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: 11.1

Reference Number: 352

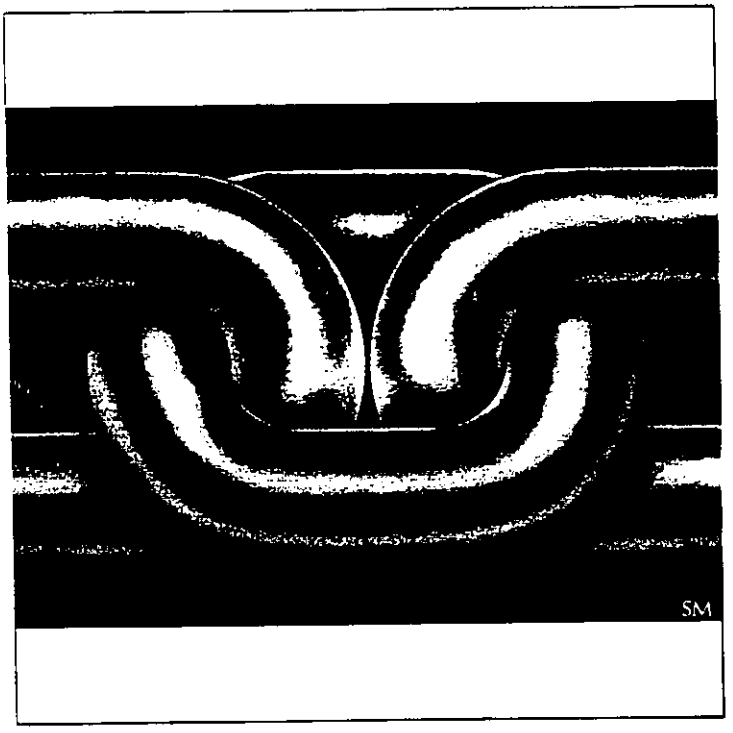
Title: Measurement Of NOx Emissions, General Crushed Stone, Inc., Glen Mills Asphalt Plant Baghouse Exhaust, Easton, PA,

United Energy Services Corp., Reading, PA,

June 27, 1995.

Gen-Cr-Sto Sect. 11.1
Ref. 352

United Energy Services Corporation



The Critical Link.SM

GENERAL CRUSHED STONE, INCORPORATED

MEASUREMENT OF NO_X EMISSIONS
GLEN MILLS ASPHALT PLANT BAGHOUSE EXHAUST

June 27, 1995

UESC, REPORT 733-001-001

Prepared by

United Energy Services Corporation
Air Quality Testing Services
240 Corporate Drive
Reading, Pennsylvania 19605

United Energy Services Corporation

The Critical Link.

June 27, 1995

Mr. Vern Snyder
General Crushed Stone
P.O. Box 231
Easton, PA 18044

Re: Submittal of Report for Diagnostic NO_x Emissions Testing, Glen Mills Plant
UESC Report 733-001-001

Dear Mr. Snyder:

We are pleased to submit two (2) copies of our Report 733-001-001, dated June 1995. This report contains results for diagnostic NO_x emission testing performed on one of the two baghouse exhausts at your Glen Mills, PA facility.

The source sampling program defined by this report incorporates standard sampling procedures. The results of the sampling program are representative of flue gas emissions at the exhaust sampling location under normal operating conditions.

United Energy Services Corporation is pleased to have been of service to General Crushed Stone and trusts that this report will meet with your acceptance.

Very truly yours,

Stephen S. Schell
Senior Air Quality Specialist
Air Quality Testing Services

SSS/sss

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SUMMARY OF TEST RESULTS

The diagnostic testing performed on June 21, 1995 consisted of conducting two NO_x emissions tests, each for one hour in duration. The purpose of this testing was to get a general idea of the NO_x emissions coming from the baghouse exhaust while burning Number 5 and Number 2 Fuel Oil. The NO_x emission rate (lbs/hr), as calculated from the emission concentration (ppm) and the volumetric flow rate (DSCFM), was used in determining NO_x, lbs/ton of asphalt produced. This emission factor was then used to calculate a theoretical amount of asphalt (tons) which could be produced annually. It must be understood, however, that these results are based on only one test run at a specific set of operating conditions and the exact tonnage of asphalt which can be produced annually may change according to varying operating conditions throughout the year. A summary of the test results has been included in this report as Table 1.

TABLE 1

Results of NO_x Emissions Testing

on the Baghouse Exhaust

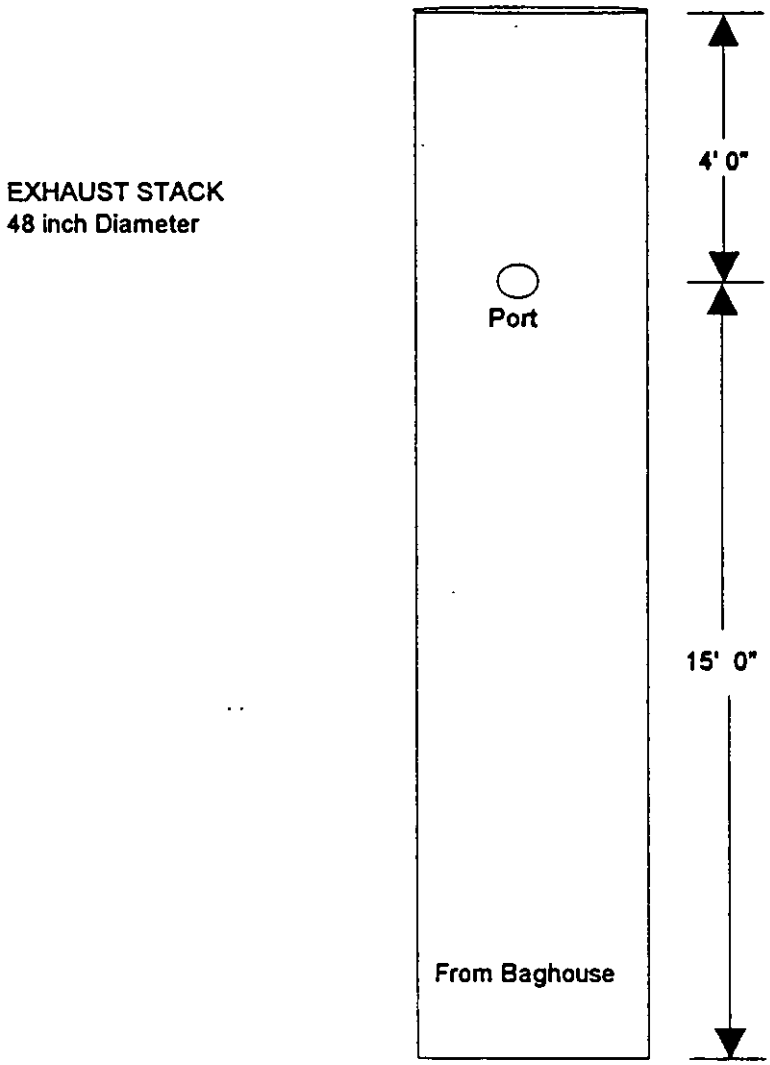
Date: 6/21/95

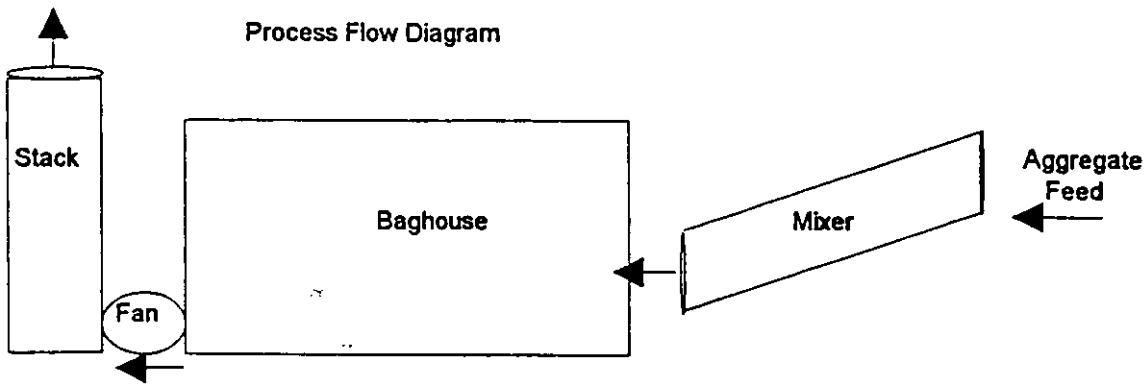
Run No.:	1	2
Time:	8:19 - 8:59	9:58 - 9:17
Fuel:	No. 5 Oil	No. 2 Oil
O_2 (%):	18.06	18.59
CO_2 (%):	2.23	1.91
Moisture (%):	7.0	8.0
Air Flow Volume (DSCFM):	38,463	36,238
NO_x lbs/hr:	11.13	5.03
Asphalt Production (ton/hr):	127.95	113.51
NO_x lbs/ton of asphalt:	0.087	0.044
Approximate annual production:	575,000 tons	1,115,000

FIGURE

FIGURE 1

BAGHOUSE EXHAUST - GLEN MILLS ASPHALT PLANT





TEST RESULTS

UESC AIR QUALITY TESTING SERVICES
INSTRUMENTAL ANALYZER DATA ACQUISITION
CLIENT: General Crushed Stone Glen Mills
LOCATION: Asphalt Plant

DATE: 6/21/95
TEST RUN: RAP & #5 Oil
TEST START: 08:19
TEST END: 08:59

DATE	TIME	O2	CO2	NOx
21-Jun-95	8:19:53	17.70	2.20	39.90
21-Jun-95	8:20:53	17.80	2.30	41.80
21-Jun-95	8:21:53	17.80	2.30	42.90
21-Jun-95	8:22:53	17.80	2.30	43.70
21-Jun-95	8:23:53	18.10	2.10	38.40
21-Jun-95	8:24:53	18.20	2.00	37.70
21-Jun-95	8:25:53	18.00	2.10	43.60
21-Jun-95	8:26:53	17.50	2.30	45.60
21-Jun-95	8:27:53	17.70	2.50	46.50
21-Jun-95	8:28:53	17.30	2.60	52.60
21-Jun-95	8:29:53	17.40	2.60	49.40
21-Jun-95	8:30:53	17.50	2.60	48.20
21-Jun-95	8:31:53	17.50	2.60	49.60
21-Jun-95	8:32:53	18.00	2.40	38.70
21-Jun-95	8:33:53	18.20	2.00	35.40
21-Jun-95	8:34:53	17.70	2.20	42.50
21-Jun-95	8:35:53	17.70	2.30	42.30
21-Jun-95	8:36:53	17.90	2.30	38.40
21-Jun-95	8:37:53	17.90	2.20	42.20
21-Jun-95	8:38:53	17.80	2.20	40.40
21-Jun-95	8:39:53	17.80	2.30	40.30
21-Jun-95	8:40:53	18.00	2.30	39.70
21-Jun-95	8:41:53	18.60	1.50	29.40
21-Jun-95	8:42:53	17.60	2.30	44.60
21-Jun-95	8:43:53	17.90	2.30	42.00
21-Jun-95	8:44:53	18.10	2.10	38.30
21-Jun-95	8:45:53	18.00	2.10	39.00
21-Jun-95	8:46:53	17.80	2.30	46.10
21-Jun-95	8:47:53	17.90	2.20	40.10
21-Jun-95	8:48:53	18.20	2.00	35.00
21-Jun-95	8:49:53	17.80	2.10	44.10
21-Jun-95	8:50:53	17.80	2.30	42.30
21-Jun-95	8:51:53	18.00	2.20	37.80
21-Jun-95	8:52:53	18.00	2.10	40.70
21-Jun-95	8:53:53	17.50	2.30	46.20
21-Jun-95	8:54:53	17.70	2.40	44.50
21-Jun-95	8:55:53	17.90	2.20	43.10
21-Jun-95	8:56:53	17.80	2.10	41.20
21-Jun-95	8:57:53	17.90	2.10	38.00
21-Jun-95	8:58:53	17.70	2.30	44.20
21-Jun-95	8:59:53	17.60	2.30	45.00
		O2	CO2	NOx
		17.83	2.24	41.99
		%	%	ppm

UESC AIR QUALITY TESTING SERVICES
ANALYZER CALIBRATION DATA
CLIENT: General Crushed Stone
LOCATION: Asphalt Plant

DATE: 6/21/95
TEST RUN: RAP & #5 Oil
TEST START: 08:19
TEST END: 08:59

ANALYZER RESPONSE

GAS UNITS	ANALYZER SCALE	CYLINDER VALUE	ANALYZER VALUE	DIFF PPM	% SPAN
O2, %		0.00	0.00	0.0	0.00
O2, %	25	12.10	11.96	0.1	0.40
O2, %		20.90	20.92	0.0	0.00
CO2, %		0.00	0.00	0.0	0.00
CO2, %	20	9.87	9.95	0.1	0.50
CO2, %		18.20	18.21	0.0	0.00
NOx		0.00	-0.05	0.1	0.04
NOx	250	128.00	129.90	1.9	0.76
NOx		229.00	229.29	0.3	0.12

SYSTEM CALIBRATION BIAS AND DRIFT DATA

GAS UNITS	ANALYZER SCALE	ANALYZER VALUE	PRE-TEST CHECK	% SPAN	POST-TEST CHECK	% SPAN	% DRIFT
O2, %		0.00	0.00	0.0	0.04	0.2	0.2
O2, %	25	11.96	11.94	0.1	11.96	0.0	0.1
CO2, %		0.00	0.00	0.0	0.00	0.0	0.0
CO2, %	20	9.95	9.95	0.0	9.90	-0.2	-0.2
NOx		-0.05	0.50	3.1	-0.21	-0.1	-0.3
NOx	250	129.90	130.18	0.1	135.30	2.2	2.0

UNCORRECTED ANALYZER VALUES	
O2, % =	17.83
CO2, % =	2.24
NOx,ppm =	41.99

ANALYZER VALUES CORRECTED FOR DRIFT	
O2, % =	18.06
CO2, % =	2.23
NOx,ppm =	40.39

Velocity Traverse:	38,463	DSCFM	NOx, lbs/hr =	11.13
Asphalt Produced=	127.95	ton/hr	NOx, lbs/ton =	0.087

AIR QUALITY TESTING SERVICES
GAS FLOW ANALYSIS

CLIENT:	General Crushed Stone	**RUN NO:**	1
PLANT:	Glen Mills		
UNIT:	Asphalt Plant	**DATE:**	6/21/95
TEST:	EPA Method 2	**START:**	8:19
TEST LOCATION:	Stack	**END:**	8:59

P_b =	30.16 in. Hg	I.D. =	48.00 in.
C_p =	0.84	A_s =	12.57 Sq. Ft.
O_2 =	18.06 %	P_{ST} =	-1.00 in. H2O
CO_2 =	2.23 %	%M =	7.00 %

SAMPLE POINT	STACK TEMP.	VELOCITY HEAD	SQRT
A-1	190	0.98	0.9899
2	190	1.20	1.0954
3	190	1.20	1.0954
4	190	1.30	1.1402
5	190	1.20	1.0954
6	186	1.10	1.0488
7	192	1.10	1.0488
8	192	1.20	1.0954
9	193	1.10	1.0488
10	193	1.10	1.0488
	T_s	PITOT	SQRT
	191	1.15	1.0707

STATIC INPUTS

A	-1.00
AVG	-1.00

RESULTS

V_s =	67.23 Ft./Sec.	M_d =	29.08	P_s =	30.09 in. Hg
A =	12.57 Sq. Ft.	M_s =	28.30	B_{ws}=	0.07

STACK GAS VOLUME = 50,704.9 **ACFM**

STACK GAS VOLUME = 38,463.3 **DSCFM**

UESC AIR QUALITY TESTING SERVICES
INSTRUMENTAL ANALYZER DATA ACQUISITION
CLIENT: General Crushed Stone Glen Mills
LOCATION: Asphalt Plant

DATE: 6/21/95
TEST RUN: RAP & #2 Oil
TEST START: 09:58
TEST END: 09:17

DATE	TIME	O2	CO2	NOx
21-Jun-95	10:00:10	19.23	1.37	8.54
21-Jun-95	10:01:10	17.30	2.67	35.44
21-Jun-95	10:02:10	18.91	1.52	13.05
21-Jun-95	10:03:10	18.69	1.46	14.59
21-Jun-95	10:04:10	18.29	2.18	18.52
21-Jun-95	10:05:10	18.61	1.65	16.86
21-Jun-95	10:06:10	17.31	2.72	35.01
21-Jun-95	10:07:10	18.61	1.97	16.26
21-Jun-95	10:08:10	16.53	3.11	45.74
21-Jun-95	10:09:10	19.53	1.11	7.19
21-Jun-95	10:10:10	15.68	3.80	45.78
21-Jun-95	10:11:10	19.73	1.06	5.83
21-Jun-95	10:12:10	15.58	3.65	43.56
21-Jun-95	10:13:10	19.21	1.33	8.53
21-Jun-95	10:14:10	16.71	2.84	39.31
21-Jun-95	10:15:10	18.38	2.05	15.37
21-Jun-95	10:16:10	19.51	0.77	10.38
21-Jun-95	10:17:10	17.90	2.38	22.31
21-Jun-95	10:18:10	19.85	0.73	4.36
21-Jun-95	10:19:10	16.05	3.93	43.76
21-Jun-95	10:20:10	19.95	0.96	4.22
21-Jun-95	10:21:10	15.97	3.55	48.93
21-Jun-95	10:22:10	19.96	0.75	4.48
21-Jun-95	10:23:10	19.98	0.72	4.18
21-Jun-95	10:24:10	17.62	2.69	24.44
21-Jun-95	10:25:10	19.97	0.72	3.80
21-Jun-95	10:26:10	16.07	3.43	50.85
21-Jun-95	10:27:10	19.95	0.79	4.53
21-Jun-95	10:28:10	19.85	0.72	4.78
21-Jun-95	10:29:10	18.31	2.13	17.33
21-Jun-95	10:30:10	19.86	0.76	4.33
21-Jun-95	10:31:10	15.89	3.70	48.98
21-Jun-95	10:32:10	19.87	1.01	4.58
21-Jun-95	10:33:10	19.75	0.77	5.37
21-Jun-95	10:34:10	18.51	1.98	15.16
21-Jun-95	10:35:10	19.96	0.72	4.17
21-Jun-95	10:36:10	15.78	3.71	48.37
21-Jun-95	10:37:10	19.97	0.81	4.20
21-Jun-95	10:38:10	15.70	3.95	45.23
21-Jun-95	10:39:10	19.86	0.77	4.85
21-Jun-95	10:40:10	15.41	3.87	44.21
21-Jun-95	10:41:10	19.87	0.80	4.66
21-Jun-95	10:42:10	16.55	2.99	41.73
21-Jun-95	10:43:10	19.67	1.08	5.89
21-Jun-95	10:44:10	18.94	1.29	18.99
21-Jun-95	10:45:10	18.82	1.65	11.26
21-Jun-95	10:46:10	19.86	0.76	5.12
21-Jun-95	10:47:10	17.13	2.94	30.01
21-Jun-95	10:48:10	19.87	0.90	4.57
21-Jun-95	10:49:10	15.89	3.92	43.97
21-Jun-95	10:50:10	19.98	0.75	4.37
21-Jun-95	10:51:10	15.42	3.93	46.32
21-Jun-95	10:52:10	19.86	0.74	4.33
21-Jun-95	10:53:10	15.81	3.83	44.87
21-Jun-95	10:54:10	19.88	0.99	4.83
21-Jun-95	10:55:10	17.23	2.48	36.76
21-Jun-95	10:56:10	19.35	1.36	7.70
21-Jun-95	10:57:10	19.46	0.76	11.49
21-Jun-95	10:58:10	17.73	2.50	23.10
21-Jun-95	10:59:10	19.88	0.86	4.21
		O2	CO2	NOx
		18.35	1.92	20.03
		%	%	ppm

UESC AIR QUALITY TESTING SERVICES
ANALYZER CALIBRATION DATA
CLIENT: General Crushed Stone
LOCATION: Asphalt Plant

DATE: 6/21/95
TEST RUN: RAP & #2 Oil
TEST START: 09:58
TEST END: 09:17

ANALYZER RESPONSE

GAS UNITS	ANALYZER SCALE	CYLINDER VALUE	ANALYZER VALUE	DIFF PPM	% SPAN
O2, %		0.00	0.00	0.0	0.00
O2, %	25	12.10	11.96	0.1	0.40
O2, %		20.90	20.92	0.0	0.00
CO2, %		0.00	0.00	0.0	0.00
CO2, %	20	9.87	9.95	0.1	0.50
CO2, %		18.20	18.21	0.0	0.00
NOx		0.00	-0.08	0.1	0.04
NOx	250	128.00	131.30	3.3	1.32
NOx		229.00	229.04	0.0	0.00

SYSTEM CALIBRATION BIAS AND DRIFT DATA

GAS UNITS	ANALYZER SCALE	ANALYZER VALUE	PRE-TEST CHECK	% SPAN	POST-TEST CHECK	% SPAN	% DRIFT
O2, %		0.00	0.04	0.2	0.01	0.0	-0.1
O2, %	25	11.96	11.96	0.0	11.95	0.0	0.0
CO2, %		0.00	0.00	0.0	0.00	0.0	0.0
CO2, %	20	9.95	9.90	0.2	9.96	0.1	0.3
NOx		-0.08	0.18	1.4	0.58	0.3	0.2
NOx	250	131.30	131.50	0.1	128.75	-1.0	-1.1

UNCORRECTED ANALYZER VALUES

O2, % =	18.35
CO2, % =	1.92
NOx,ppm =	20.03

ANALYZER VALUES CORRECTED FOR DRIFT

O2, % =	18.59
CO2, % =	1.91
NOx,ppm =	19.39

Velocity Traverse:	36,238	DSCFM	NOx, lbs/hr =	5.03
Asphalt Produced=	113.51	ton/hr	NOx, lbs/ton =	0.044

AIR QUALITY TESTING SERVICES
GAS FLOW ANALYSIS

CLIENT: General Crushed Stone
PLANT: Glen Mills
UNIT: Asphalt Plant
TEST: EPA Method 2
TEST LOCATION: Stack

RUN NO: 1
DATE: 6/21/95
START: 9:58
END: 11:30

P_b =	30.16 in. Hg	LD. =	48.00 in.
C_p =	0.84	A_s =	12.57 Sq. Ft.
O_2 =	18.59 %	P_{ST} =	-1.00 in. H2O
CO_2 =	1.91 %	%M =	8.00 %

SAMPLE POINT	STACK TEMP.	VELOCITY HEAD	SQRT
A-1	198	0.74	0.8602
2	200	1.00	1.0000
3	200	1.10	1.0488
4	207	1.20	1.0954
5	207	1.20	1.0954
6	203	1.20	1.0954
7	203	1.10	1.0488
8	207	1.10	1.0488
9	205	1.00	1.0000
10	200	0.95	0.9747
	T_s	PITOT	SQRT
	203	1.06	1.0268

STATIC INPUTS	
A	-1.00
AVG	-1.00

RESULTS

V_s =	65.21 Ft./Sec.	M_d =	29.05	P_s =	30.09 in. Hg
A =	12.57 Sq. Ft.	M_s =	28.17	B_{ws}=	0.08

STACK GAS VOLUME = 49,181.4 ACFM

STACK GAS VOLUME = 36,238.5 DSCFM

SAMPLE CALCULATIONS

SAMPLE EQUATIONS

Particulate Isokinetic Sampling

I. Calculations for flue gas volume and Isokinetic Ratio

Time	Dry Gas Meter Ft^3	Pitot ΔP In. H_2O	Orifice ΔH In. H_2O	Dry Gas Temp.°F In Out	Flue Gas Static Pressure In. H_2O	Stack Temp.°F
T	V_m	Δp	ΔH	TMI TMO	P_g	t_s

1. D_n = Nozzle Diameter (inches)

1a. A_n = Area of Nozzle (ft^2)

2. P_{bar} = Barometric Pressure (in. Hg)

3. TT = Net Sampling Time (minutes)

4. V_m = V_m Final - V_m Initial = Sample Gas Volume (Ft^3)

5. T_m = Average Dry Gas Temperature at Meter (°F)

$$T_m = \frac{Avg.TMI + Avg.TMO}{2}$$

6. Δp = Velocity head of stack gas (in. H_2O)

7. ΔH = Average Orifice Pressure Drop (in.H_2O)

8. Volume of dry gas sampled at standard conditions[a] (DSCF)

$$V_{m(std)} = \frac{(17.64)(V_m)(Y)\left(P_{bar} + \frac{\Delta H}{13.6}\right)}{(T_m + 460)}$$

9. V_{lc} = Total Water Collected = gm H_2O Silica gel + ml Imp. H_2O = ml

10. Volume of water vapor at standard conditions[b] (SCF)

$$V_{w(std)} = 0.0471(V_{lc}) = SCF$$

11. Percent moisture in flue gas

$$\%M = \frac{100(V_{w(std)})}{V_{m(std)} + V_{w(std)}}$$

12. Mole fraction of water vapor in flue gas

$$B_{ws} = \frac{\%M}{100}$$

13. Molecular Weight of dry flue gas

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

13a. %EA = % Excess Air =

$$\frac{[(\%O_2) - 0.5(\%CO)]}{[0.264(\%N_2)] - [(\%O_2) - 0.5(\%CO)]} x100$$

14. Molecular weight of wet flue gas

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

15. A = Cross-sectional area of stack (Ft^2)

$$\frac{\pi r^2}{144}$$

16. P_s = Flue gas pressure (in, Hg)

$$P_s = P_{bar} + P_g$$

NOTE: $$P_g(Hg) = \frac{P_g(in.H_2O)}{13.6}$$

17. T_s = Absolute stack temperature (°R)

$$T_s = 460 + t_s$$

18. Flue velocity at stack conditions (FT/SEC)

$$V_s = (K_p)(C_p)\left[\left(\sqrt{\Delta p}\right)avg\right]\sqrt{\frac{T_s(avg)}{P_s * M_s}}$$

C_p = pitot tube coefficient
K_p = pitot tube constant = 85.49ft/sec

19. Flue gas volumetric flow rate at standard conditions[b] (SCFM)

$$Q_s = (V_s)(A)\left(\frac{528}{T_s(avg.)}\right)\left(\frac{P_s}{29.92}\right)(60)$$

20. Flue gas volumetric flow rate at standard conditions[c] (DSCFM)

$$Q_{sd} = (1 - B_{ws})(V_s)(A)\left(\frac{528}{T_s(avg.)}\right)\left(\frac{P_s}{29.92}\right)(60)$$

21. Flue gas volumetric flow rate at stack conditions (ACFM)

$$Q_a = (V_s)(A)(60)$$

22. Percent Isokinetic

$$\%I = \frac{K_4(T_s)(V_{m(std)})}{P_s V_s A_n \Theta(1 - B_{ws})}$$

K_4 = 0.09450
$\Theta = time(\min)$

NOTES: [a]Dry standard cubic feet at 68°F, 29.92 in. Hg
[b]Standard conditions at 68°F, 29.92 in. Hg
[c]Dry standard cubic feet per minute at 68°F, 29.92 in. Hg

SAMPLE CALCULATIONS

NO_x Emissions

NO_x lbs/scf = ppm x conversion factor

NO_x lbs/hr = NO_x lbs/scf x DSCFM x 60

NO_x lbs/ton of asphalt = (NO_x lbs/hr) / (Tons of asphalt/hr)

United Energy Services Corporation

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