WI & SCR. Ref 17a.

CO NOx Inlet

CO NOx Outlet. ROG NH3.

272

"13"

EMISSION TESTING AT THE BONNEVILLE PACIFIC COGENERATION PLANT

February 26 and 27, 1992

3-1

Prepared for:

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SECTION 1

INTRODUCTION

At the request of Bonneville Pacific Corporation, Steiner Environmental, Inc. undertook a series of emission measurements at the inlet and outlet of the SCR catalyst at the cogeneration plant located in Santa Maria, California on February 26 and 27, 1992. The purpose of these tests was to determine compliance with Santa Barbara County APCD Rules and Regulations.

The plant is governed by conditions in Authority to Construct Permit Application No. 6116 and the Final Decision Document dated March 3, 1987.

1.1 GENERAL DESCRIPTION

The Santa Maria Cogeneration Plant consists of a nominal 9 MW combustion gas turbine generator (CGTG) operated as a base load facility with 43,500 lb/hr design capacity heat recovery steam generator (HRSG) which is unfired. Steam is produced in the HRSG at 175 psig, saturated and supplies the motive fluid for a 890 ton capacity, ~33°F Aqua Ammonia Absorption Refrigeration System (AAAR). Refrigeration is supplied to a frozen vegetable processing plant owned by Bonneville Pacific Corporation and operated under a service contract by ALPAC Foods, Inc., located in Santa Maria, California. In addition, steam is supplied directly from the plant for use in the vegetable blanching process at the food

operations at the rate of 10,000 lb/hr. The net electrical output of the plant is supplied to Pacific Gas & Electric Company (PG&E). The plant meets the air quality requirements for the County of Santa Barbara Air Pollution Control District (SBAPCD) utilizing best available control technology (BACT). BACT, in California, for a CGTG is water injection and a selective catalytic reduction system (SCR) on the discharge of the CGTG for 80% reduction of nitrogen oxides.

Water injection into the turbine (0.8 lb H_2O:1.0 lb Fuel) reduces NO_x emissions from the turbine by 50%. The SCR is supplied by W. R. Grace (using CAMET technology) and is a low temperature (420°F ±20°F) platinum based catalyst which provides an overall 80% reduction in NO_x and a significant reduction in CO and hydrocarbon as well.

Hot exhaust gases from the turbine (950°F) enter a transition duct which contains the NH_3 injection grid (6 horizontal tubes with reserve side holes). The exhaust gases are mixed with NH_3, diluted with ambient air (2% mix) at a 1.1 lb/mole NH_3:1.0 lb/mole NO_x ratio, and pass over boiler tubes to remove some of the heat from the exhaust gases. The gases enter the SCR transition duct which contains flow straighteners to properly distribute the gases across the next section of boiler tubes. These tubes reduce the temperature of the exhaust gases to 420°F and provide additional mixing to insure uniform distribution of exhaust gases across the catalyst. The catalyst consists of 24.5-inch x 22-inch blocks (total 40) in a steel frame. The exhaust gases then leave the HRSG and enter the stack.

A CEMS has been installed to provide control for the NH_3 injection system and to monitor emissions from the stack. The CEMS is supplied

by PACE Associates and is an extractive system which monitors NO_x at the turbine exhaust and NO_x and O_2 at the stack exhaust. All concentrations are measured on a dry basis utilizing a TECO Model 10S NO_x analyzer and a Thermox Model LS O_2 analyzer. A Dietrich-Standard annubar is installed in the stack to convert the concentration data to lb/hr.

1.2 COMPLIANCE TESTING

Compliance tests were conducted upstream of the SCR for NO_x and downstream of the SCR for NO_x, CO, ROG, NH_3 and flowrate at different loads, with water injection. Testing upstream and downstream of the SCR was performed simultaneously using the average of three tests to determine compliance.

1.3 CEMS CERTIFICATION

Nine relative accuracy tests were extracted from the compliance testing data and used to certify the inlet and stack NO_x and the stack O_2 analyzers using EPA Performance Specifications 2 and 3.

Section 2 of this report describes the test matrix for this program.

SECTION 3

TEST RESULTS

Tables 3-1 to 3-6 summarize the results of the emission tests performed at the inlet and outlet of the SCR. Tables 3-7 to 3-11 summarize the results of the relative accuracy tests performed on the NO_x and O_2 continuous emission monitors located at the inlet and outlet of the SCR and the annubar installed in the stack.

3.1 COMPLIANCE TESTING

Emissions from the cogen are limited to 5.90 lb/hr NO_x and 48 ppm NO_x at 3% O_2, 5.70 lb/hr CO and 0.40 lb/hr ROG. NO_x and CO were within the permit limits. The average ROG met the lb/hr limit for the 100% load tests.

ppm
480 3% O2

3.2 RELATIVE ACCURACY TESTING

The stack NO_x analyzer failed the ±20% limit for relative accuracy. However, using the 5.9 lb/hr limit for NO_x and back calculating a corresponding ppm limit (11.81 ppm), the stack NO_x analyzer passed the ±10% limit of the standard allowed by EPA Performance Specification 2. The stack O_2 monitor passed the relative accuracy limit of ±20% and the stack annubar passed the ±20% relative accuracy limit.

3.3 NO_x REDUCTION EFFICIENCY

With the turbine operating at 100% load and the water injection on (0.85:1.0), the SCR inlet NO_x measured 137.57 ppm, 139.49 ppm and

132.45 ppm at 3% O_2. At the same time, NO_x measured at the SCR outlet was 14.39 ppm, 11.82 ppm and 11.64 pm at 3% O_2 with an ammonia injection rate of 1.4:1.0. Reduction efficiencies of 89.54%, 91.53% and 91.21% were achieved across the SCR.

TABLE 3-1. SUMMARY OF SOURCE EMISSION TESTS

Unit Tested: Bonneville Pacific Corp.
HRSG Inlet

Date: February 26, 1992

Test Number	1	2	3	Average
Test Condition	100% Gas	100% Gas	100% Gas	
F-Factor	8510.55	8510.55	8510.55	8510.55
GAS DATA				
Gas Analysis (Dry % Basis)				
Carbon Dioxide	3.26	3.32	3.31	3.30
Oxygen	15.46	15.45	15.39	15.43
EMISSION CONCENTRATION - ppm				
CO	5.39	5.40	5.90	5.56
NO_x	41.81	42.47	40.77	41.68
EMISSION FACTOR - lb/MMBtu				
CO	0.0130	0.0130	0.0141	0.0134
NO_x	0.1659	0.1682	0.1595	0.1646
EMISSION FACTOR - ppm @ 3% O_2				
CO	17.74	17.74	19.17	18.19
NO_x	137.57	139.49	132.45	136.39

WI #'s.

Qstd = 68,642 DSCFM
avg.
first
3 runs

TABLE 3-2. SUMMARY OF SOURCE EMISSION TESTS

Unit Tested: Bonneville Pacific Corp. HRSG Inlet

Date: February 26, 1992

Test Number Test Condition	4 75% Gas	5 75% Gas	6 75% Gas	Average
F-Factor	8510.55	8510.55	8510.55	8510.55
GAS DATA				
Gas Analysis (Dry % Basis)				
Carbon Dioxide	3.01	3.00	3.00	3.00
Oxygen	15.96	16.04	16.05	16.01
EMISSION CONCENTRATION - ppm				
CO	14.05	13.96	16.23	14.75
NO_x	27.98	27.58	26.58	27.38
EMISSION FACTOR - lb/MMBtu				
CO	0.0374	0.0377	0.0439	0.0397
NO_x	0.1222	0.1224	0.1182	0.1209
EMISSION FACTOR - ppm @ 3% O_2				
CO	50.91	51.42	59.90	53.99
NO_x	101.39	101.58	98.10	100.23

TABLE 3-3. SUMMARY OF SOURCE EMISSION TESTS

Unit Tested: Bonneville Pacific Corp. HRSG Inlet Date: February 26, 1992

Test Number	7	8	9	Average
Test Condition	50% Gas	50% Gas	50% Gas	
F-Factor	8510.55	8510.55	8510.55	8510.55
GAS DATA				
Gas Analysis (Dry % Basis)				
Carbon Dioxide	2.78	2.74	2.77	2.76
Oxygen	16.43	16.21	16.35	16.33
EMISSION CONCENTRATION - ppm				
CO	32.38	28.20	36.28	32.39
NO_x	21.26	21.69	20.67	21.21
EMISSION FACTOR - lb/MMBtu				
CO	0.0952	0.0789	0.1049	0.0930
NO_x	0.1027	0.0997	0.0981	0.1002
EMISSION FACTOR - ppm @ 3% O_2				
CO	129.66	107.63	142.73	126.87
NO_x	85.14	82.78	81.32	83.08

TABLE 3-4. SUMMARY OF SOURCE EMISSION TESTS

Unit Tested: Bonneville Pacific Corp. HRSG Stack

Date: February 26, 1992

Test Number Test Condition	1 100% Gas	2 100% Gas	3 100% Gas	Averagee
Barometric Pressure (in. Hg)	30.20	30.18	30.21	30.20
Stack Pressure (in. Hg)	30.16	30.11	30.16	30.14
Stack Area (ft^2)	23.758	23.758	23.758	23.758
Elapsed Sampling Time (min.)	62.50	62.50	62.50	62.50
Volume Gas Sampled (dscf)	51.765	51.008	52.047	51.607
F-Factor	8510.55	8510.55	8510.55	8510.55
GAS DATA				
Average Gas Velocity (fps)	83.50	84.71	86.00	84.74
Average Gas Temperature (°F)	384.29	387.50	391.38	387.72
Gas Flowrate (dscfm)	68,088	68,550	69,288	68,642
Gas Analysis (Dry % Basis)				
Carbon Dioxide	3.10	3.12	3.09	3.10
Oxygen	15.54	15.48	15.47	15.50
Water	7.90	8.00	8.20	8.03
EMISSION CONCENTRATION - ppm				
CO	0.00	0.16	0.01	0.06
$>C_1$ HC	1.28	3.16	2.49	2.31
NH_3	4.61	4.95	4.13	4.56
NO_x	4.31	3.58	3.53	3.81
EMISSION RATE - lb/hr				
CO	0.00	0.05	0.003	0.02
$>C_1$ HC	0.22	0.55	0.44	0.40
NH_3	0.85	0.92	0.77	0.85
NO_x	2.14	1.79	1.78	1.90
EMISSION FACTOR - lb/MMBtu				
CO	0.0000	0.0004	0.00002	0.0001
$>C_1$ HC	0.0018	0.0044	0.0034	0.0032 ROG.
NH_3	0.0069	0.0073	0.0061	0.0068
NO_x	0.0173	0.0143	0.0140	0.0152
EMISSION FACTOR - ppm @ 3% O_2				
CO	0.00	0.53	0.03	0.19
$>C_1$ HC	4.27	10.44	8.21	7.64
NH_3	15.39	16.35	13.61	15.12
NO_x	14.39	11.82	11.64	12.62

TABLE 3-5. SUMMARY OF SOURCE EMISSION TESTS

Unit Tested: Bonneville Pacific Corp. HRSG Stack

Date: February 26, 1992

Test Number	4	5	6	Average
Test Condition	75% Gas	75% Gas	75% Gas	
Barometric Pressure (in. Hg)	30.15	30.13	30.18	30.15
Stack Pressure (in. Hg)	30.12	30.10	30.15	30.12
Stack Area (ft^2)	23.758	23.758	23.758	23.758
Elapsed Sampling Time (min.)	62.50	62.50	62.50	62.50
Volume Gas Sampled (dscf)	53.336	53.613	53.505	53.485
F-Factor	8510.55	8510.55	8510.55	8510.55
GAS DATA				
Average Gas Velocity (fps)	75.12	75.42	75.99	75.51
Average Gas Temperature (°F)	379.92	381.67	382.54	381.38
Gas Flowrate (dscfm)	61,930	62,130	62,553	62,204
Gas Analysis (Dry % Basis)				
Carbon Dioxide	2.77	2.77	2.74	2.76
Oxygen	15.99	16.02	16.05	16.02
Water	7.20	7.00	7.20	7.13
EMISSION CONCENTRATION - ppm				
CO	0.31	0.50	0.93	0.58
NH_3	4.67	4.29	3.99	4.32
NO_x	2.03	2.06	2.27	2.12
EMISSION RATE - lb/hr				
CO	0.09	0.14	0.26	0.16
NH_3	0.78	0.72	0.67	0.72
NO_x	0.91	0.93	1.03	0.96
EMISSION FACTOR - lb/MMBtu				
CO	0.0008	0.0013	0.0025	0.0016
NH_3	0.0076	0.0070	0.0066	0.0071
NO_x	0.0089	0.0091	0.0101	0.0094
EMISSION FACTOR - ppm @ 3% O_2				
CO	1.13	1.83	3.43	2.13
NH_3	17.03	15.74	14.73	15.83
NO_x	7.40	7.56	8.38	7.78

TABLE 3-6. SUMMARY OF SOURCE EMISSION TESTS

Unit Tested: Bonneville Pacific Corp. HRSG Stack

Date: February 27, 1992

Test Number Test Condition	1 50% Gas	2 50% Gas	3 50% Gas	Average
Barometric Pressure (in. Hg)	30.20	30.21	30.21	30.21
Stack Pressure (in. Hg)	30.15	30.18	30.18	30.18
Stack Area (ft^2)	23.758	23.758	23.758	23.758
Elapsed Sampling Time (min.)	62.50	62.50	62.50	62.50
Volume Gas Sampled (dscf)	53.689	51.382	51.106	52.059
F-Factor	8510.55	8510.55	8510.55	8510.55
GAS DATA				
Average Gas Velocity (fps)	62.92	63.59	63.82	63.44
Average Gas Temperature (°F)	373.75	377.96	371.38	374.36
Gas Flowrate (dscfm)	52,601	53,052	53,655	53,103
Gas Analysis (Dry % Basis)				
Carbon Dioxide	2.49	2.50	2.50	2.50
Oxygen	16.45	16.42	16.34	16.40
Water	6.70	6.50	6.50	6.57
EMISSION CONCENTRATION - ppm				
CO	1.59	1.24	2.52	1.78
NH_3	4.56	3.94	4.65	4.38
NO_x	1.76	1.90	1.64	1.77
EMISSION RATE - lb/hr				
CO	0.37	0.29	0.60	0.42
NH_3	0.65	0.56	0.67	0.63
NO_x	0.67	0.73	0.64	0.68
EMISSION FACTOR - lb/MMBtu				
CO	0.0047	0.0036	0.0072	0.0052
NH_3	0.0082	0.0070	0.0082	0.0078
NO_x	0.0085	0.0091	0.0078	0.0085
EMISSION FACTOR - ppm @ 3% O_2				
CO	6.40	4.95	9.89	7.08
NH_3	18.34	15.74	18.25	17.42
NO_x	7.08	7.59	6.44	7.04