVALENT DIA. = 44"

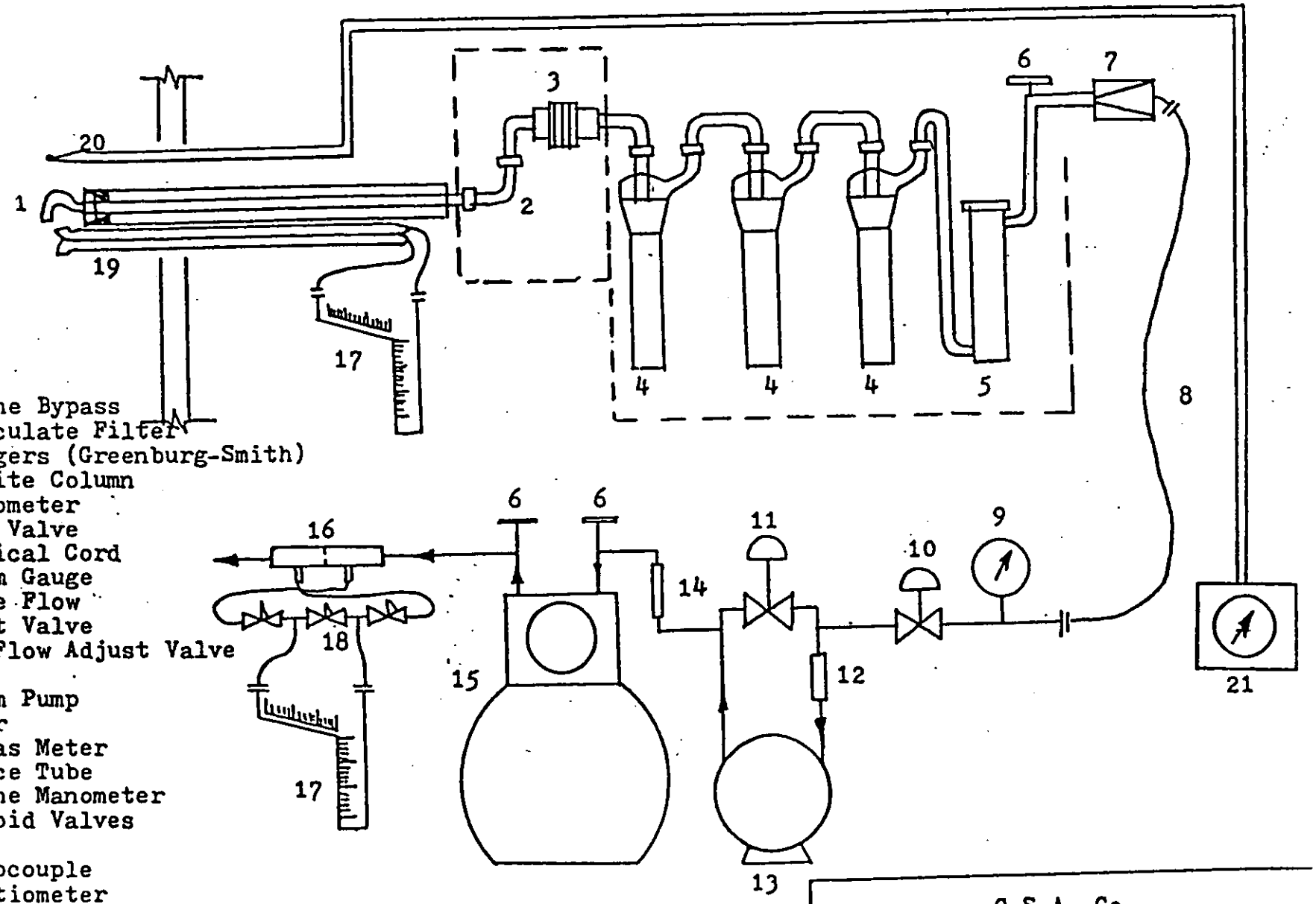
EQUIV. DIA. UPSTREAM = 7.1

EQUIV. DIA. DOWNSTREAM = 2+



BELDEN BRICK

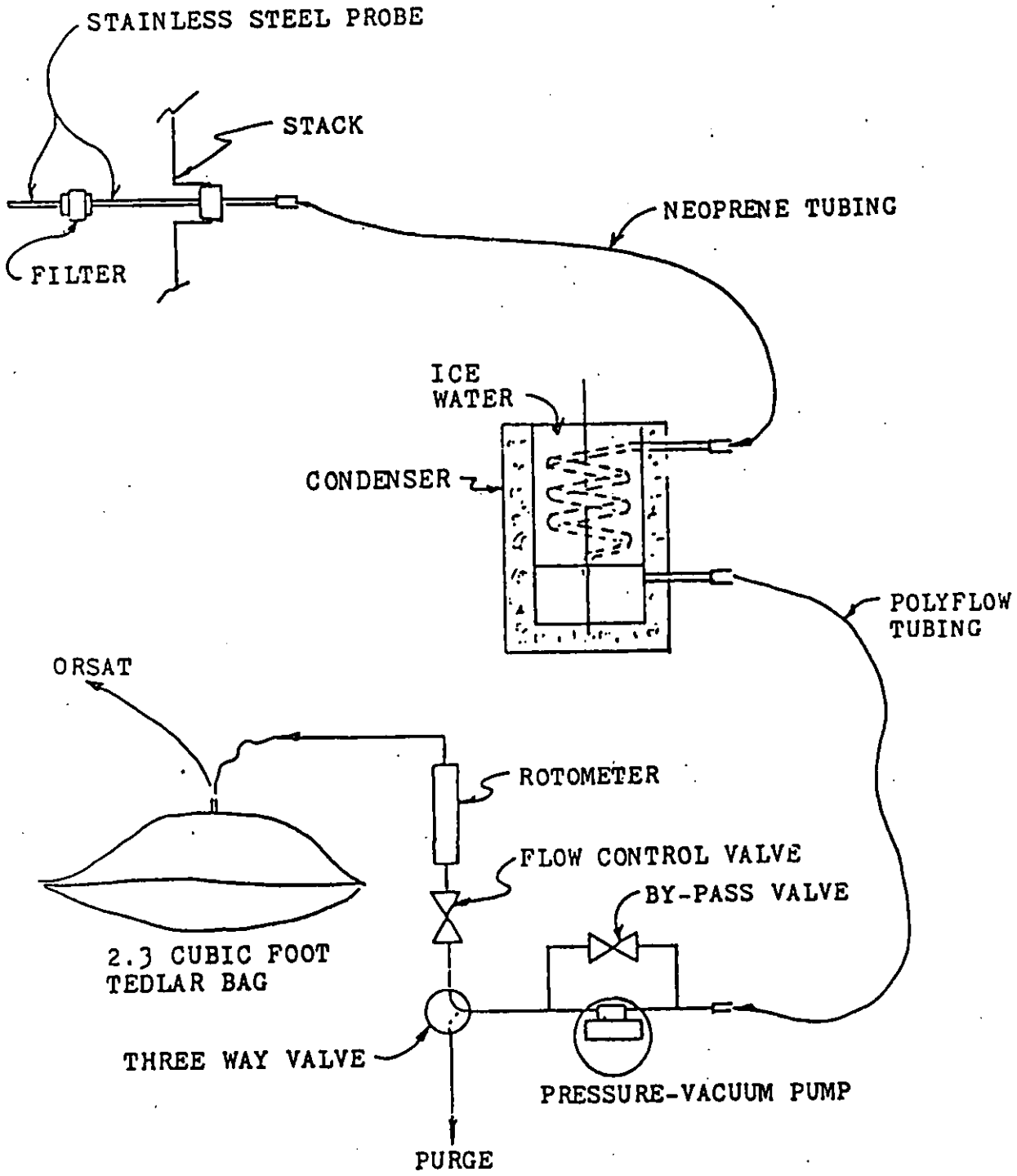
FIGURE 1



1) Probe
2) Cyclone Bypass
3) Particulate Filter
4) Impingers (Greenburg-Smith)
5) Drierite Column
6) Thermometer
7) Check Valve
8) Umbilical Cord
9) Vacuum Gauge
10) Course Flow Adjust Valve
11) Fine Flow Adjust Valve
12) Oiler
13) Vacuum Pump
14) Filter
15) Dry Gas Meter
16) Orifice Tube
17) Incline Manometer
18) Solenoid Valves
19) Pitot
20) Thermocouple
21) Potentiometer

C.S.A. Co.
MODIFICATION OF R.A.C. SAMPLE TR
USING DRIERITE COLUMN IN PLACE C
IMPINGER DESICANT

Figure 2



INTEGRATED SAMPLER

FIGURE 3

APPENDIX I

CSA CO.

COMPUTER NOMENCLATURE FOR CFR Method 5

SYMBOL	DESCRIPTION	UNITS
V_m	METER VOLUME	CUBIC FEET
Pbar	BAROMETER	INCHES MERCURY
ΔH	ORIFICE DIFERENTIAL	INCHES WATER
Pm	ABSOLUTE PRESSURE OF METER	INCHES MERCURY
tm	TEMPERATURE OF METER	°F
Tm	TEMPERATURE OF METER	°R
ts	TEMPERATURE OF STACK	°F
Ts	TEMPERATURE OF STACK	°R
Pg	STACK STATIC PRESSURE	INCHES WATER
Pga	ABSOLUTE STACK PRESURE	INCHES MERCURY
C	PITOT COEFFICIENT	DIMENSIONLESS
ΔP	PITOT DIFFERENTIAL	INCHES WATER
CO_2	CARBON DIOXIDE	PERCENT
O_2	OXYGEN	PERCENT
N_2	NITROGEN	PERCENT
CO	CARBON MONOXIDE	PERCENT
Md	MOLECULAR WEIGHT DRY	LB/LB-MOLE
Vlc	VOLUME OF CONDENSATE	MILLILITERS
As	AREA OF STACK	SQUARE FEET
Dn	DIAMETER OF NOZZLE	INCHES
An	AREA OF NOZZLE	SUARE FEET
Ms	MOLECULAR WEIGHT OF GAS WET	LB/LB-MOLE
Mn	TOTAL PARTICULATE CATCH	MILLIGRAMS
θ	TIME	MINUTES

CSA CO.

PARTICULATE CALCULATIONS FOR CFR METHOD 5

Dry Molecular Weight lb/lb-mole

$Md = 0.44\ (\%CO_2) + 0.32\ (\%O_2) + 0.28\ (\%N_2 + \%CO)$

Dry Gas Volume (standard conditions), ft^3

$V_{mstd} = 17.64 V_m Y (P_{bar} + \Delta H/13.6)/T_m$

Volume of Water (standard conditions), ft^3

$V_{wstd} = 0.04707\ V_{lc}$

Moisture Content (proportion by volume)

$B_{wo} = V_{wstd}/(V_{mstd} + V_{wstd})$

Molecular Weight of Stack Gas (wet basis), lb/lb-mole

$M_s = M_d(1-B_{wo}) + 18B_{wo}$

Stack Gas Velocity ft/sec

$V_s = 85.49 C_p \sqrt{\Delta P_{avg}} \sqrt{T_{s(avg)}/P_s M_s}$

Stack Gas Volumetric Fow Rate (dry standard conditions), ft^3/hr

$Q_s = 3600(1-B_{wo})\ V_s A_s (528/T_s avg)(P_{sa}/29.92)$

Concentration (particulate in gas), $lb/f^3{}_{std}$ dry

$C_s = 2.205 \times 10^{-6}\ M_n/V_{mstd}$

Load (particulate in stack gas), lb/hour

$L = Q_s C_s$

Concentration (particulate in gas), $grains/f^3{}_{std}$ dry

$C''_s = 0.0154 M_n V_{mstd}$

Isokinetic Variation, %

$I = 100 T_s [0.002669 V_{lc} + (V_m Y/T_m)(P_{bar} + \Delta H/13.6)]/60\theta V_s P_s A_n$

PUSH @ 9 30

12 30

3 30

---

8 CAR SCHEDULE

15660 #/HR

NEOPORD IN -

KINGSPRO OUT -

CSA CO. NO_X DATA SHEET

TEST	DATE	TIME	BAROMETER INITIAL	BAROMETER FINAL	FLASK VACUUM INITIAL	FLASK VACUUM FINAL	FLASK TEMP INITIAL	FLASK TEMP FINAL	FLASK VOLUME
1 A	3/3/92	9:50	29.10	29.06	27.0	.3	58	70	2040
1 B	"	10:10	29.1	29.06	27.0	.5	68	70	2090
2	"	12:15	29.1	29.06	27.0	.1	73	70	1953
3	"	13:25	29.1	29.06	27.0	.3	72	70	1951

SPECTROPHOTOMER CALIBRATION

ABSORBANCE OF ABSORBANT SOLUTION = 0

A1=ABSORBACE OF 100 g STD = .110

A2= " " 200 g " = .210

A3= " " 300 g " = .305

A4= " " 400 g " = .395

SAMPLE DILLUTION FACTOR = 1

A=SAMPLE ABSORBANCE

TEST	A	Q
1A	.035	998,281
1B	.037	998,281
2	.035	962,687
3	.029	939,679

Q FROM M-5 GAS FLOW CFM - DSTD

SEE COMPUTER CALCULATION SHEET FOR RESULTS

FOR BELDEN BRICK BY JCKGT

LOCATION NO 1 KILN PLANT 3

CSA CO. DATA SHEET (METHOD 5)

TEST NO. 1 PLANT BELDEN BRICK SUGARCREEK DATE 3/3/92

LOCATION NO 1 KILN STACK PLANT 3 BY ECR GT

BAROMETER (P_B) 29.10 AMBIENT TEMP ASSUMED MOISTURE "Y" 1.003

MOUDULE NO. 2031 PROBE NO. 1-5 FILTER NO. 3 HEATER NO. 3 NOZZLE DIA. 5/16

TEST POINT	METER VOLUME (Vm)	METER TEMP (Tm) IN	OUT	COND TEMP °F	FILTER HEATER TEMP °F	STACK TEMP °F (Ts)	STACK PRESS. (Ps)	VACUUM "Hg	ORIFICE "H_2O (ΔH) (Pm)	VEL HEAD (ΔP)	TIME
1	724.8	60	60	42	250	394	0	3-	.70	.13	9:57
1	727.2	64	60	42	248	393		3-	.70	.13	10:02
2	730.2	76	62	42	250	394		3-	1.1	.20	07
3	732.8	75	63	42	250	396		3-	1.1	.20	12
4	735.8	78	65	42	250	398		3-	1.2	.20	17
1	735.8	78	66	42	252	397		4-	1.6	.27	10:18
1	739.7	85	70	42	250	399		4-	1.6	.27	22
2	743.0	89	74	43	250	402		4	1.7	.28	28
3	746.5	91	76	46	250	405		4	1.7	.28	32
4	750.4	94	78	47	250	408		4	1.8	.29	38
1	750.4	92	78	48	248	409		4	1.7	.27	10:40
1	754.1	94	82	48	250	409		4	1.7	.27	45
2	757.7	95	83	48	252	412		4	1.9	.30	50
3	761.4	98	85	48	250	412		4+	2.0	.31	55
4	765.8	99	87	48	250	414		4+	2.1	.32	11:00
(Vm)	41.0	84.1	72.6								
AVERAGE		78		****	******	402	0	MAX 5	1.51	.251	60 MINUTES

INTEGRATED GAS SAMPLE	V 10			AVG
CO_2	3.3	3.2	3.4	3.2
O_2	16.5	16.4	16.4	16.4
CO				

N_2 = 80.4

CONDENSATE COLLECTED

	FINAL	INITIAL	TOTAL
DRIERITE	961.8	957.1	4.7
IMPINGER	243.9	200.0	43.9

FILTER WT	PROBE WASH WT	IMPINGER WASH WT	GRAND TOTAL 48.6
GROSS .6847	186.0298		LEAK RATE @ 10 "Hg = <.02
TARE .6637	186.0003	N/A	STACK AREA (As) 13.41 ft²
NET .0210	.0295		AVG SQ RT ΔP .5007

TOTAL PARTICULAT WT (Mn) 50.5 Mg

E.P.A. METHOD 5

DATA INPUT

Pb.In Hg	Barometer	29.10
VM.ft3	Meter Volume	41.0
ΔH.In H2O	Orifice Differential	1.51
PG.In H2O	Stack Static Pressure	0
Tm.F	Meter Temperture	78
Ts.F	Stack Temperture	402
CP	Pitot Coefficient	.84
$\sqrt{\Delta P}$,In H2O	Average Square Root Of Delta P	.5007
% CO2	Carbon Dioxide	3.2
% O2	Oxygen	16.4
% N	Nitrogen	80.4
VCL,Ml	Volume Of Condensate	48.6
AS.ft2	Stack Area	13.4
MN,Mg	Total Particulate Catch Weight	50.5
Ø,Min	Test Time	60
DN,In	Diameter Of Nozzle	.313

RESULTS

Pma,In Hg	Absolute Meter Pressure	29.21
PSA,In Hg	Absolute Stack Pressure	29.10
MD	Molecular Weight Dry Gas	29.17
MS	Molecular Weight @ Stack Conditions	28.55
VMSTP,ft3	VM Standard Temp.& Press. Dry	39.24
VWSTP,ft3	VM Standard Temp.& Press. Wet	2.29
BWO,%	Moisture	5.51
I.%	Isokeinetic Variation	99.00
VS.ft/Sec	Stack Velocity	36.62
QA,ASCFM	Stack Gas Flow (Actual)	29445
QS,ft3/HR	Stack Gas Flow (Dry STP)	998281
L,#/Hr	Emission Rate	2.83
CS,#/SCF	Particulate Emission	2.837957E-06
C''S,Grn/SCF	Particulate Emission	0.0198

BELDEN BRICK INC
SUGARCREEK OH
KILN 1 PLANT 3
3/3/92
TEST 1

CSA CO.

EPA METHOD 6 (SULFUR DIOXIDE) DATA AND CALCULATION SHEET

TEST NO 1-1 PLANT BELDEN BRICK DATE 3/3/92

LOCATION NO 1 KILN PLANT 3 BY [illegible]

Vm	Tm	ROTOMETER	TIME
123.370	56	3	9:55
3.620	59	3	10:00
3.835	59	3	10:05
4.068	62	3	10:10
4.267	64	3	10:15
3.370		—	20 min
Vm .897	avg 60		

Pb 29.10

$Vm_{std} = K_1\ Y(Vm)(Pb)/(Tm)$

Vm_{std} = 17.64 (1.001)(.897)(29.10)/(460 + 60) = .886

	1st TITRATION	2nd TITRATION	3rd TITRATION	AVERAGE	V_b TITRATION
Vt	17.9	17.9	—	2.8	.1

$Cso_2 = K_2(Vt - Vb)(N)(Va)/(Vm_{std})(Vsoln)$

= 0.00007061(17.9 - .1)(.0098)(20)/(.886)(.100)

= 2.78×10^{-6} lb/f^{3}DSTP

SO_2 PPM = $(Cso_2)(6.037 \times 10^{+6})$ = 16.8

SO_2 LB/HR = (Cso_2)(498,281 f^3/Hr DSTP*) = 2.77

SO_2 LB/mmBTU = SO_2 LB/HR / ~~mmBTU/HR~~ =

*FROM METHOD 5 CALCULATION "Q"

Cso_2 = Concentration of sulfur dioxide - lb/dry standard cubic foot
N = Normality of barium perchlorate titrant
Pb = Barometric pressure - inches Hg
Tm = Temperature of meter - °F
Va = Volume of sample aloquot - ml
Vm = Volume of gas at meter temperature and pressure - f^3
Vm_{std} = Vm corrected to standard temperature and pressure - f^3
Vsoln = Total volune of sample solution - ml
Vb = Volume of titrant used for blank - ml
Y = dry gas meter calibration factor - dimensionless
K_1 = 17.64
K_2 = 7.061×10^{-6}

(2)

CSA CO.

EPA METHOD 6 (SULFUR DIOXIDE) DATA AND CALCULATION SHEET

TEST NO 1-2 PLANT BELDEN BRICK DATE 3/3/92

LOCATION NO 1 KILN PLANT 3 BY [illegible]

Vm	Tm	ROTOMETER	TIME
124.267	66	3	10:30
4.485	68	3	35
4.797	71	3	40
4.989	74	3	45
5.160	76	3	50
4.267			
Vm .913	avg 71		

Pb 29.10

$Vm_{std} = K_1\ Y(Vm)(Pb)/(Tm)$

Vm_{std} = 17.64 (1.001)(.913)(29.10)/(460 + 71) = .8835

	1st TITRATION	2nd TITRATION	3rd TITRATION	AVERAGE	V_b TITRATION
Vt	18.0	18.0		18.0	.1

$Cso_2 = K_2(Vt - Vb)(N)(Va)/(Vm_{std})(Vsoln)$

= 0.00007061(18.0 - .1)(.0098)(20)/(.8835)(100)

= 2.864×10^{-6} lb/f^{3}DSTP

SO_2 PPM = $(Cso_2)(6.037 \times 10^{+6})$ = 16.93

SO_2 LB/HR = (Cso_2)(998,281 f^3/Hr DSTP*) = 2.80

SO_2 LB/mmBTU = SO_2 LB/HR / mmBTU/HR =

*FROM METHOD 5 CALCULATION "Q"

$\frac{2.77 + 2.80}{2}$ = 2.79 #/HR AVG

$\frac{16.8 + 16.93}{2}$ = 16.86 PPM AVG

Cso_2 = Concentration of sulfur dioxide - lb/dry standard cubic foot
N = Normality of barium perchlorate titrant
Pb = Barometric pressure - inches Hg
Tm = Temperature of meter - °F
Va = Volume of sample aloquot - ml
Vm = Volume of gas at meter temperature and pressure - f^3
Vm_{std} = Vm corrected to standard temperature and pressure - f^3
Vsoln = Total volune of sample solution - ml
Vb = Volume of titrant used for blank - ml
Y = dry gas meter calibration factor - dimensionless
K_1 = 17.64
K_2 = 7.061×10^{-6}

(1)

EPA METHOD 7
(NOx)

Barometer, Initial = 29.10	Inches Hg	(Pbi)
Flask Vacuum Initial = 27.00	Inches Hg	(Pfi)
Flask Temp. Initial = 58.0	Degrees F	(Tfi)
Barometer, Final = 29.06	Inches Hg	(Pbf)
Flask Vacuum Final = 0.30	Inches Hg	(Pbf)
Flask Temp. Final = 70.00	Degrees F	(Tff)
Flask Volume = 2040	Ml.	(Vf)

Pi = Pbi - Pfi = 2.10 Inches Hg Absolute
Ti = 460 + Tfi = 518 Temp. Absolute Degrees R
Pf = Pbf - Pff = 28.76 Inches Hg Absolute
Tf = 460 + Tff = 530 Temp. Absolute Degrees R

Vsc = 17.64 (Vf - 25ml.) ((Pf / Tf) - (Pi / Ti)) = ml. STP = 1784.7

Spectrophotometer Calibration Factor = Kc

A_1 = Absorbance of 100 ug Standard = .11
A_2 = Absorbance of 200 ug Standard = .21
A_3 = Absorbance of 300 ug Standard = .305
A_4 = Absorbance of 400 ug Standard = .395

$Kc = 100((A_1 + 2A_2 + 3A_3 + 4A_4) / (A_1^2 + A_2^2 + A_3^2 + A_4^2)) =$ 991.0

A = Absorbance Of Sample = 0.035 , F= Dilution Factor = 1.000
M = Total ug NO_2 Per Sample = 2 x Kc x A x F = 69.369

C = Sample Concentration = $6.243 \times 10^{-5} \times M / Vsc = 2.4265 \times 10^{-6}$

QS From Method 5 Or Gas Volume Calculation = 998281

C x QS = 2.422 LB/HR

BELDEN BRICK INC
SUGARCREEK OH
KILN 1 PLANT 3
3/3/92
TEST 1A

EPA METHOD 7
(NOx)

Barometer, Initial = 29.10	Inches Hg	(Pbi)
Flask Vacuum Initial = 27.00	Inches Hg	(Pfi)
Flask Temp. Initial = 68.0	Degrees F	(Tfi)
Barometer, Final = 29.06	Inches Hg	(Pbf)
Flask Vacuum Final = 0.50	Inches Hg	(Pbf)
Flask Temp. Final = 70.00	Degrees F	(Tff)
Flask Volume = 2090	Ml.	(Vf)

Pi = Pbi - Pfi = 2.10 Inches Hg Absolute
Ti = 460 + Tfi = 528 Temp. Absolute Degrees R
Pf = Pbf - Pff = 28.56 Inches Hg Absolute
Tf = 460 + Tff = 530 Temp. Absolute Degrees R

Vsc = 17.64 (Vf - 25ml.) ((Pf / Tf) - (Pi / Ti)) = ml. STP = 1818.0

Spectrophotometer Calibration Factor = Kc

A_1 = Absorbance of 100 ug Standard = .11
A_2 = Absorbance of 200 ug Standard = .21
A_3 = Absorbance of 300 ug Standard = .305
A_4 = Absorbance of 400 ug Standard = .395

$Kc = 100((A_1 + 2A_2 + 3A_3 + 4A_4) / (A_1^2 + A_2^2 + A_3^2 + A_4^2)) =$ 991.0

A = Absorbance Of Sample = 0.037 , F= Dilution Factor = 1.000
M = Total ug NO_2 Per Sample = 2 x Kc x A x F = 73.333

C = Sample Concentration = $6.243 \times 10^{-5} \times M / Vsc = 2.5182 \times 10^{-6}$

QS From Method 5 Or Gas Volume Calculation = 998281

C x QS = 2.514 LB/HR

$\frac{2.422 + 2.514}{2} = 2.47$ LB/HR AVG TEST 1

BELDEN BRICK INC
SUGARCREEK OH
KILN 1 PLANT 3
3/3/92
TEST 1B

CSA CO. DATA SHEET (METHOD 5)

TEST NO. 2 PLANT Belden Brick DATE 7/3/92

LOCATION No 1 Kiln PLANT 3 BY [illegible] GT

BAROMETER (P_B) 29.10 AMBIENT TEMP ASSUMED MOISTURE "Y" 1.003

MOUDULE NO. 2031 PROBE NO. 2-41 FILTER NO. 5 HEATER NO. 4 NOZZLE DIA. 5/16

TEST POINT	METER VOLUME (Vm)	METER TEMP (Tm) IN	METER TEMP (Tm) OUT	COND TEMP °F	FILTER HEATER TEMP°F	STACK TEMP °F(Ts)	STACK PRESS. (Ps)	VACUUM "Hg	ORIFICE "H_2O (ΔH) (Pm)	VEL HEAD (ΔP)	TIME
1	765.9	80	86	46	244	417	0	4	1.8	~~.24~~	11:12
1	769.5	96	88	46	246	418		4	1.8	.24	17
2	773.8	100	90	50	248	422		4+	2.0	.30	22
3	777.4	100	90	52	248	424		4-	2.1	.31	27
4	777.4	100	90	54	250	424		4-	2.1	.31	32
1	777.4	98	90	54	250	425		4-	1.8	~~.27~~	33
1	783.1	101	91	56	252	425		4-	1.8	.27	38
2	789.4	102	92	58	252	427		4-	1.7	.25	43
3	792.4	102	92	58	250	429		4-	1.7	.25	48
4	796.1	102	92	58	250	431		4-	1.7	.25	53
1	796.1	97	92	54	250	432		3	1.0	~~.15~~	55
1	799.0	100	92	54	250	436		3	1.0	.15	12:00
2	802.1	98	92	52	250	440		3+	1.2	.18	05
3	805.3	100	92	50	250	441		3+	1.2	.18	10
4	808.6	100	92	50	250	443		3+	1.2	.18	15
(Vm)	42.7	99.1	90.7								
AVERAGE		95		****	******	429	0	MAX 5	1.61	.240	60 MINUTES

INTEGRATED GAS SAMPLE				AVG
CO_2	3.1	3.1		3.1
O_2	16.5	16.5		16.5
CO				

N_2 = 80.4

CONDENSATE COLLECTED	FINAL	INITIAL	TOTAL
DRIERITE	967.2	962.3	4.9
IMPINGER	243.6	200.0	43.6

FILTER WT	PROBE WASH WT	IMPINGER WASH WT	GRAND TOTAL 48.5
GROSS .6399	181.6356	[illegible]	LEAK RATE @10 "Hg= <.02
TARE .6657	181.6199		STACK AREA (As) 13.4 ft²
NET .0242	.0151		AVG SQ RT ΔP .4900

TOTAL PARTICULAT WT (Mn) 39.3 Mg

E.P.A. METHOD 5

DATA INPUT

Pb.In Hg	Barometer	29.10
VM.ft3	Meter Volume	42.7
ΔH.In H20	Orifice Differential	1.61
PG.In H20	Stack Static Pressure	0
Tm.F	Meter Temperture	95
Ts.F	Stack Temperture	429
CP	Pitot Coefficient	.84
√ΔP.In H20	Average Square Root Of Delta P	.4900
% CO2	Carbon Dioxide	3.1
% O2	Oxygen	16.5
% N	Nitrogen	80.4
VCL.Ml	Volume Of Condensate	48.5
AS.ft2	Stack Area	13.4
MN.Mg	Total Particulate Catch Weight	39.3
Ø.Min	Test Time	60
DN.In	Diameter Of Nozzle	.313

RESULTS

Pma.In Hg	Absolute Meter Pressure	29.22
PSA.In Hg	Absolute Stack Pressure	29.10
MD	Molecular Weight Dry Gas	29.16
MS	Molecular Weight @ Stack Conditions	28.55
VMSTP.ft3	VM Standard Temp.& Press. Dry	39.61
VWSTP.ft3	VM Standard Temp.& Press. Wet	2.28
BWO.%	Moisture	5.45
I.%	Isokeinetic Variation	103.64
VS.ft/Sec	Stack Velocity	36.40
QA.ASCFM	Stack Gas Flow (Actual)	29266
QS.ft3/HR	Stack Gas Flow (Dry STP)	962687
L.#/Hr	Emission Rate	2.11
CS.#/SCF	Particulate Emission	2.187629E-06
C''S.Grn/SCF	Particulate Emission	0.0153

BELDEN BRICK INC
SUGARCREEK OH
KILN 1 PLANT 3
3/3/92
TEST 2

CSA CO.

EPA METHOD 6 (SULFUR DIOXIDE) DATA AND CALCULATION SHEET

TEST NO 2-1 PLANT BELDEN BRICK DATE 3/3/92

LOCATION No 1 KILN PLANT 3 BY RCK GY

Vm	Tm	ROTOMETER	TIME
125.5180	75	3	11:15
5.5381	76	3	20
5.679	79	3	25
5.820	80	3	30
5.969	83	3	35
5.180			
Vm .809	avg 79		

Pb 21.10

$Vm_{std} = K_1\ Y(Vm)(Pb)/(Tm)$

Vm_{std} = 17.64 (1.001)(.771)(29.10)/(460 + 79) = .7828

	1st TITRATION	2nd TITRATION	3rd TITRATION	AVERAGE	V_b TITRATION
Vt	17.6	17.7		17.65	.1

$Cso_2 = K_2(Vt - Vb)(N)(Va)/(Vm_{std})(Vsoln)$

= 0.00007061(17.65 - .1)(.0098)(20)/(.7828)(100)

= 3.1038×10^{-6} lb/f^{3}DSTP

SO_2 PPM = $(Cso_2)(6.037 \times 10^{-6})$ = 18.7

SO_2 LB/HR = (Cso_2)(962,687 f^3/Hr DSTP*) = 2.99

SO_2 LB/mmBTU = SO_2 LB/HR / mmBTU/HR = _____

*FROM METHOD 5 CALCULATION "Q"

Cso_2 = Concentration of sulfur dioxide - lb/dry standard cubic foot
N = Normality of barium perchlorate titrant
Pb = Barometric pressure - inches Hg
Tm = Temperature of meter - °F
Va = Volume of sample aloquot - ml
Vm = Volume of gas at meter temperature and pressure - f^3
Vm_{std} = Vm corrected to standard temperature and pressure - f^3
Vsoln = Total volune of sample solution - ml
Vb = Volume of titrant used for blank - ml
Y = dry gas meter calibration factor - dimensionless
K_1 = 17.64
K_2 = 7.061×10^{-6}

CSA CO.

EPA METHOD 6 (SULFUR DIOXIDE) DATA AND CALCULATION SHEET

TEST NO 2-2 PLANT BELDEN BRICK DATE 3/3/92

LOCATION NO 1 KILN PLANT 3 BY [illegible]

Vm	Tm	ROTOMETER	TIME
125.989	82	3	11:45
6.124	82	3	50
6.280	84	3	55
6.481	85	3	12:00
6.681	86	3	05
Vm .692	avg 84		

Pb 29.10

$Vm_{std} = K_1\ Y(Vm)(Pb)/(Tm)$

Vm_{std} = 17.64 (1.001)(.692)(29.10)/(460 + 84) = .6536

	1st TITRATION	2nd TITRATION	3rd TITRATION	AVERAGE	V_b TITRATION
Vt	13.6	13.6		13.6	.1

$Cso_2 = K_2(Vt - Vb)(N)(Va)/(Vm_{std})(Vsoln)$

= 0.00007061(13.6 - .1)(.0098)(20)/(.6536)(100)

= 2.8585×10^{-6} lb/f^{3}DSTP

SO_2 PPM = $(Cso_2)(6.037 \times 10^{+6})$ = 17.26

SO_2 LB/HR = (Cso_2)(962,687 f^3/Hr DSTP*) = 2.75

SO_2 LB/mmBTU = SO_2 LB/HR / mmBTU/HR =

$\frac{2.99 + 2.75}{2}$ = 2.87 LB/HR AVERAGE

$\frac{18.7 + 17.3}{2}$ = 18 PPM AVERAGE

*FROM METHOD 5 CALCULATION "Q"

Cso_2 = Concentration of sulfur dioxide - lb/dry standard cubic foot
N = Normality of barium perchlorate titrant
Pb = Barometric pressure - inches Hg
Tm = Temperature of meter - °F
Va = Volume of sample aloquot - ml
Vm = Volume of gas at meter temperature and pressure - f^3
Vm_{std} = Vm corrected to standard temperature and pressure - f^3
Vsoln = Total volune of sample solution - ml
Vb = Volume of titrant used for blank - ml
Y = dry gas meter calibration factor - dimensionless
K_1 = 17.64
K_2 = 7.061×10^{-6}

EPA METHOD 7
(NOx)

Barometer, Initial = 29.10	Inches Hg	(Pbi)
Flask Vacuum Initial = 27.00	Inches Hg	(Pfi)
Flask Temp. Initial = 73.0	Degrees F	(Tfi)
Barometer, Final = 29.06	Inches Hg	(Pbf)
Flask Vacuum Final = 0.10	Inches Hg	(Pbf)
Flask Temp. Final = 70.00	Degrees F	(Tff)
Flask Volume = 1953	Ml.	(Vf)

Pi = Pbi - Pfi = 2.10 Inches Hg Absolute
Ti = 460 + Tfi = 533 Temp. Absolute Degrees R
Pf = Pbf - Pff = 28.96 Inches Hg Absolute
Tf = 460 + Tff = 530 Temp. Absolute Degrees R

Vsc = 17.64 (Vf - 25ml.) ((Pf / Tf) - (Pi / Ti)) = ml. STP = 1724.4

Spectrophotometer Calibration Factor = Kc

A_1 = Absorbance of 100 ug Standard = .11
A_2 = Absorbance of 200 ug Standard = .21
A_3 = Absorbance of 300 ug Standard = .305
A_4 = Absorbance of 400 ug Standard = .395

$Kc = 100((A_1 + 2A_2 + 3A_3 + 4A_4) / (A_1^2 + A_2^2 + A_3^2 + A_4^2)) =$ 991.0

A = Absorbance Of Sample = 0.035 , F= Dilution Factor = 1.000
M = Total ug NO_2 Per Sample = 2 x Kc x A x F = 69.369

C = Sample Concentration = $6.243 \times 10^{-5} \times M / Vsc = 2.5115 \times 10^{-6}$

QS From Method 5 Or Gas Volume Calculation = 962687

C x QS = 2.418 LB/HR

BELDEN BRICK INC
SUGARCREEK OH
KILN 1 PLANT 3
3/3/92
TEST 2

CSA CO. DATA SHEET (METHOD 5)

TEST NO. 3 PLANT BELDEN BRICK DATE 3/3/92

LOCATION No 1 KILN PLANT 3 BY [illegible]

BAROMETER (P_B) 29.10 AMBIENT TEMP ASSUMED MOISTURE "Y" 1.003

MOUDULE NO. 2031 PROBE NO. 3-4 FILTER NO. 4 HEATER NO. 6 NOZZLE DIA. 5/16

TEST POINT	METER VOLUME (Vm)	METER TEMP (Tm) IN	METER TEMP (Tm) OUT	COND TEMP °F	FILTER HEATER TEMP°F	STACK TEMP °F (Ts)	STACK PRESS. (Ps)	VACUUM "Hg	ORIFICE "H_2O (ΔH) (Pm)	VEL HEAD (ΔP)	TIME
1	808.8	95	92	50	248	416	0	3	1.0	~~.15~~	12:23
1	812.0	98	92	50	248	446		3	1.0	.15	28
2	815.5	101	93	50	250	408		4	1.6	.25	33
3	818.2	100	94	48	250	391		3-	.62	.10	38
4	821.4	100	93	48	250	396		3+	1.3	.19	43
1	821.4	98	93	48	250	387		4-	1.6	~~.25~~	44
1	824.9	100	93	50	252	388		4-	1.6	.23	49
2	828.9	103	93	50	250	388		4-	1.5	.23	54
3	832.5	104	94	50	250	388		4-	1.5	.24	59
4	836.8	104	94	50	250	388		4-	1.5	.24	13:04
1	836.8	102	94	50	248	389		4-	1.5	~~.24~~	05
1	839.6	104	94	50	250	391		4-	1.5	.24	10
2	843.4	104	95	52	250	393		5-	1.8	.27	15
3	850.1	104	95	56	248	394		5-	1.8	.27	20
4	850.7	104	95	56	250	396		5-	1.6	.29	25
(Vm)	41.9	101.4	93.6								
AVERAGE		99		****	******	397	0	MAX 6	1.44	.222	60 MINUTES

INTEGRATED GAS SAMPLE				AVG
CO_2	3.0	3.0		3.0
O_2	16.9	16.9		16.9
CO				

N_2 = 80.1

CONDENSATE COLLECTED	FINAL	INITIAL	TOTAL
DRIERITE	970.7	963.9	6.8
IMPINGER	242.8	200.0	42.8
GRAND TOTAL			49.6

FILTER WT	PROBE WASH WT	IMPINGER WASH WT
GROSS .6850	188.5725	N/A
TARE .6645	188.5454	
NET .205	.0271	

LEAK RATE @ 11 "Hg = <.02

STACK AREA (As) 13.4 ft²

AVG SQ RT ΔP .4706

TOTAL PARTICULAT WT (Mn) 47.6 Mg

E.P.A. METHOD 5

DATA INPUT

Pb,In Hg	Barometer	29.10
VM,ft3	Meter Volume	41.9
ΔH,In H2O	Orifice Differential	1.44
PG,In H2O	Stack Static Pressure	0
Tm,F	Meter Temperture	98
Ts,F	Stack Temperture	397
CP	Pitot Coefficient	.84
√ΔP,In H2O	Average Square Root Of Delta P	.4706
% CO2	Carbon Dioxide	3.0
% O2	Oxygen	16.9
% N	Nitrogen	80.1
VCL,Ml	Volume Of Condensate	49.6
AS,ft2	Stack Area	13.4
MN,Mg	Total Particulate Catch Weight	47.6
Ø,Min	Test Time	60
DN,In	Diameter Of Nozzle	.313

RESULTS

Pma,In Hg	Absolute Meter Pressure	29.21
PSA,In Hg	Absolute Stack Pressure	29.10
MD	Molecular Weight Dry Gas	29.16
MS	Molecular Weight @ Stack Conditions	28.52
VMSTP,ft3	VM Standard Temp.& Press. Dry	38.66
VWSTP,ft3	VM Standard Temp.& Press. Wet	2.33
BWO,%	Moisture	5.69
I.%	Isokeinetic Variation	103.63
VS,ft/Sec	Stack Velocity	34.34
QA,ASCFM	Stack Gas Flow (Actual)	27610
QS,ft3/HR	Stack Gas Flow (Dry STP)	939679
L,#/Hr	Emission Rate	2.55
CS,#/SCF	Particulate Emission	2.714833E-06
C''S,Grn/SCF	Particulate Emission	0.0190

BELDEN BRICK INC
SUGARCREEK OH
KILN 1 PLANT 3
3/3/92
TEST 3

CSA CO.

EPA METHOD 6 (SULFUR DIOXIDE) DATA AND CALCULATION SHEET

TEST NO 3-1 PLANT BELDEN BRICK DATE 3/3/92

LOCATION NO 1 KILN PLANT 3 BY [illegible]

Vm	Tm	ROTOMETER	TIME
126.681	82	3	12:30
126.958	82	3	35
127.235	84	3	40
127.547	86	3	45
127.659	87	3	50
6.681			
Vm .978	avg 84		

Pb 29.10

$Vm_{std} = K_1\ Y(Vm)(Pb)/(Tm)$

Vm_{std} = 17.64 (1.001)(.978)(29.10)/(460 + 84) = .9238

	1st TITRATION	2nd TITRATION	3rd TITRATION	AVERAGE	V_b TITRATION
Vt	16.9	16.8		16.85	.1

$Cso_2 = K_2(Vt - Vb)(N)(Va)/(Vm_{std})(Vsoln)$

= 0.00007061(16.85 - .1)(.0099)(20)/(.9238)(100)

= 2.5093×10^{-6} lb/f^{3}DSTP

SO_2 PPM = $(Cso_2)(6.037 \times 10^{+6})$ = 15.15

SO_2 LB/HR = (Cso_2)(939,679 f^3/Hr DSTP*) = 2.36

SO_2 LB/mmBTU = SO_2 LB/HR / mmBTU/HR = _____

*FROM METHOD 5 CALCULATION "Q"

Cso_2 = Concentration of sulfur dioxide - lb/dry standard cubic foot
N = Normality of barium perchlorate titrant
Pb = Barometric pressure - inches Hg
Tm = Temperature of meter - °F
Va = Volume of sample aloquot - ml
Vm = Volume of gas at meter temperature and pressure - f^3
Vm_{std} = Vm corrected to standard temperature and pressure - f^3
Vsoln = Total volune of sample solution - ml
Vb = Volume of titrant used for blank - ml
Y = dry gas meter calibration factor - dimensionless
K_1 = 17.64
K_2 = 7.061×10^{-6}

CSA CO.

EPA METHOD 6 (SULFUR DIOXIDE) DATA AND CALCULATION SHEET

TEST NO 3-2 PLANT BELDEN BRICK DATE 3/3/91

LOCATION NO 1 KILN PLANT 3 BY [illegible]

Vm	Tm	ROTOMETER	TIME
127.659	84	3	13:02
7.890	86	3	07
8.120	88	3	12
8.326	89	3	17
128.531	90	3	22
1.629			
Vm .872	avg 87		

Pb 29.10

$Vm_{std} = K_1\ Y(Vm)(Pb)/(Tm)$

Vm_{std} = 17.64 (1.001)(.872)(29.10)/(460 + 87) = .8191

	1st TITRATION	2nd TITRATION	3rd TITRATION	AVERAGE	V_b TITRATION
Vt	16.4	16.4		16.4	.1

$Cso_2 = K_2(Vt - Vb)(N)(Va)/(Vm_{std})(Vsoln)$

= 0.00007061(16.4 - .1)(.0098)(20)/(.8191)(100)

= 2.7541×10^{-6} lb/f^{3}DSTP

SO_2 PPM = $(Cso_2)(6.037 \times 10^{+6})$ = 16.62

SO_2 LB/HR = (Cso_2)(939,679 f^3/Hr DSTP*) = 2.59

SO_2 LB/mmBTU = SO_2 LB/HR / mmBTU/HR =

$\frac{2.36 + 2.59}{2}$ = 2.48 LB/HR AVERAGE

*FROM METHOD 5 CALCULATION "Q"

$\frac{15.13 + 16.62}{2}$ = 15.9 PPM AVERAGE

Cso_2 = Concentration of sulfur dioxide - lb/dry standard cubic foot
N = Normality of barium perchlorate titrant
Pb = Barometric pressure - inches Hg
Tm = Temperature of meter - °F
Va = Volume of sample aloquot - ml
Vm = Volume of gas at meter temperature and pressure - f^3
Vm_{std} = Vm corrected to standard temperature and pressure - f^3
Vsoln = Total volune of sample solution - ml
Vb = Volume of titrant used for blank - ml
Y = dry gas meter calibration factor - dimensionless
K_1 = 17.64
K_2 = 7.061×10^{-6}

EPA METHOD 7
(NOx)

Barometer, Initial = 29.10	Inches Hg	(Pbi)
Flask Vacuum Initial = 27.00	Inches Hg	(Pfi)
Flask Temp. Initial = 72.0	Degrees F	(Tfi)
Barometer, Final = 29.06	Inches Hg	(Pbf)
Flask Vacuum Final = 0.30	Inches Hg	(Pbf)
Flask Temp. Final = 70.00	Degrees F	(Tff)
Flask Volume = 1951	Ml.	(Vf)

Pi = Pbi - Pfi = 2.10 Inches Hg Absolute
Ti = 460 + Tfi = 532 Temp. Absolute Degrees R
Pf = Pbf - Pff = 28.76 Inches Hg Absolute
Tf = 460 + Tff = 530 Temp. Absolute Degrees R

Vsc = 17.64 (Vf - 25ml.) ((Pf / Tf) - (Pi / Ti)) = ml. STP = 1709.5

Spectrophotometer Calibration Factor = Kc

A_1 = Absorbance of 100 ug Standard = .11
A_2 = Absorbance of 200 ug Standard = .21
A_3 = Absorbance of 300 ug Standard = .305
A_4 = Absorbance of 400 ug Standard = .395

$Kc = 100((A_1 + 2A_2 + 3A_3 + 4A_4) / (A_1^2 + A_2^2 + A_3^2 + A_4^2)) = 991.0$

A = Absorbance Of Sample = 0.029 , F= Dilution Factor = 1.000
M = Total ug NO_2 Per Sample = 2 x Kc x A x F = 57.477

C = Sample Concentration = $6.243 \times 10^{-5} \times M / Vsc = 2.0990 \times 10^{-6}$

QS From Method 5 Or Gas Volume Calculation = 939679

C x QS = 1.972 LB/HR

BELDEN BRICK INC
SUGARCREEK OH
KILN 1 PLANT 3
3/3/92
TEST 3

APPENDIX II

Agency Use Only
Date Received _____
No. Assigned _____
Premise No. _____

INTENT TO TEST NOTIFICATION

Proposed Test Date MARCH 3, 1992
Pre-Test Meeting Desired? Yes /_/ No /_/

A. Facility Information

Name BELDEN BRICK

Address PLANT 3 SUGARCREEK OH 44681

Contact Person JOHN JENSON

Telephone Number (216) 852-2424

B. Testing Firm Information

Name CSA CO. (CUSTOM STACK ANALYSIS)

Address 24385 CENTER ROAD, ALLIANCE, OH 44601

Contact Person ERNIE KOLM

Telephone Number (216) 525-5119

C. Source Sampling Information: Identify all sources and pollutants to be sampled.

Source	Control Equipment	Monitoring Equipment	Pollutant to be Tested	EPA Test Method	Filter Box Temperature	Number of Sampling Points	Total Time for Test Run	Number of Sampling Runs
BRICK KILN	—	—	PARTICULATE	5	250	12	60	3
			SO_2	6	—	2	20/RUN	6
			NO_x	7	—	2	GRAB	4

Any modifications to USEPA Reference Method(s)? Yes /_/ No /_/ ; If yes explain _____

Sampling Location(s): Inlet /_/ Outlet /✓/ Simultaneous /_/ Will cyclonic flow check(s) be conducted? Yes /_/ No /✓/

Fuel Sampling: Coal - Proximate /_/ Ultimate /_/ Other (specify) _____

Emission Rate to be calculated using: F-Factor /✓/ Ultimate Coal Analysis /_/ Other (specify) _____

Are concurrent Method 9 readings to be performed? Yes /_/ No /_/

D. Sample Train Calibration: All affected measuring and metering equipment should be calibrated within 60 days of the scheduled testing.

31

AIR POLLUTION SOURCE TESTING PHONE -216- 525-5119

CSA COMPANY

CUSTOM STACK ANALYSIS
24661 CENTER ROAD
P.O. BOX 2750
ROUTE 5
ALLIANCE, OHIO 44601

GENERAL

Source emission tests will be performed at BELDEN BRICK PLANT #3 on JULY 21, 198 with testing to commence at about 9100 O'clock — AM ____ PM as per INTENT TO TEST NOTIFICATION.

The sample train is a Research Appliance Corp modle 2043 using a PYREX lined probe heated to 250 °F. The filter media is A/E FIBERGLASS enclosed in pyrex holders heated to 250 °F. The contents of the impingers will be used for (a) — moisture determination only, (b) ____ moisture determination and particulate weight. The gas drying agent after the impingers is calcium sulfate contained in a "Drierite" desicant column. The probe and glassware will be washed using ACETONE & BRUSH. If impinger contents are used as part of the particulate weight, they will be dried by ____ at ____ °C. The test and analytical procedures used are as per latest FEDERAL EPA REGULATIONS AS WRITTEN IN THE FEDERAL REGISTER.

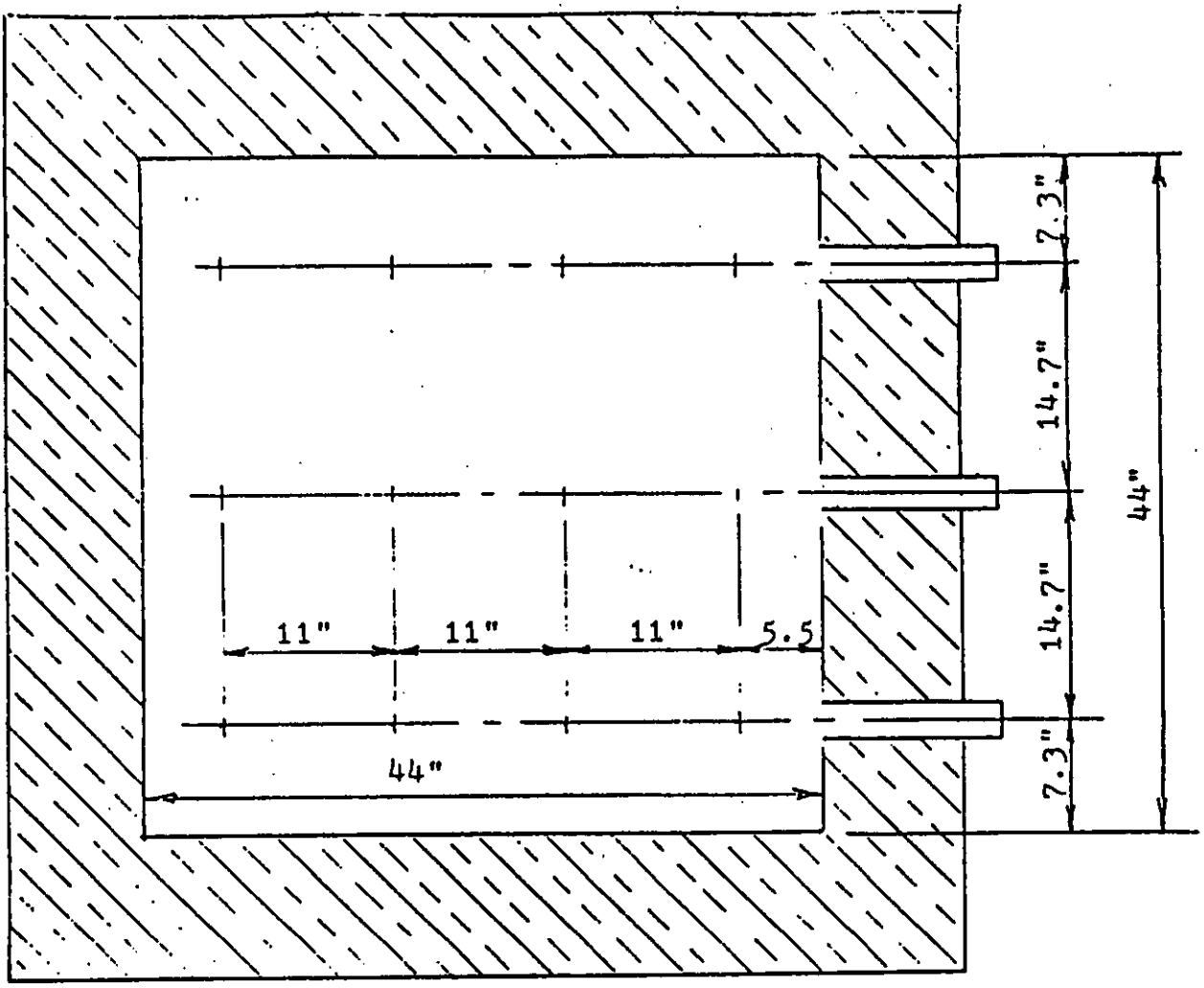
____ An equivalent emissions opacity test is requested

DESCRIPTION OF PLANT OPERATION

CONTINUOUS BRICK KILN

STACK AND VENT DESCRIPTION

SEE SKETCHES

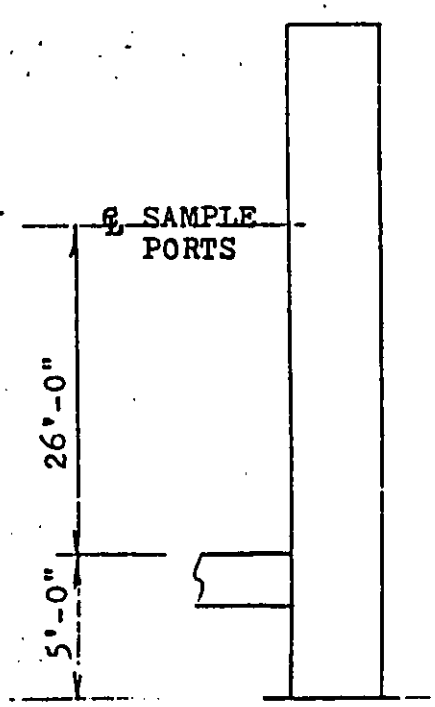


AREA = 13.4 f^2

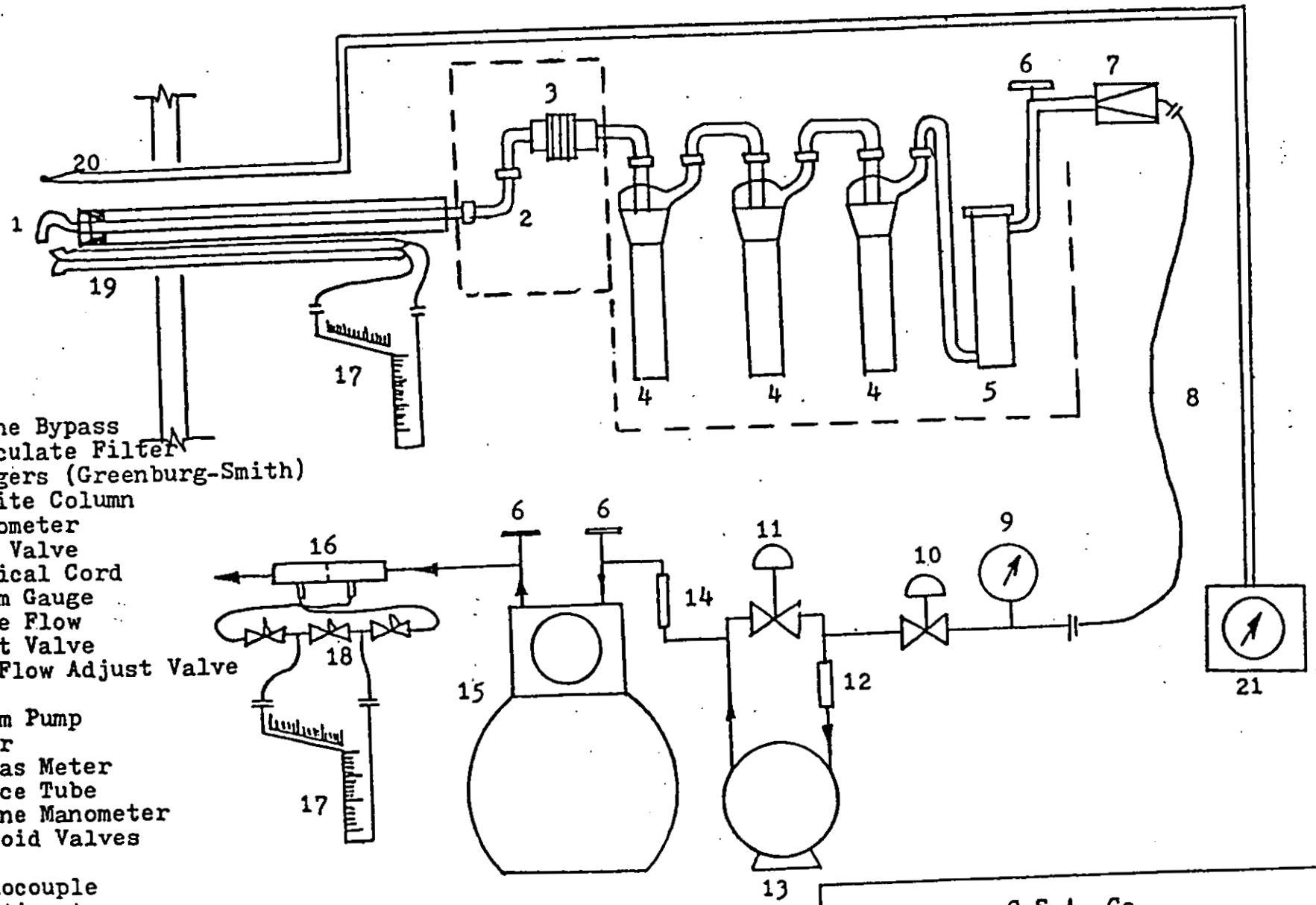
EQUIVALENT DIA. = 44"

EQUIV. DIA. UPSTREAM = 7.1

EQUIV. DIA. DOWNSTREAM = 2+



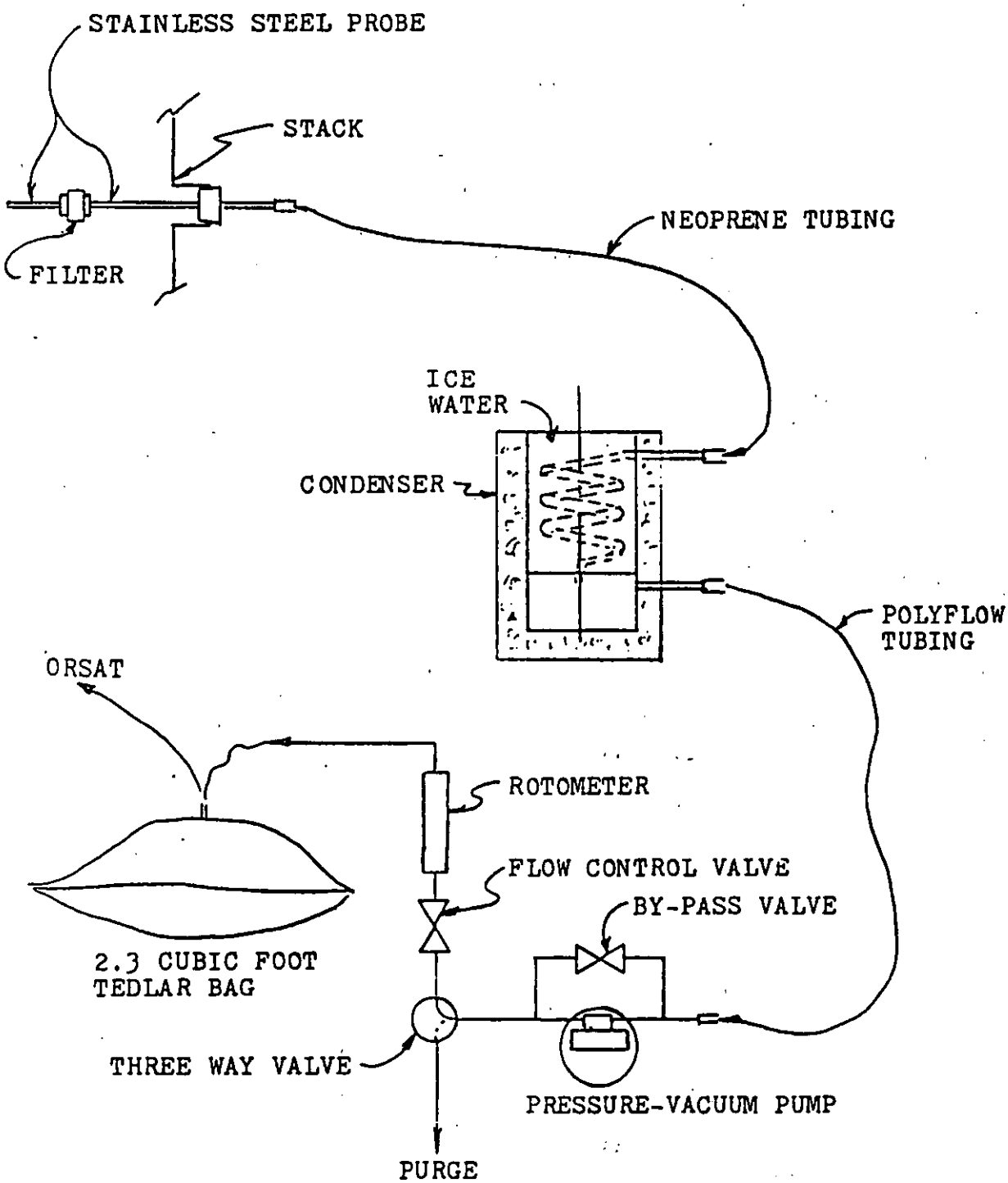
BELDEN BRICK



1) Probe
2) Cyclone Bypass
3) Particulate Filter
4) Impingers (Greenburg-Smith)
5) Drierite Column
6) Thermometer
7) Check Valve
8) Umbilical Cord
9) Vacuum Gauge
10) Course Flow Adjust Valve
11) Fine Flow Adjust Valve
12) Oiler
13) Vacuum Pump
14) Filter
15) Dry Gas Meter
16) Orifice Tube
17) Incline Manometer
18) Solenoid Valves
19) Pitot
20) Thermocouple
21) Potentiometer

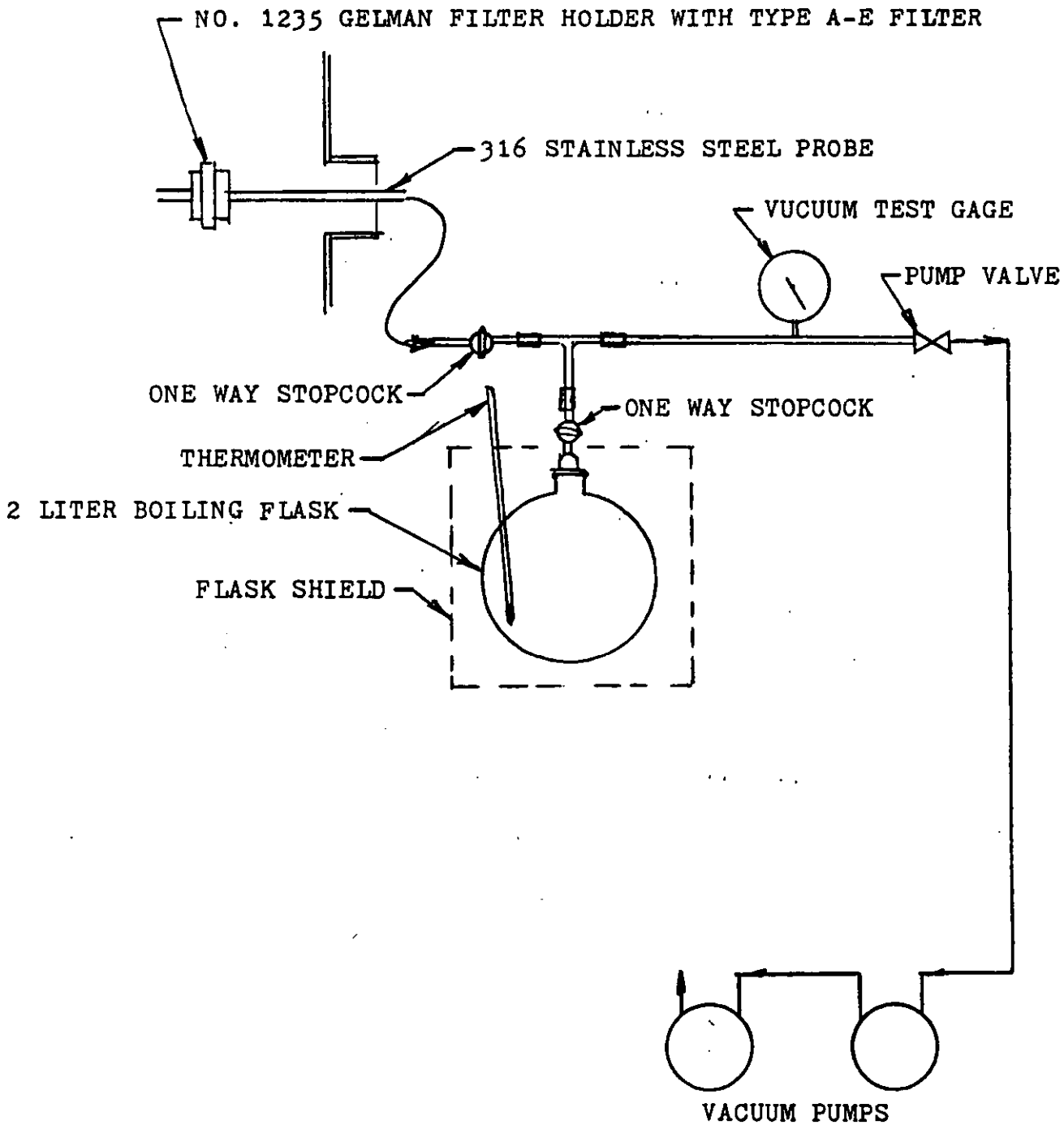
C.S.A. Co.
MODIFICATION OF R.A.C. SAMPLE TR
USING DRIERITE COLUMN IN PLACE O
IMPINGER DESICANT

Figure 2



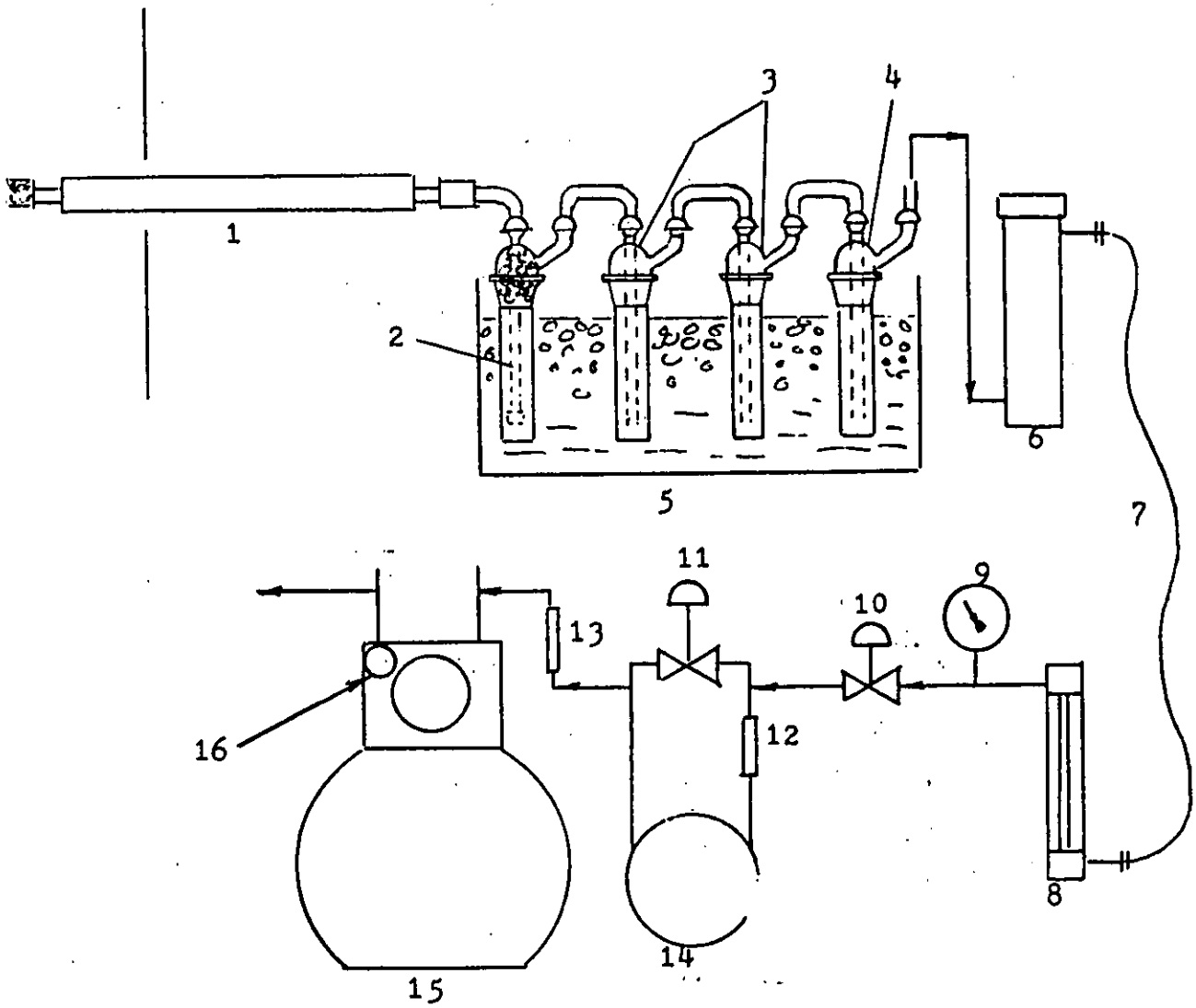
INTEGRATED SAMPLER

FIGURE 3



METHOD 7 NO_X SAMPLE APPARATUS

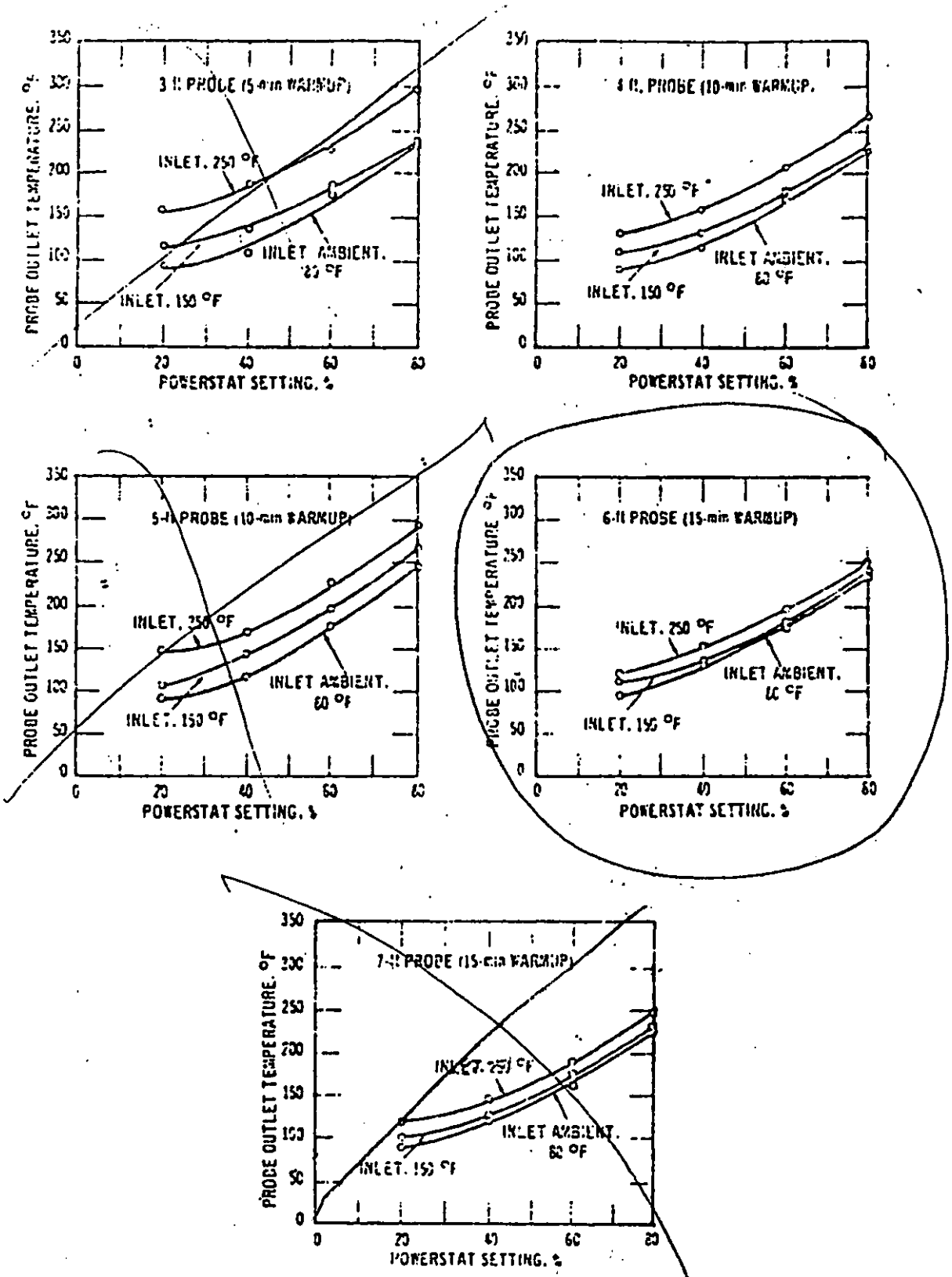
FIGURE 4



1) HEATED PYREX LINED PROBE. END PACKED WITH QUARTZ WOOL
2) MIDGET BUBBLER. TOP PAKED WITH GLASS WOOL
3) MIDGET IMPINGERS. EACH FILLED WITH 15 ml OF H_2O_2 (3%)
4) MIDGET IMPINGER. DRY TRAP
5) ICE BATH
6) DRIERITE COLUMN. FILLED WITH CALCIUM SULFATE DESICANT
7) UMBILICAL CORD
8) ROTAMETER
9) VACUUM GAGE
10) VALVE FOR COARSE FLOW ADJUSTMENT
11) VALVE FOR FINE FLOW ADJUSTMENT
12) OILER
13) OIL FILTER
14) VACUUM PUMP
15) DRY GAS TEST METER
16) THERMOMETER

E.P.A. METHOD 6 SO_2 SAMPLING TRAIN

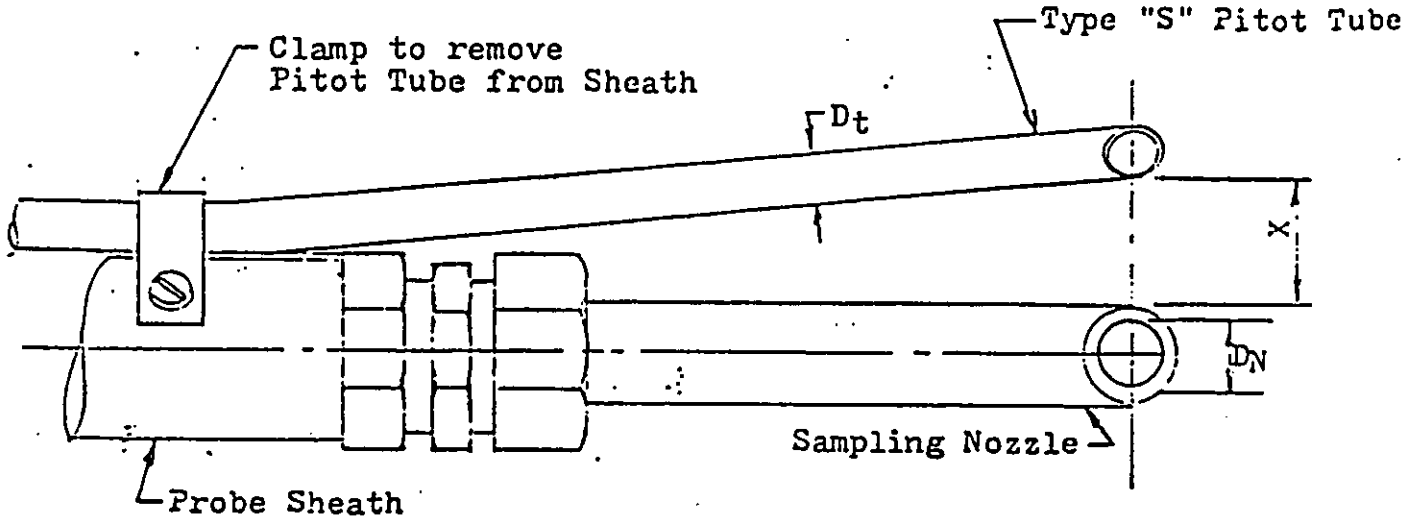
FIGURE 1



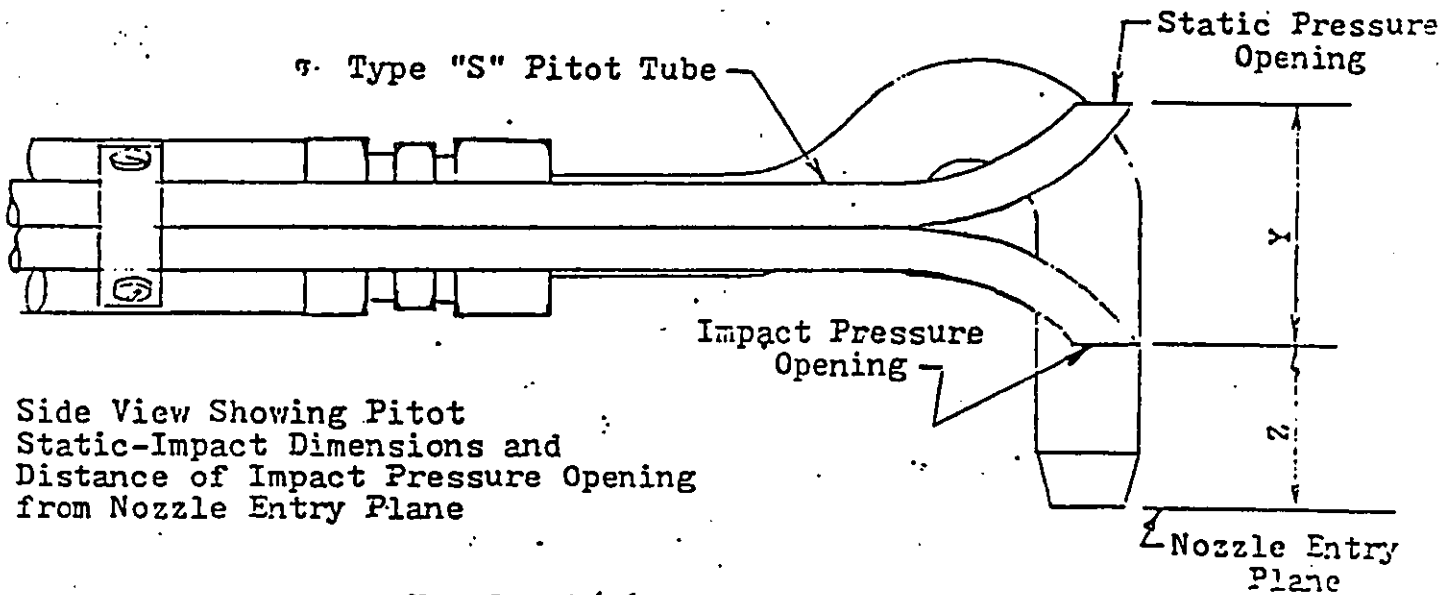
NOTE: Flow rate held constant at 0.75; 50% change in flow rate has little effect on probe temperature.

Figure 16

Probe Temperatures



Bottom View Showing Pitot-Nozzle Separation



Side View Showing Pitot
Static-Impact Dimensions and
Distance of Impact Pressure Opening
from Nozzle Entry Plane

X & Z 1/16" Tolerance

D_N - Inches (Nominal)	X	Y	Z	D_t
3/16	1	1 7/16	5/16	3/8
1/4	15/16	1 7/16	5/16	3/8
5/16	7/8	1 7/16	5/16	3/8
3/8	3/4	1 7/16	5/16	3/8
1/2	5/8	1 7/16	1/2	3/8

PITOT TUBE INTERFERENCE DIMENSIONS

CSA CO

EPA METHOD 6 (SULFUR DIOXIDE)

DATA AND CALCULATION SHEET

TEST NO._____ PLANT_____ DATE_____

LOCATION_____ BY_____

Pbar_____

Vm	Tmi	Tmo	ROTOMETER	TIME
Vm	Tm			

$$Vmstd = K_1 Y \frac{Vm\ Pb}{Tm}$$

$$Vmstd = 17.64 \left(\quad \right) \frac{(\quad)(\quad)}{(460 + \quad)} = \_\_\_\_\_$$

	1st TITRATION	2nd TITRATION	3rd TITRATION	AVERAGE	Vb TITRATION
Vt					

$$Cso_2 = K_2 \frac{(Vt - Vb)(N)\left(\frac{Vsoln}{Va}\right)}{Vmstd}$$

$$= .00007061 \frac{(\quad - \quad)(\quad)(\_\_\_\_\_)}{(\quad)} = \_\_\_\_\_ Lb/f^3DSTP$$

SO_2 (PPM) $= (Cso_2)(6.037)(10^6) = \_\_\_\_\_$

Lb SO_2/Hr = (f^3/HrDSTP)(Lb/f^3DSTP) = _____

Lb/MBTU =_____ Lb/Hr - _____ MBTU = _____

Cso_2 = Concentration of sulfur dioxide - lb/dry standard cubic foot
N = Normality of barium perclorate titrant
Pbar = Barometric pressure - inches Hg
Tmi = Temperature at meter inlet - °F
Tmo = Temperature at meter outlet - °F
Tm = Average meter temperature -°F
Va = Volume of sample aliquot titrated - ml
Vm = Dry gas volume as measured at meter - dcf
Vm(std) = Vm corrected to standard conditions - dscf
Vsoln = Total volume of sample solution - ml
Vt = Average volume of titrant used for sample aliquot - ml
Vb = Volume of titrant used for blank - ml
Y = Dry gas meter calibration factor
K_1 = 17.64 $K_2 = 7.061 \times 10^{-5}$

CSA CO. NO_x DATA SHEET

TEST	DATE	TIME	BAROMETER		FLASK VACUUM		FLASK TEMP		FLASK
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	VOLUME

SPECTROPHOTOMER CALIBRATION

ABSORBANCE OF ABSORBANT SOLUTION = 0

A1=ABSORBACE OF 100 g STD =_____

A2= " " 200 g " =_____

A3= " " 300 g " =_____

A4= " " 400 g " =_____

SAMPLE DILLUTION FACTOR =_____

A=SAMPLE ABSORBANCE

TEST	A

SEE COMPUTER CALCULATION SHEET FOR RESULTS

FOR_____ BY_____

LOCATION_____

C.S.A. Co.
STACKSAMPLR CALIBRATION SHEET

Customer _____ Order No. _____
Date 12/3/91 Serial No. 2031 RAC Order No. _____

Pump OK Pump Oil CHG Clean Quick Disconnects YES
Manometers CHG FLUID Dry Test Meter OK Thermometers CALIBRATED
Lights OOK Electrical Check OK Variac OK
Vacuum Gauge REPACED Leak Check @ 27" Hg Vacuum NO LEAKES
Remarks PRESSURE CHECK AT 9 IN. H2Ø-NO LEAKS

Barometer (Pb) 29.09

K	N	DH	CFw	CFd	Tw	ITd	OTd	TD	t	H	Y
.0158	.0368	0.5	5	5.05	70	75	72	74	12.84	1.891	0.996
.0317	.0737	1.0	5	5.03	70	77	73	75	9.06	1.886	1.001
.0634	.1470	2.0	10	10.04	70	79	74	76	12.85	1.893	1.002
.1268	.2490	4.0	10	10.11	70	85	81	83	9.12	1.882	1.005
.1902	.4310	6.0	10	10.09	70	89	81	85	7.48	1.899	1.004
.2536	.5880	8.0	10	10.09	70	91	82	86	6.47	1.891	1.001

Tolerances H=1.6-1.84-2.1 , Y=0.99-1.00-1.01 AVG 1.89[illegible] 1.002

$H=(K/(Pb(OTd+460)))*(((Tw+460)t)/CFw)^2$

Y=(CFw Pb (Td avg.+460))/(CFd (Pb+N) (Tw+460))

DH= Orifice pressure drop - in. H_2O
CFw= Volume wet test meter - f^3
CFd= Volume dry test meter - f^3
Tw= Temp. wet test meter
ITd= Inlet temperature dry test meter
OTd= Outlet temperature dry test meter
Td avg.= Average temperature dry test meter
t= Time - minutes
Pb=Barometer press.

DIAL THERMOMETER CALIBRATION		ICE WATER	BOILING WATER
Precision Lab Thermometer		32	211
Meter Thermometers		ITd 32 OTd 32	ITd 210 OTd 210
Impinger Outlet Thermometer	(1)	32	211
	(2)	32	211

STACK DIGITAL TEMPERATURE INDICATORS
NBS TRACABLE FROM FACTORY. 2 UNITS CALIBRATED AGAINST EACH OTHER(PyroMation)
ALL THERMOCOUPLES ARE CALIBRATED BY OVEN FROM 100 TO 500°F AGAINST A CMS LAB THERMOMETER (No. 227-934). ANY THERMOCOUPLE THAT IS MORE THAN ±2°F FROM STANDARD IS DISCARDED.

C.S.A. Co.
STACKSAMPLR CALIBRATION SHEET

Customer _____ Order No. _____
Date 2/29/92 Serial No. 2031 RAC Order No. _____

Pump OK Pump Oil CHG Clean Quick Disconnects YES
Manometers OK Dry Test Meter OK Thermometers OK
Lights OK Electrical Check OK Variac OK
Vacuum Gauge OK Leak Check @ 27" Hg Vacuum NO LEAKS
Remarks _____

Barometer (Pb) 28.96

K	N	DH	CFw	CFd	Tw	ITd	OTd	TD	t	H	Y
.0158	.0368	0.5	5	5.06	72	76	73	74	12.82	1.905	0.991
.0317	.0737	1.0	5	5.03	72	79	76	78	9.05	1.894	1.003
.0634	.1470	2.0	10	10.05	72	81	76	78	12.83	1.903	1.001
.1268	.2490	4.0	10	10.10	72	87	82	84	9.10	1.893	1.004
.1902	.4310	6.0	10	10.08	72	90	83	86	7.45	1.900	1.003
.2536	.5880	8.0	10	10.07	72	92	84	88	6.45	1.895	1.003

Tolerances H=1.6-1.84-2.1 , Y=0.99-1.00-1.01

$H=(K/(Pb(OTd+460)))*(((Tw+460)t)/CFw)^2$

Y=(CFw Pb (Td avg.+460))/(CFd (Pb+N) (Tw+460))

DH= Orifice pressure drop - in. H_2O
CFw= Volume wet test meter - f^3
CFd= Volume dry test meter - f^3
Tw= Temp. wet test meter
ITd= Inlet temperature dry test meter
OTd= Outlet temperature dry test meter
Td avg.= Average temperature dry test meter
t= Time - minutes
Pb=Barometer press.

DIAL THERMOMETER CALIBRATION		ICE WATER	BOILING WATER
Precision Lab Thermometer		32	211
Meter Thermometers		ITd 33 OTd 33	ITd 210 OTd 211
Impinger Outlet Thermometer	(1)	31	210
	(2)	33	212

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