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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.

Can and Bottle Filler Vent
Volatile Organic Compound Test
for
Coors Brewing Company

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Introduction

Air Pollution Testing, Inc. was contracted by Coors Brewing Company to conduct a series of source emissions tests on the can filler line and bottle filler line vents. Testing at each location was conducted to determine mass flow rates of volatile organic compounds. The testing was conducted on October 14, 1992.

Summary of Procedures

At each location, testing was conducted in accordance with EPA methods 1 through 4 and 25A as detailed in *Code of Federal Regulations, Title 40, Part 60, Appendix A*. Methods 1 through 4 were used to determine the volumetric air flows in the two ducts and method 25A was used to determine the concentrations of volatile organic compounds (VOCs). The data from all of the methods was then combined to calculate mass flow rates of VOCs at each location Additionally, data was collected on the total volume of beer processed at each location during the testing, and the data was used to calculate the lbs of VOCs per barrel of beer at each location.

Each one hour method 25A sampling period consisted of extracting a gas sample from the duct through a heated sample line and running it directly into the inlet port of a Model 3-100 Flame Ionization Analyzer manufactured by JUM. The organic concentration was displayed in real-time on the analyzer front panel and recorded on a strip chart. Before and after the sampling program, the analyzer was calibrated with a high level propane calibration gas and zero gas, and then challenged with a mid level propane calibration gas to verify linearity of response. Before and after each one hour sampling period, the analyzer was challenged with the mid level calibration gas and zero gas to quantify any analyzer span and zero drift for the previous period. Additionally, the analyzer was re-calibrated at this point as necessary. To ensure accurate data collection, all calibration gases were prepared and certified in accordance with EPA Protocol 1, and were introduced to the analyzer at the sampling probe tip at ambient pressure. Additionally, at both locations, a traverse of the duct was conducted with the analyzer sampling probe to ensure that no VOC concentration gradient existed which would bias the data as a function of probe placement within the duct. In both cases, no gradient was indicated by the data, and sampling was conducted at the approximate area centers of the ducts. The recorded data from each sampling period was averaged using 40 equally spaced points per one hour sampling period, with all data corrected for analyzer span and zero drift.

Concurrent with each VOC sampling period, a differential pressure and temperature traverse of the duct was conducted in accordance with method 2 at a grid of sampling points selected in accordance with method 1. Additionally, a gas sample was extracted from the duct and pulled through a series of chilled glass impingers and through a calibrated dry gas meter to determine the duct gas moisture content in accordance with method 4. The effluent gas from the method 4 sampling train was collected in a Tedlar gas bag and analyzed for oxygen and carbon dioxide using Orsat analysis in accordance with method 3. This data was combined to determine the volumetric flow rate in each of the ducts sampled.

Additional Notes

Because flame ionization analyzers do not respond perfectly to all organic species, it may be necessary to calibrate the analyzer with the specific organic compound or compounds present, if they are known. In this testing program, it was assumed that the dominant organic compound present was ethanol. In a previous VOC testing program conducted at Coors Brewing Company, a similar VOC analyzer was calibrated with ethanol and propane to determine an empirical constant for conversion of propane-calibrated VOC data to true ethanol values. The constant determined in this earlier program is assumed to be valid for analyzers employing similar detection technology, and is used in the current program. Consequently, where noted, the VOC data presented in this report have been corrected to ethanol using these two assumptions.

Results

The results of the testing are presented in the following tables. Any testing variables not presented here may be found in *Appendix 1 Testing Parameters / Sample Calculations.*

run #	1	2	averages
start time stop time	11:32 12:32	13:30 14:30	
stack temp. (°F)	72	72	72
stack moisture (vol. %)	1.24	1.98	1.61
gas velocity (ft/sec)	21.4	21.0	21.2
gas flow (acfm)	12352	12096	12224
gas flow (dscfm)	9970	9691	9830
volume beer (bbls)	519	605	562
VOC (ppm wet as propane)	42.2	52.1	47.2
VOC (lb/hr as propane)	2.93	3.62	3.27
VOC (lb/hr as ethanol)*	6.90	8.53	7.72
VOC (lb/bbl as ethanol)*	0.013	0.014	0.014

Table 1 - Bottle Filler Vent
VOC Testing Results
10-14-92

* - An empirical constant of 2.36 demonstrated in an earlier testing program was used to convert propane-calibrated analyzer data to ethanol. See Additional Notes (page 3) for more details.

Results (continued)

run #	1	2	averages
start time stop time	15:30 16:30	17:00 18:00	
stack temp. (°F)	75	75	75
stack moisture (vol. %)	1.11	1.29	1.20
gas velocity (ft/sec)	44.5	43.8	44.1
gas flow (acfm)	32306	31777	32041
gas flow (dscfm)	25932	25461	25697
volume beer (bbls)	1245	1108	1177
VOC (ppm wet as propane)	31.5	33.3	32.4
VOC (lb/hr as propane)	5.67	6.07	5.87
VOC (lb/hr as ethanol)*	13.38	14.33	13.86
VOC (lb/bbl as ethanol)*	0.011	0.013	0.012

Table 2 - Can Filler Vent
VOC Testing Results
10-14-92

* - An empirical constant of 2.36 demonstrated in an earlier testing program was used to convert propane-calibrated analyzer data to ethanol. See Additional Notes (page 3) for more details.

Appendix 1
Testing Parameters
Sample Calculations

Coors Brewing Company

Bottle Filler Vent

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EPA Methods 1-4 : Determination of Volumetric Flow Rate and Molecular Weight

Field Data	Run #1	Run #2	Averages
sample volume (ft3)	35.120	36.797	35.959
sampling time (minutes)	30	30	30
stack temp. (oF) (pre-test)	72	72	72
stack temp. (oF) (post-test)	72	72	72
meter temp. (oF)	77	94	86
barometric pressure (mbar)	834	834	834
barometric pressure (" Hg)	24.633	24.633	24.633
static press. (in. water) (pre-test)	0.03	0.04	0.04
static press. (in. water) (post-test)	0.03	0.04	0.04
moisture (grams)	8.0	13.0	10.5
oxygen (%)	20.9	20.9	20.9
carbon dioxide (%)	0.0	0.0	0.0
delta H	4.00	4.00	4.00
(delta p)^1/2 (pre-test)	0.3435	0.3359	0.3397
(delta p)^1/2 (post-test)	0.3435	0.3359	0.3397
meter box Y	1.0389	1.0389	1.0389
delta H@	1.683	1.683	1.683
pitot tube constant	0.84	0.84	0.84
stack diameter (inches)	42	42	42
port length (inches)	1.75	1.75	1.75
Calculations			
sample volume (dscf)	29.880	30.346	30.113
moisture volume (scf)	0.377	0.612	0.494
moisture content (%/100)	0.0124	0.0198	0.0161
molecular weight (dry)	28.836	28.836	28.836
molecular weight (actual)	28.701	28.622	28.661
gas velocity (ft/sec)	21.40	20.95	21.17
gas flow (acfm)	12352	12096	12224
gas flow (dscfm)	9970	9691	9830

Coors Brewing Company

Can Filler Vent

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EPA Methods 1-4 : Determination of Volumetric Flow Rate and Molecular Weight

Field Data	Run #1	Run #2	Averages
sample volume (ft3)	35.012	34.517	34.764
sampling time (minutes)	30	30	30
stack temp. (oF) (pre-test)	75	75	75
stack temp. (oF) (post-test)	75	75	75
meter temp. (oF)	85	87	86
barometric pressure (mbar)	833	833	833
barometric pressure (" Hg)	24.604	24.604	24.604
static press. (in. water) (pre-test)	0.03	0.03	0.03
static press. (in. water) (post-test)	0.03	0.03	0.03
moisture (grams)	7.0	8.0	7.5
oxygen (%)	20.9	20.9	20.9
carbon dioxide (%)	0.0	0.0	0.0
delta H	4.00	4.00	4.00
(delta p)^1/2 (pre-test)	0.7121	0.7002	0.7062
(delta p)^1/2 (post-test)	0.7121	0.7002	0.7062
meter box Y	1.0389	1.0389	1.0389
delta H@	1.683	1.683	1.683
pitot tube constant	0.84	0.84	0.84
stack diameter (inches)*	47.1	47.1	47
port length (inches)	1.25	1.25	1.25
Calculations			
sample volume (dscf)	29.316	28.796	29.056
moisture volume (scf)	0.329	0.377	0.353
moisture content (%/100)	0.0111	0.0129	0.0120
molecular weight (dry)	28.836	28.836	28.836
molecular weight (actual)	28.716	28.696	28.706
gas velocity (ft/sec)	44.49	43.77	44.13
gas flow (acfm)	32306	31777	32041
gas flow (dscfm)	25932	25461	25697

* - diameter of a round stack with area equal to duct cross-section area.

EPA Methods 1 - 4 : Determination of Volumetric Flow Rate and Molecular Weight

Sample Calculations

sample volume (dscf)

$= [17.64\ (^{\circ}R/in\ Hg)]V_mY[P_{bar} + (\Delta H/13.6)]/T_m$

$= (17.64\ ^{\circ}R/in\ Hg)(35.120\ ft^3)(1.0389)[24.633+(4.00/13.6)\ inches\ Hg]/(77+460\ ^{\circ}R)$

$= 29.880$ dscf

moisture volume (scf)

$= (0.04707\ ft^3/ml)V_{lc}$

$= (0.04707\ ft^3/ml)(8.0)$

$= 0.377$ scf

moisture content (%/100)

$= V_{w(std)}/(V_{m(std)} + V_{w(std)})$

$= (0.377\ scf)/(29.880\ dscf + 0.377\ scf)$

$= 0.0124$

molecular weight dry (grams/mole)

$= 0.440(\%CO_2) + 0.320(\%O_2) + 0.280(\%N_2 + \%CO)$

$= 0.440(0.0\ \%CO_2) + (0.320)(20.9\ \%O_2) + (0.280)(79.1\ \%N_2)$

$= 28.836$ grams/mole

molecular weight actual (grams/mole)

$= M_d(1 - B_{ws}) + 18.0(B_{ws})$

$= (28.836\ grams/mole)(1 - 0.0124) + (18.0)(0.0124)$

$= 28.701$ grams/mole

gas velocity (ft/sec)

$= \{85.49\ ft/sec\ [(lb/lb\text{-}mole)(in.\ Hg)/(^{\circ}R)(in.\ H_2O)]^{1/2}\}Cp(\Delta p^{1/2})_{avg}(T_{s(avg)}/P_sM_s)^{1/2}$

$= (85.49)(0.84)(0.3435)\{(72+460)/[(24.633+0.03/13.6)(28.701)]\}^{1/2}$

$= 21.40$ ft/sec

gas flow (acfm)

$= A_{vs}(60\ seconds/minute)$

$= (\Pi)(42/12\ ft)^2(21.40\ ft/sec)(60)/4$

$= 12352$ acfm

gas flow (dscfm)

$= (60\ seconds/minute)(1 - B_{ws})v_sAT_{std}P_s/(T_{s(avg)}P_{std})$

$= (60)(1-0.0124)(21.40)(\Pi)(42/12\ ft)^2(528)(24.633+0.03/13.6)/[(72+460)(29.92)(4)]$

$= 9970$ dscfm

EPA Methods 1 - 4 : Determination of Volumetric Flow Rate and Molecular Weight

Variables

A = Stack cross-sectional area (ft^2)
B_{ws} = Water vapor in the gas stream, proportion by volume
C_p = Pitot coefficient (0.84 dimensionless)
ΔH = Average pressure differential across the orifice meter (in. H_2O)
Δp = Velocity head of stack gas (in. H_2O)
M_d = Molecular weight of dry stack gas (lb/lb mole)
M_s = Molecular weight of wet stack gas (lb/lb mole)
P_{bar} = Barometric pressure (in. Hg)
P_g = Sack pressure relative to ambient (in. H_2O)
P_s = Absolute stack pressure (in. Hg)
P_{std} = Standard atmospheric pressure (29.92 in. Hg)
Q_a = Actual volumetric air flow out of stack (acfm)
Q_{std} = Volumetric air flow out of stack corrected to standard conditions (dscfm)
T_m = Average meter temperature (°F + 460 = °R)
$T_{s(avg)}$ = Average stack temperature (°F + 460 = °R)
T_{std} = Standard temperature (528 °R)
V_{lc} = volume of moisture collected from gas sample (ml)
v_s = Stack gas velocity (ft/sec)
V_m = Volume of gas through dry gas meter (ft^3)
$V_{m(std)}$ = Volume of gas through dry gas meter corrected to standard conditions (dscf)
$V_{w(std)}$ = Volume of water vapor in gas sample at standard conditions (scf)
Y = Dry gas meter calibration factor (dimensionless)
Q = Total sampling time (minutes)

Coors Brewing Company

Bottle Filler Vent

10-14-92

VOC Mass Emission Rates

Field Data

run #	1	2	Averages
start time	11:32	13:30	
stop time	12:32	14:30	
VOC conc. (ppm wet)	42.2	52.1	47.2
% H2O*	1.24	1.98	1.61
volumetric flow rate (dscfm)*	9970	9691	9831
bbls beer**	519	605	562

Calculations

VOC emissions (lb/hr as propane)	2.93	3.62	3.27
VOC emissions (lb/hr as ethanol)***	6.90	8.53	7.72
VOC emissions (lb/bbl as ethanol)	0.013	0.014	0.014

* - flow data was obtained from concurrent methods 1 - 4 traverses.

** - operating data was collected concurrently with sampling by Coors Brewing Company personnel.

*** - propane to ethanol conversion uses 2.36 empirical conversion factor obtained previously.

Coors Brewing Company

Can Filler Vent

10-14-92

VOC Mass Emission Rates

Field Data

run #	1	2	Averages
start time	15:30	17:00	
stop time	16:30	18:00	
VOC conc. (ppm wet)	31.5	33.3	32.4
% H2O*	1.11	1.29	1.20
volumetric flow rate (dscfm)*	25932	25461	25697
bbls beer**	1245	1108	1177

Calculations

VOC emissions (lb/hr as propane)	5.67	6.07	5.87
VOC emissions (lb/hr as ethanol)***	13.38	14.33	13.86
VOC emissions (lb/bbl as ethanol)	0.011	0.013	0.012

* - flow data was obtained from concurrent methods 1 - 4 traverses.

** - operating data was collected concurrently with sampling by Coors Brewing Company personnel.

*** - propane to ethanol conversion uses 2.36 empirical conversion factor obtained previously.

Coors Brewing Company

Bottle Filler Vent

10-14-92

Method 25A : Measurement of Total Organic Concentration Using a Flame Ionization Analyzer

Strip Chart Data

Run #1

		Zero (%FS)	Span (%FS)	Actual Span (ppm)
Start	11:32	0.0	38.5	40.1
Stop	12:32	-1.5	38.0	

point #	%FS VOC	ppm VOC	point #	%FS VOC	ppm VOC
1	49.0	51.2	21	39.0	40.9
2	48.0	50.1	22	42.0	44.0
3	47.0	49.1	23	39.0	40.9
4	50.0	52.2	24	37.0	38.8
5	40.0	41.9	25	40.0	41.9
6	35.0	36.8	26	44.0	46.0
7	36.0	37.8	27	44.0	46.0
8	35.0	36.8	28	48.0	50.1
9	35.0	36.8	29	38.0	39.8
10	35.0	36.8	30	40.0	41.9
11	34.0	35.7	31	47.0	49.1
12	37.0	38.8	32	43.0	45.0
13	34.0	35.7	33	46.0	48.1
14	31.0	32.6	34	41.0	42.9
15	30.0	31.6	35	39.0	40.9
16	22.0	23.4	36	45.0	47.0
17	18.0	19.3	37	46.0	48.1
18	40.0	41.9	38	48.0	50.1
19	48.0	50.1	39	48.0	50.1
20	47.0	49.1	40	48.0	50.1
averages:	37.5	39.4		43.1	45.1

Drift Cal. Avg. VOC (ppm as propane) 42.2

Coors Brewing Company

Bottle Filler Vent

10-14-92

Method 25A : Measurement of Total Organic Concentration Using a Flame Ionization Analyzer

Strip Chart Data

Run #2

		Zero (%FS)	Span (%FS)	Actual Span (ppm)
Start	13:30	0.0	40.0	40.1
Stop	14:30	-0.8	39.0	

point #	%FS VOC	ppm VOC	point #	%FS VOC	ppm VOC
1	51.0	51.7	21	53.0	53.7
2	52.0	52.7	22	53.0	53.7
3	52.0	52.7	23	52.0	52.7
4	47.0	47.6	24	52.0	52.7
5	47.0	47.6	25	52.0	52.7
6	50.0	50.7	26	53.0	53.7
7	47.0	47.6	27	53.0	53.7
8	49.0	49.6	28	55.0	55.7
9	48.0	48.6	29	55.0	55.7
10	47.0	47.6	30	53.0	53.7
11	46.0	46.6	31	55.0	55.7
12	51.0	51.7	32	53.0	53.7
13	50.0	50.7	33	53.0	53.7
14	53.0	53.7	34	51.0	51.7
15	54.0	54.7	35	50.0	50.7
16	53.0	53.7	36	49.0	49.6
17	52.0	52.7	37	49.0	49.6
18	53.0	53.7	38	52.0	52.7
19	53.0	53.7	39	53.0	53.7
20	54.0	54.7	40	51.0	51.7
averages:	50.5	51.1		52.4	53.0

Drift Cal. Avg. VOC (ppm as propane) 52.1

Coors Brewing Company

Can Filler Vent

10-14-92

Method 25A : Measurement of Total Organic Concentration Using a Flame Ionization Analyzer

Strip Chart Data

Run #3

		Zero (%FS)	Span (%FS)	Actual Span (ppm)
Start	15:30	0.0	40.0	40.1
Stop	16:30	0.0	39.0	

point #	%FS VOC	ppm VOC	point #	%FS VOC	ppm VOC
1	33.0	33.5	21	28.0	28.4
2	35.0	35.5	22	25.0	25.4
3	34.0	34.5	23	27.0	27.4
4	34.0	34.5	24	25.0	25.4
5	32.0	32.5	25	23.0	23.3
6	36.0	36.5	26	28.0	28.4
7	34.0	34.5	27	30.0	30.5
8	35.0	35.5	28	29.0	29.4
9	35.0	35.5	29	30.0	30.5
10	35.0	35.5	30	30.0	30.5
11	32.0	32.5	31	30.0	30.5
12	35.0	35.5	32	28.0	28.4
13	34.0	34.5	33	26.0	26.4
14	35.0	35.5	34	28.0	28.4
15	34.0	34.5	35	29.0	29.4
16	28.0	28.4	36	27.0	27.4
17	32.0	32.5	37	28.0	28.4
18	33.0	33.5	38	32.0	32.5
19	34.0	34.5	39	34.0	34.5
20	34.0	34.5	40	32.0	32.5
averages:	33.7	34.2		28.4	28.9

Drift Cal. Avg. VOC (ppm as propane) 31.5

Coors Brewing Company

Can Filler Vent

10-14-92

Method 25A : Measurement of Total Organic Concentration Using a Flame Ionization Analyzer

Strip Chart Data

Run #4

		Zero (%FS)	Span (%FS)	Actual Span (ppm)
Start	17:00	0.0	40.0	40.1
Stop	18:00	0.0	39.5	

point #	%FS VOC	ppm VOC	point #	%FS VOC	ppm VOC
1	33.0	33.3	21	34.0	34.3
2	34.0	34.3	22	29.0	29.3
3	33.0	33.3	23	33.0	33.3
4	34.0	34.3	24	34.0	34.3
5	35.0	35.3	25	33.0	33.3
6	34.0	34.3	26	33.0	33.3
7	34.0	34.3	27	34.0	34.3
8	34.0	34.3	28	33.0	33.3
9	34.0	34.3	29	34.0	34.3
10	32.0	32.3	30	34.0	34.3
11	35.0	35.3	31	33.0	33.3
12	30.0	30.3	32	30.0	30.3
13	34.0	34.3	33	31.0	31.3
14	34.0	34.3	34	28.0	28.2
15	34.0	34.3	35	33.0	33.3
16	32.0	32.3	36	31.0	31.3
17	32.0	32.3	37	33.0	33.3
18	32.0	32.3	38	34.0	34.3
19	33.0	33.3	39	34.0	34.3
20	34.0	34.3	40	34.0	34.3
averages:	33.4	33.6		32.6	32.9

Drift Cal. Avg. VOC (ppm as propane) 33.3

EPA Method 25A : Measurement of Total Organic Concentration Using a Flame Ionization Aanlyzer

Sample Calculations

drift cal. ppm as propane

= [(%FS analyzer stack value) - (%FS analyzer average 0 value)](span gas value ppm)
[(%FS analyzer average span value) - (%FS analyzer average 0 value)]

= (40.3 %FS) - [(0.0 %FS - 1.5 %FS) / 2](40.1 ppm)
[(38.5 %FS + 38.0 %FS) / 2]-[(0.0 %FS - 1.5 %FS)/2]

= 42.2 ppm VOC as propane

VOC emissions (lb/hr as propane)

= [avg. VOC conc. (ppm)][stack flow (dscfm)](60 min/hr)(28.317 liter/ft^3)(44.09 g/mole)(2.205 lb/kg)
(24.055 liters/mole @ STP)(1000 g/kg)(1x10^6)(1 - %H_2O/100)

= (42.2 ppm)(9970 dscfm)(60)(28.317)((44.09)(2.205)
(24.055)(1000)(1x10^6)(1 - 0.0124)

= 2.93 lb/hr VOC

VOC emissions (lb/hr as ethanol)

= [VOC emissions (lb/hr as propane)](2.36 empirical constant)

= (2.93 lb/hr)(2.36)

= 6.90

VOC emissions (lb/bbl as ethanol)

= [VOC emissions (lb/hr as ethanol)] / {[beer volume (bbl)] / [sampling time (hours)]}

= (6.90 lb/hr) / (519/1)

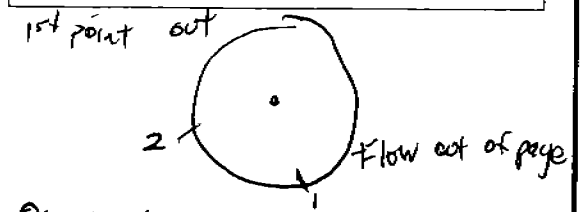
= 0.013 lb/bbl as ethanol

Appendix 2
Field Data

Plant	Coors Brewing Co
Date	10-14-92
Location	Golden, Co
Operator	RO/MM
Run Number	1
Pitot Tube Coefficient	.84
Sample Box ID#	/
Meter Box ID#	/
Meter ΔH@	1.683
C Factor	/
Pre-Test Pitot Leak Check	✓
Post-Test Pitot Leak Check	✓
Pre-Test Pump Leak Check	✓
Post-Test Pump Leak Check	✓

Air Pollution Testing, Inc.

Schematic of Stack Cross Section



D = 42" P = 1.75" A = 9.621

Measured 24.633 lbs

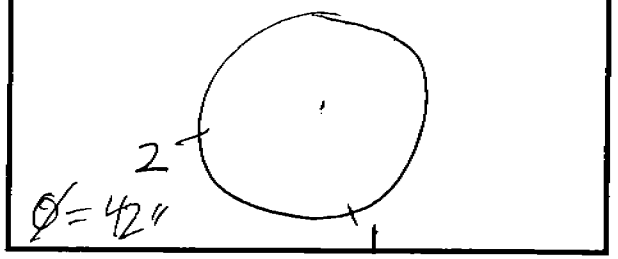
CO2 (%)	0.0	O2 (%)	20.8
Assumed Moisture (%)	1	Barometric Pressure (mbar)	834
Ambient Temperature (oF)	75	Probe Material	SS
Probe Length (ft)	4'	Filter Temperature (oF)	/
Probe Temperature (oF)	/	Moisture (grams)	8.0
Nozzle Diameter (in)	/	Start Time	
Static Pressure (in H2O)	+.03	Stop Time	
Filter ID#	/	Method	1-4

Traverse Point Number	Sampling Time (minutes)	Vacuum (in Hg)	Velocity Head (in H2O)	Pressure Differential (in H2O)	Gas Volume (ft3) Initial Volume 337.387	Stack Temp. (oF)	Probe Temp. (oF)	Filter Temp. (oF)	Gas Temp. Inlet (oF)	Gas Temp. Outlet (oF)	Condenser Temp. (oF)	Notes
1-1	10	2	.11	4.0	349.10	76			68	69		10:58 → 11:28 Moisture R1
2	20	2	.11	4.0	360.80	74			85	73		7.0 g + 1.0 ml
3	30	2	.12	4.0	372.507	73			90	76		
4			.12			73						~~dscfm = 9554~~
5			.13		35.120	72						
6			.12			72						Bwo = .012
7			.12			72						V_s = 21.4
8			.11			72						ACFM = 12352
2-1			.11			74						DSCFM = 9964
2			.12			73						Bottle Vent R1
3			.13			72						
4			.13			72						
5			.11			72						
6			.11			72						
7			.12			73			77			
8			.12			72						
			.3435			72						

Plant	Coors Brewing Co
Date	10-14-92
Location	Golden, CO
Operator	PD/MM
Run Number	2
Pitot Tube Coefficient	.84
Sample Box ID#	
Meter Box ID#	
Meter ΔH@	1.683
C Factor	
Pre-Test Pitot Leak Check	✓
Post-Test Pitot Leak Check	✓
Pre-Test Pump Leak Check	✓
Post-Test Pump Leak Check	✓

Air Pollution Testing, Inc.

Schematic of Stack Cross Section



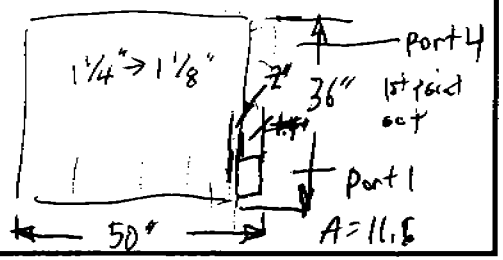
CO2 (%) 0.0 (Measured)	O2 (%) 20.8
Assumed Moisture (%)	Barometric Pressure (mbar) 834
Ambient Temperature (oF) 75	Probe Material SS
Probe Length (ft) 4	Filter Temperature (oF)
Probe Temperature (oF)	Moisture (grams) 13.0
Nozzle Diameter (in)	Start Time
Static Pressure (in H2O) +.04	Stop Time
Filter ID#	Method 1-4

Traverse Point Number	Sampling Time (minutes)	Vacuum (in Hg)	Velocity Head (in H2O)	Pressure Differential (in H2O)	Gas Volume (ft3) Initial Volume 372.707	Stack Temp. (oF)	Probe Temp. (oF)	Filter Temp. (oF)	Gas Temp. Inlet (oF)	Gas Temp. Outlet (oF)	Condenser Temp. (oF)	Notes
H1	10	3	.10	4.0	385.26	75			90	89		Bottle Vent R2
2	20	2	.10	4.0	397.80	72			101	89		Floor 2½
3	30	2	.10	4.0	409.504	71			104	91		
4			.11		36.797	71						Moisture R2 start 13:21
5			.11			71						4.0g 9.0mL
6			.11			71						
7			.11			71						
8			.11			72						
2-1			.10			73						
2			.12			72						
3			.14			72						
4			.13			72						
5			.11			72						
6			.11			72						
7			.12			71						
8			.13			71			94			
			.3359			72						

24.603 Hg

Plant	Coors Brewing Co	Date	10-14-92
Location	Golden, CO		
Operator	PO / MM		
Run Number	3	Pitot Tube Coefficient	.84
Sample Box ID#	~	Meter Box ID#	~
Meter ΔH@	1.683	C Factor	~
Pre-Test Pitot Leak Check	✓	Post-Test Pitot Leak Check	✓
Pre-Test Pump Leak Check	✓	Post-Test Pump Leak Check	✓

Air Pollution Testing, Inc.
Schematic of Stack Cross Section



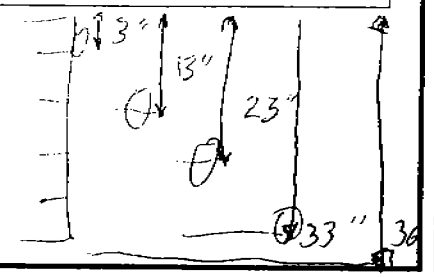
CO2 (%)	0.0	O2 (%)	20.9
Assumed Moisture (%)	1	Barometric Pressure (mbar)	833
Ambient Temperature (oF)	75	Probe Material	SS
Probe Length (ft)	4	Filter Temperature (oF)	
Probe Temperature (oF)	~	Moisture (grams)	7.0
Nozzle Diameter (in)	~	Start Time	
Static Pressure (in H2O)	.03	Stop Time	
Filter ID#	~	Method	1-4

Traverse Point Number	Sampling Time (minutes)	Vacuum (in Hg)	Velocity Head (in H2O)	Pressure Differential (in H2O)	Gas Volume (ft3) Initial Volume 409.503	Stack Temp. (oF)	Probe Temp. (oF)	Filter Temp. (oF)	Gas Temp. Inlet (oF)	Gas Temp. Outlet (oF)	Condenser Temp. (oF)	Notes
												48" × 34.8"
1-1	10	2	.22	4.0		75			~~78~~ 82	78		Moisture R1 3:51 → 4:21
2	20	2	.47	4.0		74			88	82		
3	30	2	.42	4.0	444.515	75			97	85		$\pi d^2 = L \times W$
4			.37			75						$\frac{\pi}{4}$ deg = ~~46.1~~
2-1			.44			75						
2			.57			75						48.75 × 35.75
3			.58			75						47.1 = deg
4			.77			75						
3-1			.40			75						Can Vent R1
2			.61			75						
3			.59			75						
4			.81			75						
4-1			.22			75						
2			.44			75						
3			.59		35.012	75			85			
4			.89			75						
			.7121			75						

Plant	COORS
Date	10-14-92
Location	GOLDEN
Operator	MJM
Run Number	4
Pilot Tube Coefficient	.84
Sample Box ID#	/
Meter Box ID#	/
Meter ΔH@	1.683
C Factor	/
Pre-Test Pitot Leak Check	✓
Post-Test Pitot Leak Check	✓
Pre-Test Pump Leak Check	✓
Post-Test Pump Leak Check	✓

Air Pollution Testing, Inc.

Schematic of Stack Cross Section



24.60 Hg

CO2 (%)	0.0
O2 (%)	20.9
Assumed Moisture (%)	1
Barometric Pressure (mbar)	833
Ambient Temperature (oF)	75
Probe Material	SS
Probe Length (ft)	4
Filter Temperature (oF)	/
Probe Temperature (oF)	/
Moisture (grams)	8.0
Nozzle Diameter (in)	/
Start Time	
Static Pressure (in H2O)	.03
Stop Time	
Filter ID#	/
Method	1-4

Traverse Point Number	Sampling Time (minutes)	Vacuum (in Hg)	Velocity Head (in H2O)	Pressure Differential (in H2O)	Gas Volume (ft3) Initial Volume 444.515	Stack Temp. (oF)	Probe Temp. (oF)	Filter Temp. (oF)	Gas Temp. Inlet (oF)	Gas Temp. Outlet (oF)	Condenser Temp. (oF)	Notes
1-1	10	3	.23		455.425	74			81	81		moisture < 1mL. +7g
1-2	20	2	.38		467.035	75			89	84		Can Vent R2
1-3	30	2	.33		479.032	75			99	86		
1-4			.36		(34.517)	75						
2-1			.48			75						
2-2			.62			75						
2-3			.64			75						
2-4			.72			75						
3-1			.37			75						
3-2			.63			75						
3-3			.76			75						
3-4			.79			75						
4-1			.17			75						
4-2			.27			75						
4-3			.56			75			(87)			
4-4			.82			75						
			(.7002)			(75)						

AIR POLLUTION TESTING, INC.

4535 West 68th Avenue • Westminster, CO 80030 (303) 426-0402 Fax (303) 426-1922

Client	Coors Brewing Co
Plant	Golden, Co
Date	10-14-92
Analyst	PO/AM

Location Bottle Vent Date 10-14	CO_2 0.0	$CO_2 + O_2$ 20.8	O_2 20.8
Run # 1	0.0	20.8	20.8
Notes Ambient assumed			
	0.0		20.8

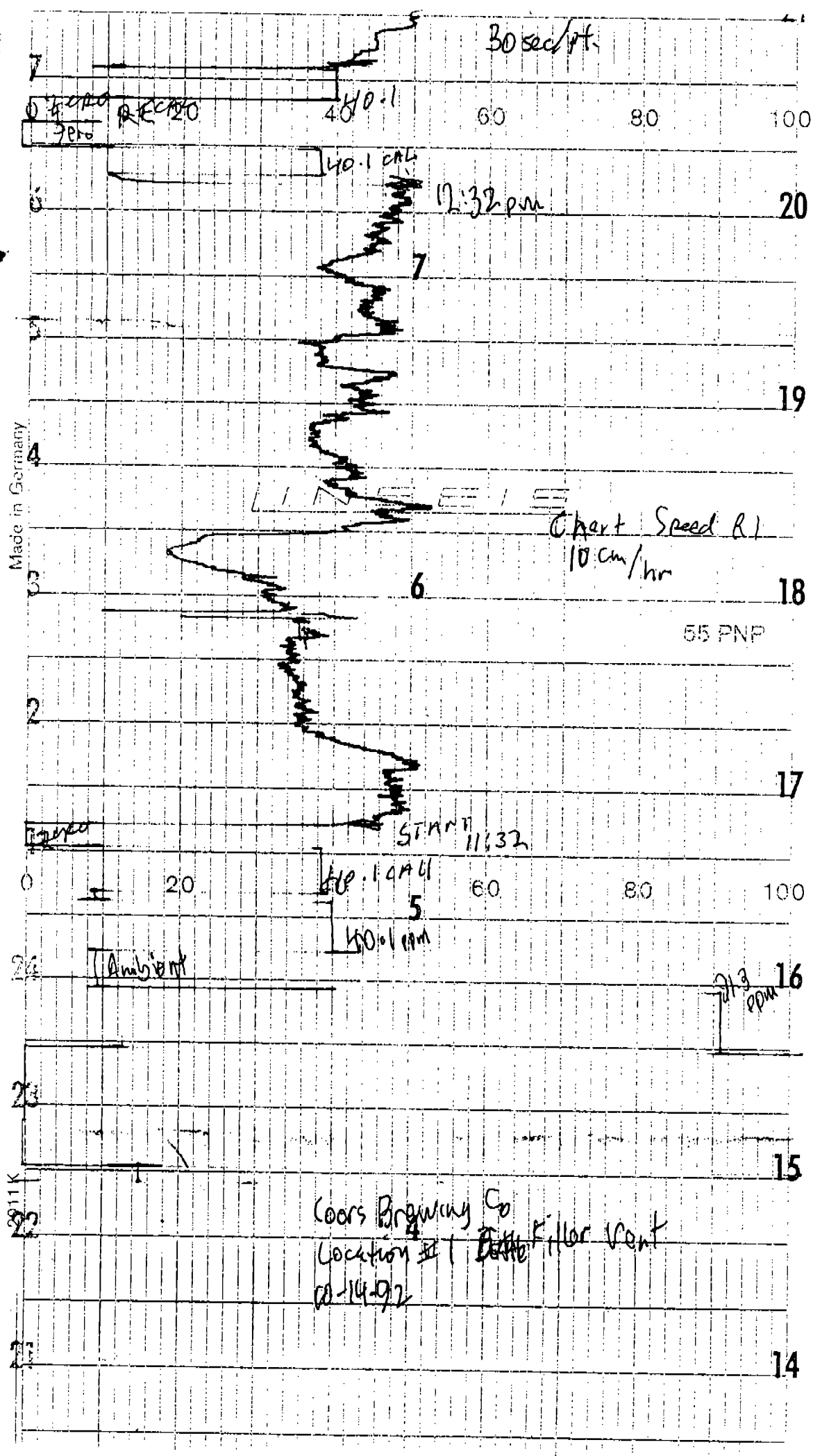
Location Bottle Vent Date 10-14	CO_2 0.0	$CO_2 + O_2$ 20.8	O_2 20.8
Run # 2	0.0	20.8	20.8
Notes Ambient assumed			
	0.0		20.8

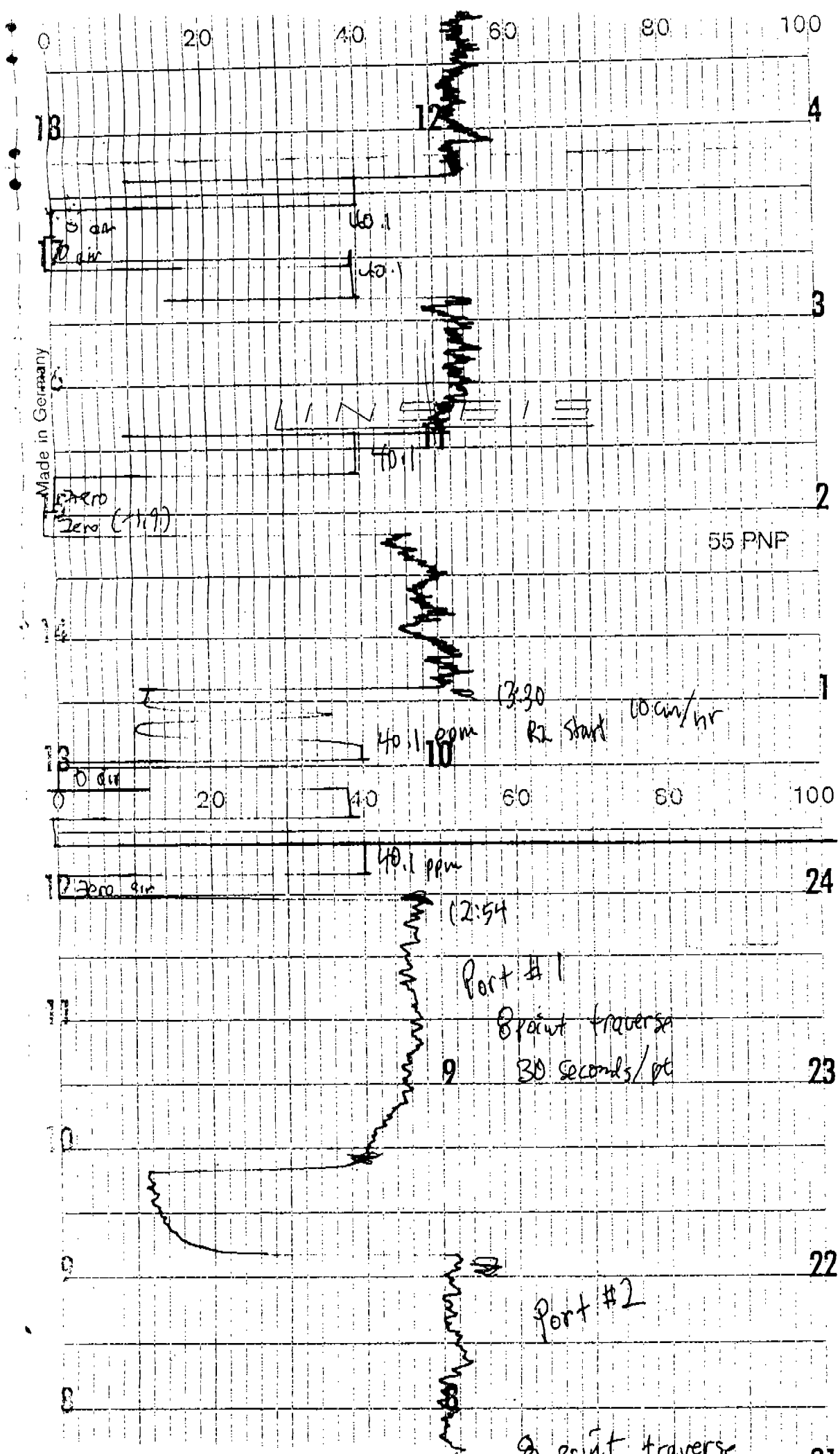
Location Can Vent Date 10-14	CO_2 0.0	$CO_2 + O_2$ 20.6	O_2 20.6
Run # 3	0.0	20.8	20.8
Notes Ambient assumed			
	0.0		20.7

Location Can Vent Date 10-14	CO_2 0.0	$CO_2 + O_2$ 20.8	O_2 20.8
Run # 4	0.1	20.6	20.5
Notes Ambient Assumed			
	0.0		20.7

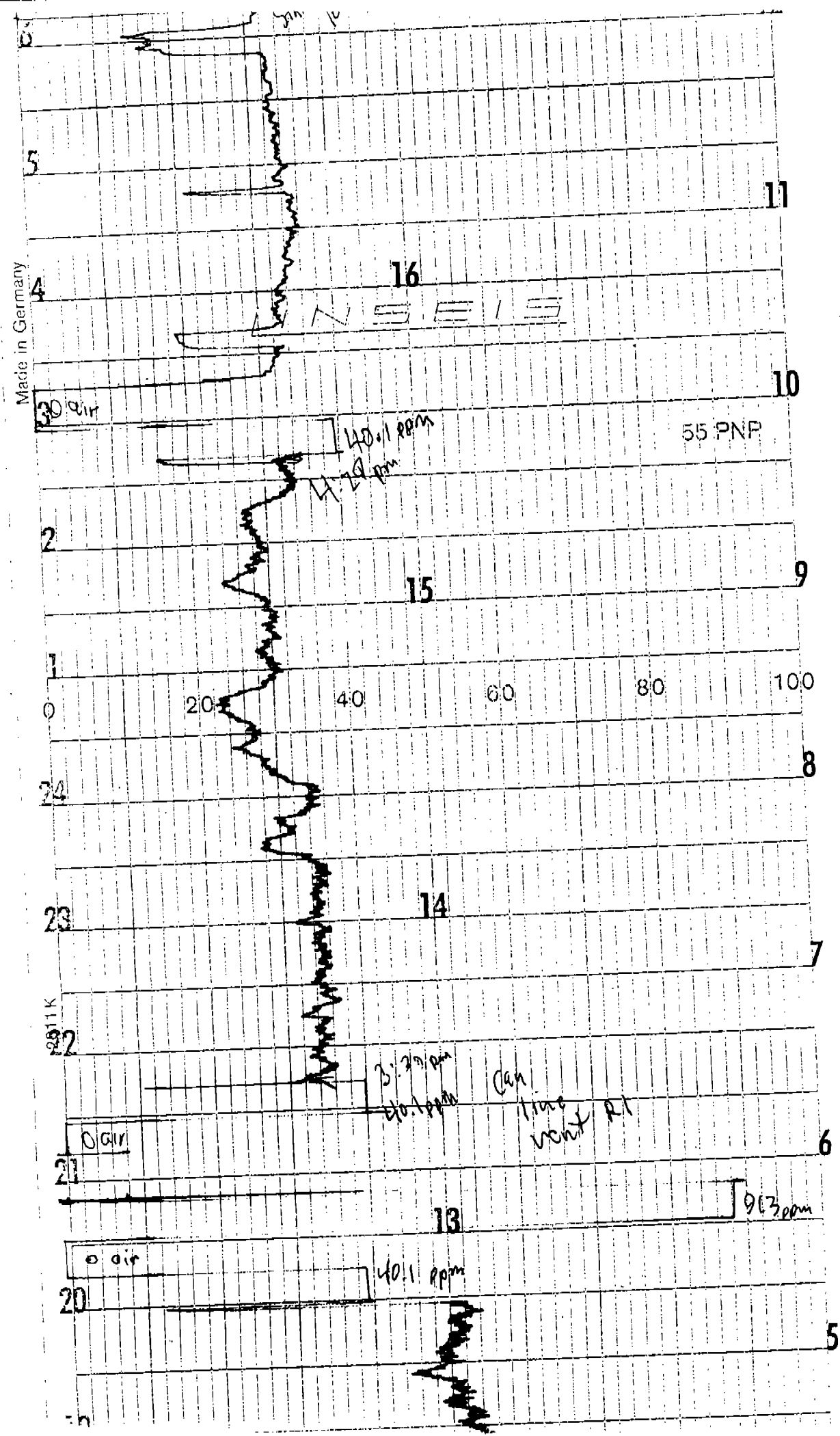
Location Date	CO_2	$CO_2 + O_2$	O_2
Run #			
Notes			

Location Date	CO_2	$CO_2 + O_2$	O_2
Run #			
Notes			

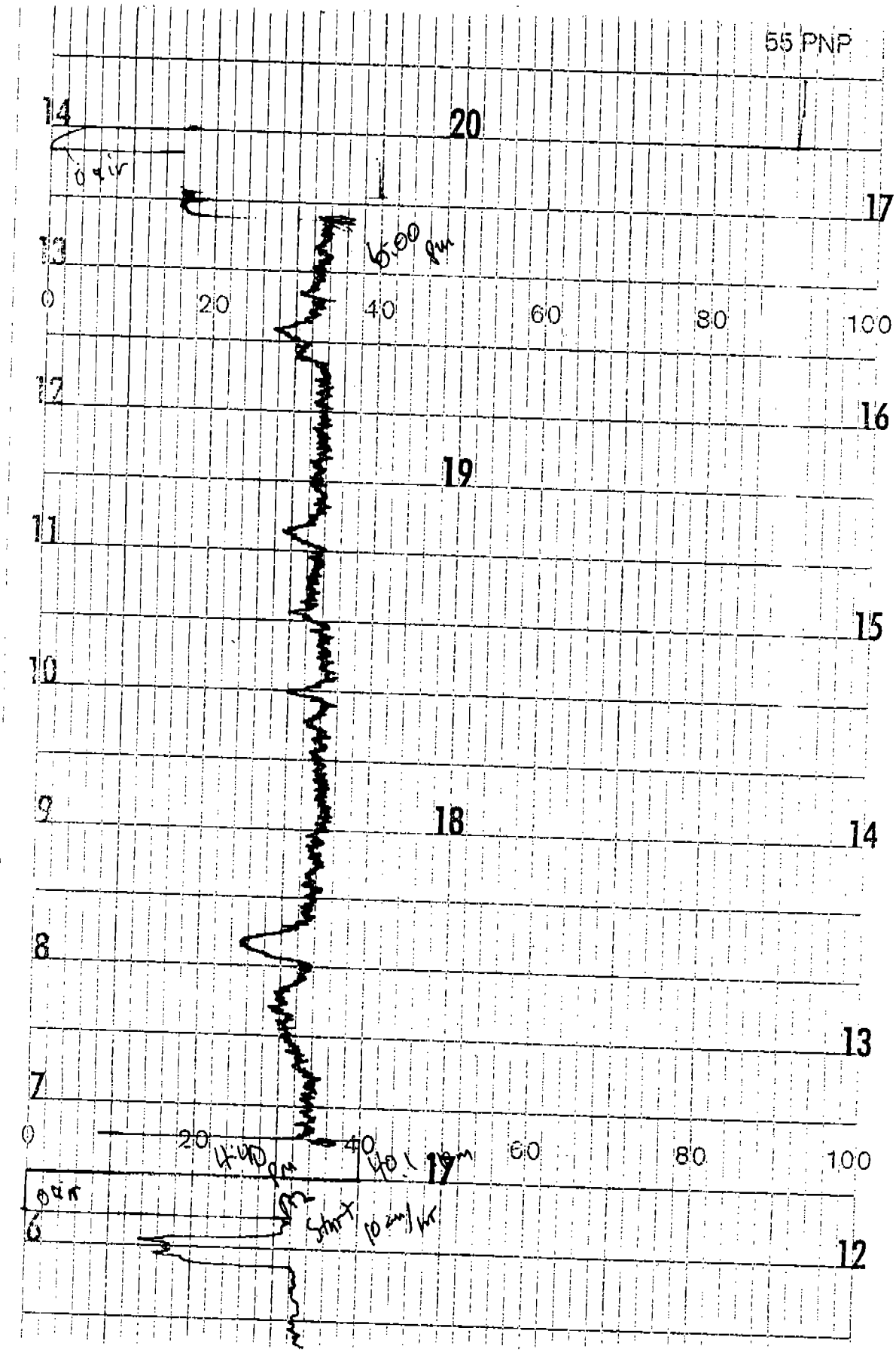

30 sec/pt.
40.1
40.1 CAL
12:32 pm
Chart Speed R1
10 cm/hr
55 PNP
START 11:32
40.1 CAL
40.1 ppm
Ambient
21.3 ppm
Coors Brewing Co
Location #1 Filler Vent
10-14-92
Made in Germany
2011 K



0
20
40
60
80
100
13
12
4
0 air
40.1
10 air
40.1
3
Made in Germany
40.1
Zero
Zero (-1.9)
2
55 PNP
14
13:30
1
40.1 ppm
R2 start
10 cm/hr
13
10
0 air
0
20
40
60
80
100
40.1 ppm
Zero air
24
12:54
Port #1
8 point traverse
9
30 seconds/pt
23
10
9
22
Port #2
8
8 point traverse



Made in Germany
55 PNP
0
20
40
60
80
100
11
16
10
15
9
8
14
7
6
13
5
0 air
40.1 ppm
4:29 pm
3:39 pm
40.1 ppm
Can line vent R1
0 air
913 ppm
0 air
40.1 ppm


55 PNP
14
20
17
13
0
20
40
60
80
100
12
16
19
11
15
10
9
18
14
8
13
7
0
20
40
60
80
100
17
6
12

Appendix 3
Calibration Certificates

Scott Specialty Gases, Inc.

E. P. A. PROTOCOL CERTIFICATE OF ANALYSIS

Shipped from:
Scott Specialty Gases
Route 611
Plumsteadville, PA 18949
Purchase order :
91047

Shipped to:
AIR POLLUTION TESTING INC
ATTN: PO#91047
4535 W 68TH AVE
WESTMINSTER, CO 80030

Project No 0134629

Certified per E.P.A. Protocol # 1 Procedure #G1 Section # 3.0.4
Certified accuracy +/- 1 % NIST Traceable

Cylinder number	ALM019712	Cylinder pressure 2000 psig.	Date of assay: 1/23/92
Component		Certified concentration	Expiration date: 7/23/93
PROPANE		91.3 ppm	
NITROGEN		Balance	

Standard		Analyzer	
Type	GMIS	Make	: VARIAN
Concentration	98.21 ppm	Model	: VA3300
Cylinder #	CAL4282	Serial number	: 7945
		Analytical principle	: FID
		Date of calibration	: 1/23/92

Raw data units:	AREA		Concentration of Customer Cylinder
Analysis	1/23/92		
Z1=0.00	R1=432474	T1=402119	91.3 ppm
R2=432431	Z2=0.00	T2=402018	91.3 ppm
Z3=0.00	T3=402149	R3=432116	91.4 ppm

Analyst Paul W. Smith

Approved by Ted Neeme
Mark S. Sirinides/Ted Neeme

Scott Specialty Gases, Inc.

E. P. A. PROTOCOL CERTIFICATE OF ANALYSIS

Shipped from:
Scott Specialty Gases
Route 611
Plumsteadville, PA 18949
Purchase order :
91047

Shipped to:
AIR POLLUTION TESTING INC
ATTN: PO#91047
4535 W 68TH AVE
WESTMINSTER, CO 80030

Project No 0134629

Certified per E.P.A. Protocol # 1 Procedure #G1 Section # 3.0.4
Certified accuracy +/- 1 % NIST Traceable

Cylinder number	ALM016822	Cylinder pressure 2000 psig.	Date of assay: 1/23/92
Component		Certified concentration	Expiration date: 7/23/93
PROPANE		40.1 ppm	
NITROGEN		Balance	

Standard		Analyzer	
Type	GMIS	Make	: VARIAN
Concentration	98.21 ppm	Model	: VA3300
Cylinder #	CAL4282	Serial number	: 7945
		Analytical principle	: FID
		Date of calibration	: 1/23/92

Raw data units:		AREA		Concentration of Customer Cylinder
Analysis		1/23/92		
Z1=0.00	R1=433693	T1=176863		40.1 ppm
R2=432885	Z2=0.00	T2=177019		40.2 ppm
Z3=0.00	T3=176482	R3=432460		40.1 ppm

Analyst Paul W. Smith

Approved by Ted Neeme
Mark S. Sirinides/Ted Neeme

Appendix 4
Diagrams

Diagrams

The following diagrams detail the duct dimensions and sampling points.

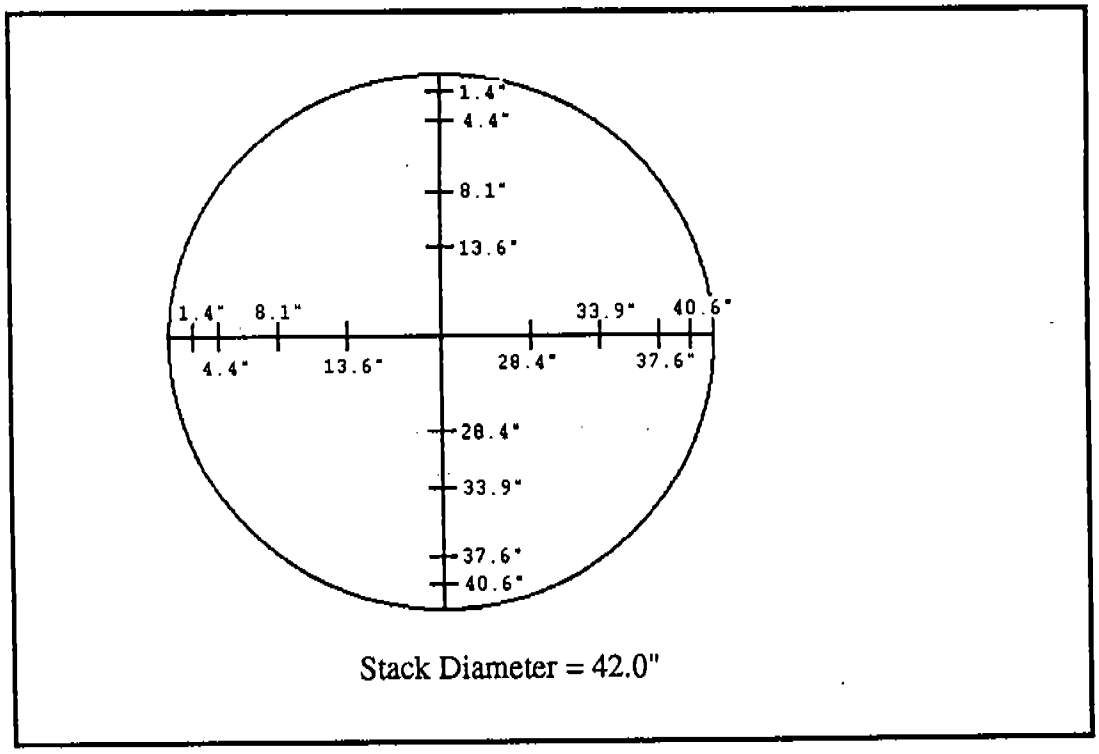


Diagram 1 - Bottle Filler Vent Cross-Section
and Sampling Points

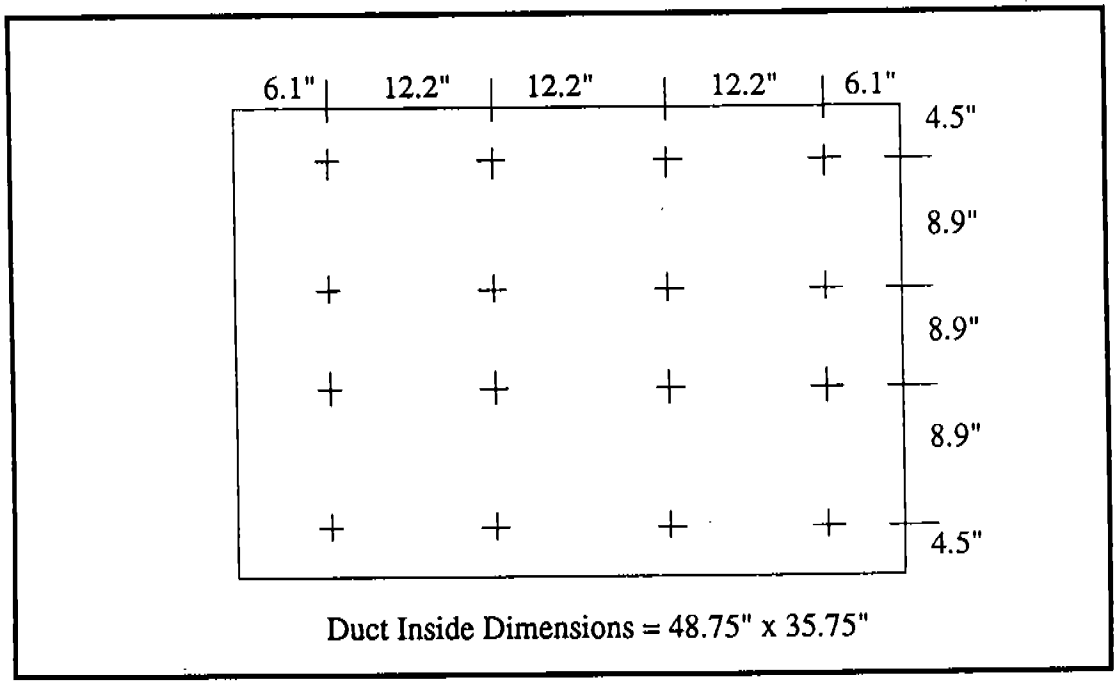


Diagram 2 - Can Filler Vent Cross-Section
and Sampling Points

Appendix 5
Process Data

M E M O R A N D U M

OCTOBER 15, 1992

TO: TOM BUEB

FROM: MIKE MURPHY

SUBJECT: BARRELAGE DURING PACKAGING STACK TESTING

The following is a listing of the number of cases/barrels produced during the air emissions stack re-testing on October 14, 1992:

BOTTLE FILLER ROOM VENTS

11:30-12:30	-	5150 cs. (12 oz.) 1500 cs. (32 oz.)	=>	519 bbls.
13:30-14:30	-	6200 cs. (12 oz.) 1600 cs. (32 oz.)	=>	605 bbls.
Total cs/bbls.	-	11350 cs. (12 oz.) 3100 cs. (32 oz.)	=>	1124 bbls.
Average	-	5675 cs. (12 oz.) 1550 cs. (32 oz.)	=>	562 bbls.

CAN FILLER ROOM VENTS

15:30-16:30	-	14150 cs. (12 oz.) 2250 cs. (16 oz.)	=>	1245 bbls.
17:00-18:00	-	13570 cs. (12 oz.) 2300 cs. (16 oz.)	=>	1108 bbls.
Total cs/bbls.	-	27720 cs. (12 oz.) 4550 cs. (16 oz.)	=>	2353 bbls.
Average	-	13860 cs. (12 oz.) 2275 cs. (16 oz.)	=>	1177 bbls.

NOTE: All barrelage figures represent the total for both package types produced during the times listed.

Conversion factors for cases to barrels are:

12 oz. (cans or btls.)	-	(# cs. * .07258)
16 oz. cans	-	(# cs. * .09677)
32 oz. btls.	-	(# cs. * .09677)