AP42 Section 1.4
4/93
Reference 17

Source Test for Measurement of Nitrogen Oxides and Carbon Monoxide Emissions from Boiler Exhaust at

GAF BUILDING MATERIALS
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Fontana, CA 92335

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PES Job Number: 4450
5/16/91

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INTRODUCTION and PROCESS DESCRIPTION

Pacific Environmental Services (PES) was retained by Southern California Boiler Company to measure CO and NOx emissions from a 16.8 MMBTU boiler located at GAF Building Materials in Fontana, CA. The tests were conducted to determine compliance with SCAQMD method 1146.

The object of the source test was to determine NOx and CO emissions under minimal, normal, and maximum load conditions with the boiler operating on number 2 fuel oil and natural gas. Instruments were used to determine the concentrations of oxides of nitrogen, oxygen, and carbon dioxide on a continuous basis. A velocity traverse was conducted to determine the volumetric stack gas flow rate for each fuel. PES conducted the test on May 13, 1991. The test was performed by Steve Hernandez and Siya Mokh of PES. Mr M. Dean High, Senior Vice President of PES, provided guidance and supervision for planning and supervision purposes.

The existing water tube boiler was retrofitted with an Industrial Combustion Model LNDG-210P burner assembly rated at 16.8 MMBTU/hr for natural gas and No. 2 fuel oil. The boiler is equipped with a flue gas recirculation (FGR) system and a oxygen trim system (see Figure 1). The permit to Construct for this equipment can be found in Appendix A.

TEST METHODOLOGY

For each test condition, SCAQMD method 100.1 was used to determine the oxides of nitrogen (NO_x), carbon monoxide (CO), carbon dioxide (CO_2), and oxygen (O_2) levels in the effluent gas from the boiler. The concentrations were measured by using a Continous Emissions Monitoring System (CEMS) installed in a PES mobil monitoring van. A schematic of this system is shown in Figure 2.

A Horiba model PIR 2000 non-dispersive infrared analyzer was used to determine the carbon monoxide concentration, a Beckman Industrial Model 880 Nondispersive Infrared Analyzer was used to determine the CO_2 concentration, a Beckman Industrial Model 755 Paramagnetic Analyzer was used to determine the oxygen concentration, and a Thermo Electron Model 10 Chemiluminescent Analyzer was used to determine the NOx concentration. Specifications for each analyzer are shown in Table 1. The output of the analyzers was linearized by the manufacturers.

The monitoring train consisted of a 3/8-inch stainless steel sampling probe, a 3/8-inch heated Teflon sampling line, a sample refrigeration system (operated at 40°F), a glass fiber filter in a 47 mm stainless steel holder, a diaphragm vacuum pump, and a sample distribution manifold. The distribution manifold was equipped with a series of 3-way valves with flow meters (rotometer style). One flow meter acted as a bypass, and the others were connected to the individual analyzers. The output of each analyzer was logged 60 times per minute with a Yokogawa Model 2400 multi-channel strip chart recorder. The recorder monitored the output of each individual analyzer on a separate channel scaled specifically for that component.

Prior to the source tests, the suction side of the monitoring system was leak-checked at 20" vacuum, and the sampling bias of the system was determined by introducing a CO, CO_2, O_2 span gas blend at the tip of the sampling line. A comparison of the analyzer responses was made between the span gas introduced at the sample line tip and the span gas introduced directly to the analyzers to ensure a differential of less than 5%. Since all analyzers were left on line during this procedure, a cross interference check was accomplished at the same time. The analyzers were spanned at a point between 20% and 80% of full scale before and after each source test with NBS traceable calibration gases, and with zero nitrogen. Table 2 lists all the gases used.

Table No. 1 Continuous Monitor Specifications

NO_x Chemiluminiscent Analyzer - Thermo-Electron Model 10A

Response Time	1.5 sec - NO 1.7 sec - NOx
Zero Drift	± 0.5% after warm up (30 min)
Linearity	± 1% of full scale
Accuracy	Derived from the calibration NO/NOx ± 1% gas was used.
Output	NO 0-10 Vdc NOx 0-1 Vdc (Scaled 0-100 ppm on stripchart)

O2 Paramagnetic Analyzer - Beckman Model 755R

Response Time	2 Sec
Zero Drift	± 1% of full scale
Linearity	± 1% of full scale
Accuracy	Derived from the calibration O2 ± 1% gas was used.
Output	0-1 Vdc (Scaled 0-25.0% on stripchart)

CO/CO2 Infrared Analyzers - Horiba model PIR 2000, Beckman 880

Response Time	2 sec.
Zero Drift	± 1% of full scale
Span Drift	± 1% of full scale
Linearity	± 1% of full scale
Accuracy	Derived from the calibration CO ± 1% gas was used.
Output	0-1 Vdc (Scaled 0-500ppm on strip chart)

Table No. 2 Calibration Gases

Gas Composition	Use:	Cylinder Ser. No.	Certified Accuracy	Analysis Date
Nitrogen	Zero Gas	AAL2931	Zero Grade	N/A
19.9% O2 400 ppm CO 4.0% CO2 Bal N2	Span Gas	ALMO 13973	± 1%	2-12-91
4.0% O2 2000 ppm CO 8.0% CO2 Bal N2	Span Gas	ALMO 12743	± 1%	3-21-91
NO 92.57 ppm NO_x 92.82 ppm Bal N2	Span Gas	AAL 2284	± 1%	5-6-91 Exp 11-92

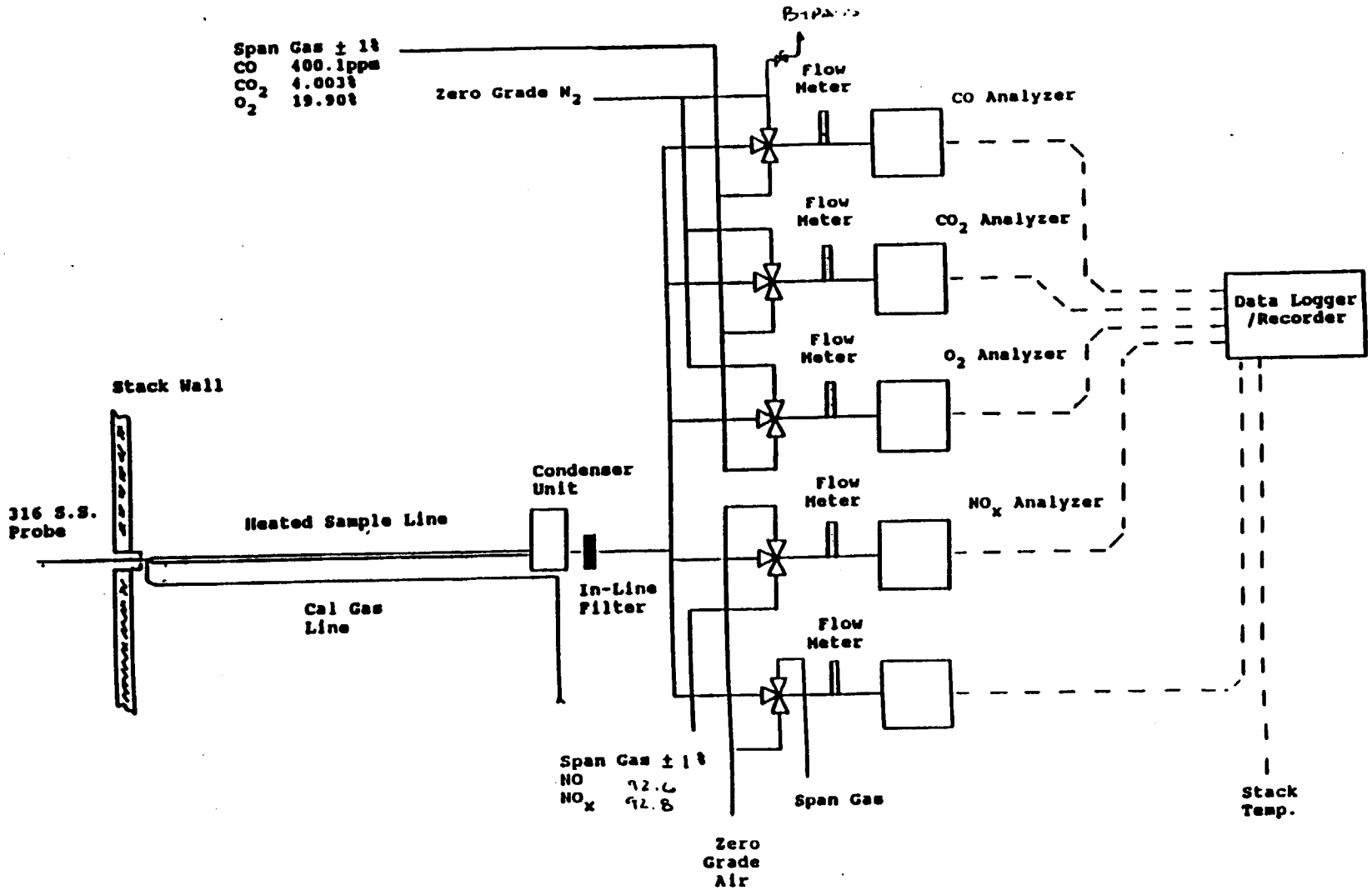
Span Gas ± 1%
CO 400.1ppm
CO_2 4.003%
O_2 19.90%
Zero Grade N_2
Flow Meter
CO Analyzer
Flow Meter
CO_2 Analyzer
Flow Meter
O_2 Analyzer
Flow Meter
NO_x Analyzer
Flow Meter
Data Logger /Recorder
Stack Wall
316 S.S. Probe
Heated Sample Line
Condenser Unit
In-Line Filter
Cal Gas Line
Span Gas ± 1%
NO 92.6
NO_x 92.8
Span Gas
Zero Grade Air
Stack Temp.

FIGURE 2

TEST RESULTS

The first three tests were conducted with the boiler using number 2 fuel oil. Test 1 was conducted at a minimum firing rate of 3.5 MMBTU/hr, test 2 was conducted at a normal firing rate of 8.12 MMBTU/hr, and test 3 was conducted at a maximum firing rate of 16.1 MMBTU/hr. The second three tests were run with the boiler using natural gas. Test 4 was conducted at a minimum firing rate of 3.26 MMBTU/hr, test 5 was conducted at a normal firing rate of 9.5 MMBTU/hr, and test 6 was conducted at a maximum firing rate of 16 MMBTU/hr.

Since no steam was produced with this type of boiler, loads were determined by the fuel consumption during the test period.

The results of each test are presented with all relative data and the monitored and corrected concentrations. Table 3 details the results for No. 2 fuel oil, and Table 4 the results for natural gas.

Table No. 3 Fuel Oil *

RUN 1:

Condition: 25% of load capacity 3.5 MMBTU/hr
Fuel: No. 2 Fuel oil 25 gal/hr

		RESULTS			
Pollutant	Units	Measured	Corr to 3%	Allowed	SCAQMD Rule
NO_x	ppm	21.4	22.6	40	1146
** CO	ppm	80.4	85.2	400	1146

RUN 2:

Condition: 50% of load capacity 8.12 MMBTU/hr
Fuel: No. 2 Fuel Oil 58 gal/hr

		RESULTS			
Pollutant	Units	Measured	Corr to 3%	Allowed	SCAQMD Rule
NO_x	ppm	29.6	28.8	40	1146
CO	ppm	121.2	118.0	400	1146

RUN 3:

Condition: 100% of capacity 16.1 MMBTU/hr
Fuel: No. 2 Fuel Oil 115 gal/hr

		RESULTS			
Pollutant	Units	Measured	Corr to 3%	Allowed	SCAQMD Rule
NO_x	ppm	29.0	27.9	40	1146
CO	ppm	192.9	185.6	400	1146

* Special Low NOx Oil referred to as "Low Sulfur #2 Fuel Oil" by SCAQMD

** High CO due to abnormally low O_2 ($< 3\%$) during test run

Table No. 4 Natural Gas

RUN 4:

Condition: 25% of capacity — 3.3 MMBTU/hr
Fuel: Natural Gas — 3,102 cu ft/hr

		RESULTS			
Pollutant	Units	Measured	Corr to 3%	Allowed	SCAQMD Rule
NO_x	ppm	21.8	28.2	40	1146
*CO	ppm	48.2	62.5	400	1146

RUN 5:

Condition: 50% of load cpacity — 9.5 MMBTU/hr
Fuel: Natural Gas — 9,069 cu ft/hr

		RESULTS			
Pollutant	Units	Measured	Corr to 3%	Allowed	SCAQMD Rule
NO_x	ppm	21.0	26.9	40	1146
CO	ppm	84.8	108.4	400	1146

RUN 6:

Condition: 100% of load capacity — 16.0 MMBTU/hr
Fuel: Natural Gas — 15,275 cu ft/hr

		RESULTS			
Pollutant	Units	Measured	Corr to 3%	Allowed	SCAQMD Rule
NO_x	ppm	19.0	22.6	40	1146
CO	ppm	103.7	123.8	400	1146

* High CO due to abnormally high Flue Gas Recirculation during test run (>20%)

SOURCE CATEGORY: Natural Gas

EXCLUSION CRITERIA CHECKLIST

REFERENCE [illegible]

CRITERIA	YES	NO
1. Test series averages are reported in units that can be converted to the selected reporting units?	✓	
2. Test series represent compatible test methods?	✓	
3. In tests in which emission control devices were used, the control devices are fully specified?	✓	
4. Is it clear whether or not the emissions were controlled (or not controlled)?	✓	

Form filled out by [illegible]

Date [illegible]

INDICATE WHETHER ANSWER IS YES OR NO WITH AN "X" IN APPROPRIATE BOX.

IF ALL ANSWERS ARE "YES" PROCEED TO METHODOLOGY/DETAIL CRITERIA CHECKLIST.

SOURCE CATEGORY [illegible]

METHODOLOGY/DETAIL CRITERIA CHECKLIST

REFERENCE [illegible]

CRITERIA	YES	NO	COMMENTS
1. Is the manner in which the source was operated well documented in the report?	✓		
Was the source operating within typical parameters during the test?	✓		
2. Did sampling procedures deviate from standard methods?		✓	
If so, were the deviations well documented?			
Were the deviations appropriate?			
Comment on how any alterations in sampling procedure may have influenced the results.			
3. Were there wide variations in the results?		✓	
If yes, can the variations be adequately explained by information in the report?			Y
If the variations are not well explained, should the data be considered of poor quality?			Y
4. Do the test reports contain the raw data sheets?		✓	
Are the nomenclature and equations used equivalent to those specified by the EPA?	✓		
Comment on the consistency and completeness of the results.	✓		[illegible]

Form filled out by [illegible]

Date [illegible]

INDICATE YES OR NO WITH AN "X" IN THE APPROPRIATE BOX. FILL IN COMMENTS.

IF, BASED ON ABOVE ANSWERS, THE SOURCE REPORT PROVIDES ADEQUATE DETAIL AND DEMONSTRATES SOUND METHODOLOGY, PROCEED TO RATING THE DATA IN THE RATING CRITERIA CHECKLIST.

SOURCE CATEGORY [illegible]

RATING CRITERIA CHECKLIST

Reference [illegible]

RATING CRITERIA	YES	NO
A Tests performed by a sound methodology and reported in enough detail for adequate validation?		
B Tests were performed by a generally sound methodology, but not enough detail for adequate validation?		
C Were tests based on untested or new methodology that lacks significant amount of background data?		
D Were tests based on generally unacceptable methods, but may provide order-of-magnitude values for the source?		

COMMENTS
[illegible]

Form filled out by [illegible]

Date [illegible]

BASED ON ANSWERS AND COMMENTS ABOVE, ASSIGN A RANK TO THIS LITERATURE SOURCE:

B

RANK ASSIGNED TO EMISSION SOURCE DATA

PES/GAF Building Materials

Natural gas combustion

With flue gas recirculation + LNE

Test No.	Load, % of Max	Emissions, ppm: CO @ 3% O2	Emissions, ppm: NOx @ 3% O2	Emissions, ppm: CO2	Emissions @ 0% O2: % O2	Emissions @ 0% O2: CO	Emissions @ 0% O2: NOx	Emissions @ 0% O2: CO2	CO EF, lb/MM ft3	NOx EF, lb/MM ft3	CO2 EF, lb/MM ft3
4	25	62.5	28.2	-	NA	73	33	ERR	.050 52	.037 39	ERR
5	50	108.4	26.9	-	NA	127	31	ERR	91	37	ERR
6	100	123.8	22.6	-	NA	145	26	ERR	.099 104	.030 31	ERR
								Averages	82.5	35.7	ERR
									.057	.036	

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