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 2.3

Reference: 26

Title: Emission Compliance Test Program, Nazareth Hospital, Philadelphia, Pennsylvania,
Ralph Manco, Nazareth Hospital, September 1989.

Newer test already scanned, but this is the original

2.3
#26

Project No. 1161

Nazareth Hospital

Emission Compliance Test Program

Prepared for:

Mr. Ralph Manco
Vice President - Institutional Affairs
Nazareth Hospital
2601 Holme Avenue
Philadelphia, PA 19152

September 1989

1.0 Introduction

AirNova, Inc. conducted an emission compliance test program at the Nazareth Hospital located in Philadelphia, Pennsylvania on July 21 and 24, 1989 for the purpose of demonstrating compliance with applicable Pennsylvania Department of Environmental Resources (DER) and Philadelphia Air Management Services (AMS) regulations. Emission sampling was conducted in evaluation of a solid waste incinerator/waste heat boiler system and associated control device recently installed at this site. The specific parameters determined as part of this test program included the following:

Control Device Inlet	Control Device Outlet
Hydrogen Chloride	Oxygen
Sulfur Dioxide	Particulate
	Metals - Regulation 6
	Hydrogen Chloride
	Sulfur Dioxide
	Carbon Monoxide
	Visual Emissions

This report contains the complete results of the test program.

2.0 Site Description

The emission source under evaluation consists of a solid waste incinerator with associated waste heat recovery boiler. The incinerator is a Cleaver Brooks Model 1280-A/72 with a maximum charging rate of 825 lbs/hr. Both the main combustion chamber and integral afterburner are fired by natural gas. The waste heat recovery boiler is a Cleaver Brooks Model SFB-250. This unit is additionally fired by natural gas or No. 6 fuel oil. Natural gas was fired during the compliance test program.

Flue gas exiting the waste heat boiler is treated by a wet scrubber. The scrubber is an Anderson 2000 Model WAV-97 venturi throat type operating at approximately 18-inches of pressure drop. The venturi is followed by a packed tower absorber and mist eliminator. The scrubber liquid is a caustic solution.

Emission sampling at the scrubber inlet was performed in a horizontal length of exhaust ducting with an inside diameter of 19.5 inches. Two test ports situated 90° apart and located 2 diameters upstream and 8 diameters downstream from the nearest flow disturbance were utilized for all sampling. Outlet emission sampling was conducted in a horizontal section of 16-inch I.D. ducting. Two test ports situated at 90° and located 2 duct diameters upstream and 8 duct diameters downstream were utilized for all sampling. The sample traverse points for each test location were as follows:

Inlet Test Location			Outlet Test Location		
Traverse Point	Diameter (%)	Distance (in)	Traverse Point	Diameter (%)	Distance (in)
1	4.4	0.9	1	4.4	0.7
2	14.6	2.8	2	14.6	2.3
3	29.6	5.8	3	29.6	4.7

Table 3-6
Metals Emission Summary

Run No. 1
Test Date: 07/24/89
Test Period: 1015-1130

A

A x 0.000437

		Volume (DSCF)	Volume (DSCF)	Concentration (mg/DSCM)	Stack Gas Flow Rate (DSCFM)	Emission Rate (lb/hr)	Emission Rate (gm/sec)	gr/dscf
						lb/hour		
Sb	Antimony	44.82	1.269	0.0198	2,389	0.0002	0.00002	0.0000086
As	Arsenic			0.0020		<0.0001	<0.00001	0.0000008
Be	Beryllium			0.0009		<0.0001	<0.00001	0.0000003
Cd	Cadmium			0.2434		0.0022	0.00027	0.0001063
Cr	Chromium			0.0158		0.0001	0.00002	0.0000069
Pb	Lead			1.3393		0.0120	0.00151	0.0005852
Mn	Manganese			0.0280		0.0003	0.00003	0.0000122
Hg	Mercury			2.1987		0.040 0.0197	0.00248	0.0009608
Ni	Nickel			ND		ND	ND	
Se	Selenium			ND		ND	ND	
Th	Thallium			0.0023		<0.0001	<0.0001	0.0000010

Run No. 2
Test Date: 07/24/89
Test Period: 1200-1315

Antimony	50.64	1.434	0.0209	2,750	0.0002	0.00003	0.0000091
Arsenic			0.0025		<0.0001	<0.00001	0.0000010
Beryllium			0.0008		<0.0001	<0.00001	0.0000003
Cadmium			0.0700		0.0007	0.00009	0.0000305
Chromium			ND		ND	ND	—
Lead			0.3277		0.0034	0.00043	0.0001432
Manganese			0.0323		0.0003	0.00004	0.0000141
Mercury			0.7669		0.016 0.0079	0.00100	0.0003351
Nickel			ND		ND	ND	
Selenium			ND		ND	ND	
Thallium			0.0035		<0.0001	0.00001	0.0000015

0.028

Standard Conditions: 68°F, 29.92 in. Hg.

4.0 Test Methodologies

The emission test program was conducted for the following parameters utilizing the methodologies as specified below.

Emission Parameter	Test Location	No. Test Run	Sampling and Analytical Methodology
Carbon Dioxide, Oxygen	Inlet	3*	EPA Method 3
Particulate	Outlet	2	EPA Method 5
	Outlet	2	EPA method 5 with DER Modifications
Hydrogen Chloride	Inlet/Outlet	2	EPA Modified Method 5 - Mercuric Nitrate Titration
Metals - Regulation 6	Outlet	2	EPA Modified Method 5 - Mixed Metals Sampling Train
Sulfur Dioxide	Inlet/Outlet	2	EPA Method 6
Carbon Monoxide	Outlet	2	EPA Method 10
Visual Emissions	Outlet	2	EPA Method 9

* Performed during all emission determinations.

A full description of each of the above referenced test methodologies is provided below.

Particulates, Hydrogen Chloride, and Moisture Content

Outlet determinations of hydrogen chloride, EPA Method 5 particulate, and moisture content were sampled isokinetically using a single Modified EPA Method 5 sampling system. The combined sampling system allowed for discrete determination of these parameters without presenting interferences to the prescribed analytical methodologies.

The sample train consisted of a heated glass-lined probe with a

CITY OF PHILADELPHIA

DEPARTMENT OF PUBLIC HEALTH
500 S. Broad Street
Philadelphia, Pa. 19146

MAURICE C. CLIFFORD, M.D.
Health Commissioner

PLANT Nazareth Hospital
ADDRESS 2601 Holme Avenue - 19152
STACK Infectious Waste Incinerator
DATE 7/21-24/89 Tests, 9/89 Rpt, 10/2/89 Rev

PARTICULATE CALCULATIONS
EPA RM 5

			RUN 1	RUN 2	Avg	RUN 1	RUN 2	Avg
1. Vm	Actual Meter Volume	ft3	37.71	39.337		56.751	49.444	
2. Vmcorr	Corrected Meter Vol.,VmxPm=		37.710	39.337		56.751	49.444	
	Meter Conditions. Pm = _____		1	1		1	1	
3. dHavg	Average Orifice Pressure Drop	in H20	1.634	1.442		2.183	1.583	
4. Pbar	Barometric Pressure	in Hg	29.9	29.9		29.9	29.91	
5. Pm	Absolute Meter Pressure							
	Pm = Pbar +(dHavg/13.6) =	in Hg	30.02	30.01		30.06	30.03	
6. Tmr	Absolute Avg. Meter Temperature	deg. F	86	88.4		92.1	89.2	
	TmR = TmF + 460	deg. R	546	548.4		552.1	549.2	
7. Vmstd	Dry Standard Volume Metered	scfd	36.574	37.967		54.507	47.685	
	Vmstd = (VmcorrxPmx17.64)/TmR							
8. Vwci	Std. Vol. H2O Vapor - Impingers	scf	3.95	5.55		10.45	9.18	
	Vwci = Vlc(mls)x 0.04707 Ft3/ml enter mls		84	118		222	195	
9. Vwcgel	Std. Vol. H2O Vapor - Silica Gel -	scf	1.367	1.160		1.179	1.414	
	Vwcgel = Vlc(gms)x 0.04715 Ft3/grm enter	gms	29	24.6		25	30	
10. Vwc	Total H2O Vapor = Vwci + Vwcgel	scf	5.321	6.714		11.628	10.593	
11. Bwo	% Water = 100 x Vwc/(Vmstd+Vwc)	%	12.70	15.03	13.86	17.58	18.18	17.880
12. %CO2	Carbon Dioxide (dry)	%	5.4	5.2	5.30	5.4	6.8	6.100
13. %O2	Oxygen (dry)	%	13.7	14.5	14.10	14.3	13.3	13.800
14. %CO	Carbon Monoxide (dry)	%	0	0	0.00	0	0	0.000
15. %N2	Nitrogen = 100-%CO2-%O2-%CO	%	80.9	80.3	80.60	80.3	79.9	80.100
16. Md	Dry MW=.44*CO2+.32*O2+.28*(N2+CO)	g/gmol	29.41	29.41	29.41	29.44	29.62	29.528
17. Ms	Wet Molecular Weight Stack Gas	g/gmol	27.96	27.70	27.83	27.43	27.51	27.467
	Ms= Mdx(1-Bwo/100) + 18(Bwo/100)							
18. Cp	Pitot Tube Coefficient	no units	0.85	0.85		0.85	0.85	
19. TsR	Avg. Stack Temp	deg. F	124	138	131	141	143	142.000
	Deg. R = Deg. F + 460 Absolute	deg. R	584	598	591	601	603	602.000
20. Psg	Static Guage Pressure of Stack	in H2O	0.15	0.22	0.19	0.17	0.25	0.210

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PARTICULATE CALCULATIONS

				RUN 1	RUN 2	Avg	RUN 1	RUN 2	Avg
21.	Ps	Abs. Stack Press.=Pbar +(Psg/13.6)	in Hg	29.91	29.92		29.91	29.93	
22.		Avg Square Root Delta-p	(sq. rt.in H2O)	0.5975	0.6325	0.62	0.7835	0.6648	0.724
23.	Vs	Velocity of Stack Gas							
		= 85.49xCpx[Sq.Rt.(TsR/PsMs)]x[Avg.Sq.Rt.(dp)]	fps	36.28	39.05	37.66	48.73	41.34	45.038
24.	Ds	Stack Diameter	inches	16.00	16.00		16.00	16.00	
	As	Stack Area	sq. feet	1.3963	1.3963		1.3963	1.3963	
25.	Qs	Actual Flow Rate = AsxVsx60	acfm	3039.4	3271.1	3155	4082.5	3463.6	3773.1
26.	Qsstd	Standard Flow Rate, Dry							
		Qsstd= 17.64x(QsPs/TsR)x(1-Bwo/100)	scfmd	2397.3	2452.9	2425	2954.1	2481.3	2717.7
27.	m	Particulate Catch Front Half	grams	0.0357	0.0329	0.03	0.0443	0.0452	0.045
		Back Half	grams	0.0000	0.0000		0.0016	0.0003	
		Total	grams	0.0357	0.0329		0.0459	0.0455	
28.	Dn	Nozzle Diameter	inches	0.2450	0.2500		0.2500	0.2500	
	An	Nozzle Area	sq. inches	0.047143	0.049087		0.049087	0.049087	
29.	O	Run Time	minutes	60	60		72	72	
30.	Cs	Conc. = mx15.43/Vmstd Front	grains/dscf	0.0151	0.0134	0.01	0.0125	0.0146	0.014
		Back	grains/dscf	0.0000	0.0000		0.0005	0.0001	
		(x 12/%CO2,combustion) Total	grains/dscf	0.0151	0.0134		0.0130	0.0147	
		@7%O2 Front x 13.9/(20.9-%O2)	grains/dscf	0.029	0.029		0.026	0.027	
		@12%CO@ Totalx12/%CO2	grains/dscf	0.033	0.031		0.029	0.026	
			(PA Regulation - 1 Decimal Place)						
31.	pmr(c)	Mass Rate = 0.1323xmxQsstd/Vmstd							
		(Regulatory Rate) Front	#/Hr	0.31	0.28	0.30	0.32	0.31	0.314
		Back	#/Hr	0.000	0.000		0.011	0.002	
		Total	#/Hr	0.31	0.28		0.33	0.31	
32.	pmr(a)	Mass Rate (Area Ratio) Front or Tot.							
		pmr(a) = 19.048 x mxAs/(OxAn)	#/Hr.	0.34	0.30		0.33	0.34	
33.	I	% Isokinetic = (pmr(a)/pmr(c)) x 100	%	108.43	105.65		104.95	109.31	
				Permitted 90-100%					

Mr. Ralph Manco, VP, Institutional Affairs
Inlet - HCl, SO2 . Outlet - O2, Particulate, Metals, HCl, SO2, CO, VE
C.B. Model 1280-A/72 825 #/Hr - Gas/#6 oil. Gas during tests.
Anderson 2000 Model WAV -97 venturi - 18" dp then packed tower and demister.
Caustic solution in the scrubber.
ID at inlet sampling duct (not stack outlet) - 19.5 inches. 2 dia up and 8 down
ID at outlet duct (not the stack) - 16" - also 2 and 8 dias. 12 points per site were used.

Charge 195 #/12 min
980 lb/hour mixed

Category - New Regulation XI, Non BAT

Allowable		Actual
Particulate	0.03 gr/dscf @ 7% O2 and 0.1 gr/dscf @ 12% CO2 PA	0.026-0.029 gr/dscf at 7%O2
Sulfur Dioxide	100PPMV or 70% control.	0.04 PPMV and >99.6%
Hydrogen Chloride	- 50 PPMV or 90% control.	0.7 PPMV and >99.9%
Carbon Monoxide	- 100 PPMV,4 day and 400 PPMV 8 hour.	18-60 PPMV
Comb Eff	- 99.9% 4 day running average = 100*CO2/(CO2+CO)	99.93-99.97

CO	RUN 1	RUN 2	Avg
Date	07/21/89	07/21/89	
Time	'1105-1213	'1307-1410	
DSCFM	2406	2461	2433.500
PPMV-dry	18	30	24.000
Lb/Hr	0.19	0.32	0.255
G/sec	0.02	0.04	0.030

Combustion Efficiency Based On EPA 1&2/CO tests

RUN 1	RUN 2	Avg	
0.0018	0.003		CO - %
5.4	5.2		CO2 -%
99.97	99.94		C. E.

Inlet Sulfur Dioxide

	RUN 1A	RUN 1B	Avg	RUN 2A	RUN 2B	Avg
Date	07/24/89	07/24/89		07/24/89	07/24/89	
Time	'1255-1315	'1347-1407		'1436-1456	'1514-1534	
DSCFM	2950	2950	2950.000	2945	2945	2945.000
PPMV-dry	14.8	27.2	21.000	82.4	90.3	LD
Lb/Hr	0.22	0.4	0.310	1.2	1.3	1.250
G/sec	0.03	0.05	0.040	0.15	0.16	0.155

Outlet Sulfur Dioxide EPA - RM 6. 15ml 80% isopropanol, glass plug outlet arm, 1LPM

	RUN 1A	RUN 1B	Avg	RUN 2A	RUN 2B	Avg
Date	07/24/89	07/24/89		07/24/89	07/24/89	
Time	'1255-1315	'1347-1407		'1436-1456	'1514-1534	
DSCFM	2382	2382	2382.000	2750	2750	2750.000
PPMV-dry	0.04	0.04	0.040	0.04	0.04	LD
Lb/Hr	0.001	0.001	0.001	0.001	0.001	LD
G/sec	0.00012	0.00012	1.20E-04	0.00012	0.00012	LD
Efficiency	99.6	99.76	99.680	99.92	99.925	99.923 Minimum

	Hydrogen Chloride Inlet			Hydrogen Chloride Outlet		
CO	RUN 1	RUN 2	Avg	RUN 1	RUN 2	Avg
Date	07/21/89	07/21/89		07/21/89	07/21/89	
Time	'1104-1206	'1305-1410		'1104-1206	'1305-1410	
DSCFM	3059	3049	3054.000	2406	2461	2433.500
PPMV	1719	993	1356.000	0.7	0.7	0.700
Lb/Hr	29.7	17.1	23.400	0.01	0.01	0.010
G/sec	3.7	2.2	2.950	0.0013	0.0013	1.30E-03
			Efficienc	99.959278	99.929506	99.944

H20 - Inlet
H20 - Outlet

Mercuric Nitrate Titration 0.1N NaOH
One hour each - approx. 30 cuTitrate with Hg(NO3)3% H2O2
Pretreatment for sulfite interference and Rexyn 101-H column for end-point masking by cat
Non- iso pre-scrubber.

PLANT _____Nazareth Hospital
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Metals

07/24/89	RUN 1	RUN 2	RUN 1	RUN 2				
Time	'1015-1130'	'1200-1315						
DSCF-Vol	44.82	50.64						
DSCM-Vol	1.269	1.434						
DSCFM	2389	2750						
UG/DSCM	ug/m³	ug/m³	Gr/dscf	Gr/dscf			Gr/dscf Max	Avg
Sb	19.8	20.9	0.0000086	0.0000091	(5)	Antimony Sb	0.000009	0.000008
As	2	2.5	0.0000008	0.0000010	(6)	Arsenic As	0.000001	0.000000
Be	0.9	0.8	0.0000003	0.0000003	(11)	Beryllium Be	0.000000	0.000000
Cd	243.4	70	0.0001063	0.0000305	(17)	Cadmium Cd	0.000106	0.000068
Cr all	15.8	ND	0.0000069	ND	(26)	Chromium Cr	0.000006	0.000006
Pb	1339.3	327.7	0.0005852	0.0001432	(All	Valences)**		
Mn	28	32.3	0.0000122	0.0000141	(53)	Lead Pb	0.000585	0.000364
Hg	2198.7	766.9	0.0009608	0.0003351	(54)	Manganese Mn	0.000014	0.000013
Ni	ND	ND	ND	ND	(55)	Mercury Hg	0.000960	0.000647
Be	ND	ND	ND	ND	(65)	Nickel Ni	0	0
Th	2.3	3.5	0.0000010	0.0000015	(88)	Thallium Tl	0.000001	0.000001

Quartz nozzle, glass fiber filter.Empty, 2x 5% nitric/10% H2O2, 1x 1.5%KmNo4, silica gel.
Analysis by SW-846, 7000 Series. Acid digest - Method 3050.

Oxygen/Carbon Dioxide.

	RM5 - at the scrubber inlet			DER		
	RUN 1	RUN 2	Avg	RUN 1	RUN 2	Avg
Max O2-%	14.2	15				
Min O2-%	12.5	13.9				
Avg O2-%	13.7	14.5	14.100			
Max CO2-%	6.9	5.9				
Min CO2-%	4.4	4.4				
Avg CO2-%	5.4	5.2	5.300			
Max CO - PPMV	50	60				
Min CO - PPMV	9	14				
Avg CO - PPMV	19.6	32.6	26.100			

Outlets - Integrated Bag

CO2 - %	15.2		14.6	13.8
O2 - %	5		5.5	6.4
CO - PPMV	32.5		20.8	
C.E.=100*CO2/(CO2+CO)	99.935042		99.962196	

Nazareth Hospital
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Infectious Waste Incinerator
7/21-24/89 Tests, 9/89 Rpt, 10/2/89 Rev

Charge

Primary T F Range	'1095-1450
Secondary T F Range	'1894-2324
AB T F Range	'1733-2113
Stack Draft Range -	'0-0.13
Bypass T F Range	'145-373
Scrubber GPM	7.0-9.5
Scrubber dP In. H2O	'19-27
Scrubber pH	'6-9.8
Scrubber H2O Inlet P	'21-31"
Scrubber Bed dP "H2O	'2-4
Makeup H2O	'48-53.9
Venturi GPM	'40
Tower GPM	'50