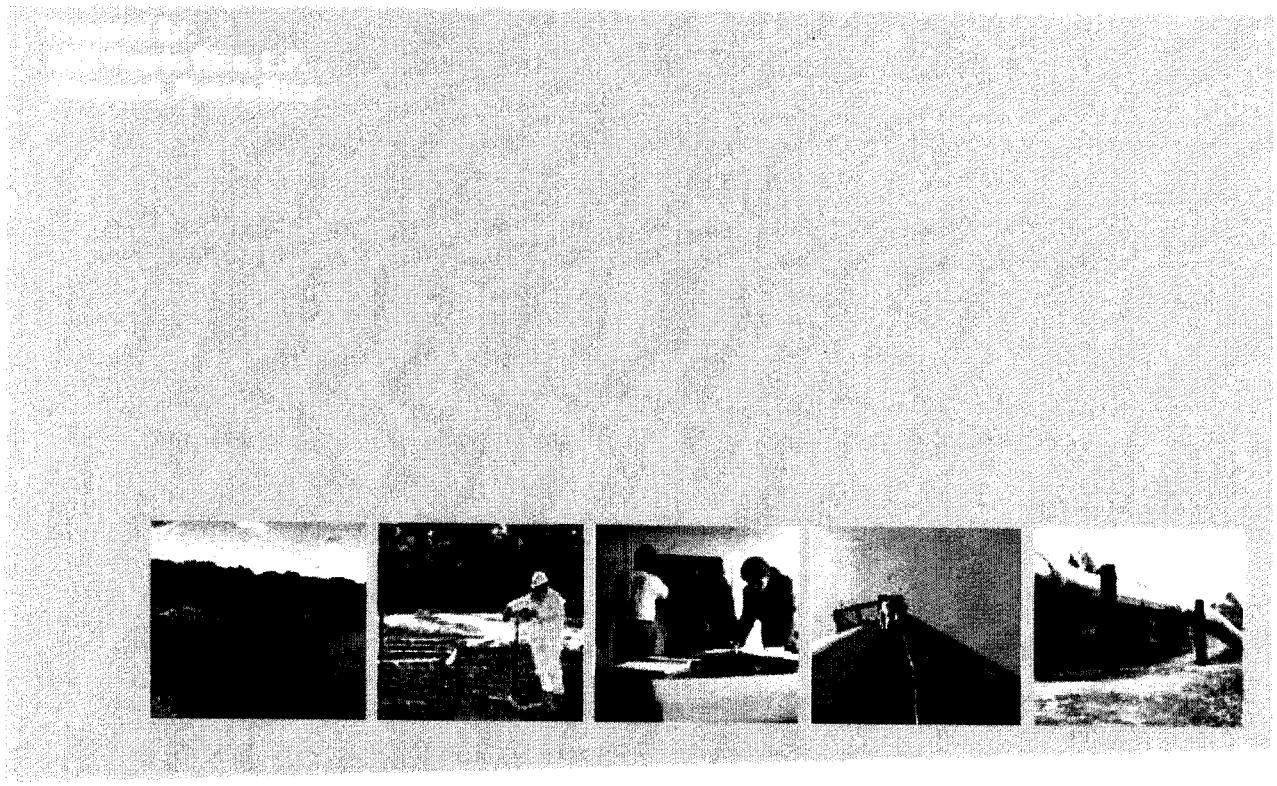

Relative Accuracy Test Audit Results for Units 1 and 2 Guayama Cogeneration Facility - December 2007

ENSR Corporation
December 21, 2007
Document No.: 00052-170-0004

ENSR | AECOM

Prepared for:
AES Puerto Rico, L.P.
Guayama, Puerto Rico

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Contents

APPENDICES

APPENDIX A – ENSR Field Data Sheets

APPENDIX B – Facility RA Data

APPENDIX C – Gas Certificates of Analyses, Equipment Calibration Forms, NO_x Converter Efficiency Results, Opacity Filter Certification Forms

List of Tables

1.0 Introduction

ENSR was retained by AES Puerto Rico, L.P. to conduct a series of performance specification tests during the week of December 3, 2007, at the Guayama Cogeneration Facility, located in Guayama, Puerto Rico. The power plant has two Continuous Emissions Monitoring Systems (CEMS) with Continuous Opacity Monitoring Systems (COMS) installed on Units 1 and 2. This document presents the results of the annual RATA conducted on the Unit 1 and Unit 2 CEMS and COMS.

A summary of results for the relative accuracy is presented in Table 1-1 for Unit 1 and Table 1-2 for Unit 2. The accuracy results indicate that the O_2, CO_2, NO_X, CO, flow and SO_2 analyzers were operating within their required accuracy criteria both on an individual monitor and system basis. Relative accuracy results were calculated for O_2% (dry), CO_2% (wet), Flow (kwscfm), NO_X lb/MMBtu, CO lb/MMBtu, SO_2 lb/MMBtu, and NO_X, CO and SO_2 corrected to 7%O_2. Opacity calibration error audits were performed on the Unit 1 and 2 Continuous Opacity Monitoring Systems (COMS). The calibration error results were within the required error limit for each system.

The remainder of this document is organized as follows. Section 2 of this document provides a summary and discussion of results for the relative accuracy test and opacity audit. A description of the flue gas monitoring, sampling port locations and facility CEMS system is provided in Section 3. Section 4 describes the test procedures that were followed and provides a description of ENSR's portable CEMS system. Section 5 describes the Quality Assurance/Quality control measures for the test program. Section 6 describes how the data reduction was performed. Three appendices are included as part of this report specifically: Appendix A - ENSR Field Data Sheets; Appendix B - Facility Data Sheets; Appendix C - Audit Gas Certificates of Analysis, Test Equipment Calibration Forms, NO_X Converter Efficiency Results and the Opacity Filter Certification Form.

Table 1-1 Relative Accuracy Test Audit and Opacity Audit Summary of Results for Unit 1

Analyzer / Parameter	Relative Accuracy Average	Relative Accuracy Criteria	Pass/Fail
O_2	*0.16%*	≤1% Absolute	Pass
CO_2	*0.33%*	≤1% Absolute	Pass
Stack Flow	*6.84%*	≤20% RA	Pass
NO_X lb/MMBtu	*5.30%* *5.19%*	≤20% RA or ≤10% of the applicable standard	Pass
NO_X @7%O_2	*4.99%* *4.89%*	≤20% RA or ≤10% of the applicable standard	Pass
CO lb/MMBtu	*8.68%* *4.15%*	<10% RA or 5% of the applicable standard	Pass
CO @ 7% O_2	*2.26%* *1.13%*	<10% RA or 5% of the applicable standard	Pass
SO_2 lb/MMBtu	*11.93%* *6.45%*	≤20% RA or ≤10% of the applicable standard	Pass
SO_2 @7%O_2	*9.92%* *5.53%*	≤20% RA or ≤10% of the applicable standard	Pass
Opacity Audit			
Opacity	*Low - 0.36%* *Mid - 0.23%* *High - 0.53%*	≤3% Calibration Error	Pass

Table 1-2 Relative Accuracy Test Audit and Opacity Audit Summary of Results for Unit 2

Analyzer / Parameter	Relative Accuracy Average	Relative Accuracy Criteria	Pass/Fail
O_2	*0.12%*	≤1% Absolute	Pass
CO_2	*0.72%*	≤1% Absolute	Pass
Stack Flow	*11.45%*	≤20% RA	Pass
NO_X lb/MMBtu	*5.37%* *4.35%*	≤20% RA or ≤10% of the applicable standard	Pass
NO_X @7%O_2	*5.18%* *4.19%*	≤20% RA or ≤10% of the applicable standard	Pass
CO lb/MMBtu	*7.61%* *4.97%*	<10% RA or 5% of the applicable standard	Pass
CO @ 7% O_2	*1.50%* *0.98%*	<10% RA or 5% of the applicable standard	Pass
SO_2 lb/MMBtu	*8.08%* *4.41%*	≤20% RA or ≤10% of the applicable standard	Pass
SO_2 @7%O_2	*6.95%* *3.79%*	≤20% RA or ≤10% of the applicable standard	Pass
Opacity Audit			
Opacity	*Low - 0.33%* *Mid - 0.08%* *High - 0.30%*	≤3% Calibration Error	Pass

2.0 Summary and Discussion of Results

This section summarizes the results of the RA test program. Results of the relative accuracy and opacity audit determinations are presented below.

2.1 Relative Accuracy Test Results

Relative accuracy testing was conducted using the instrumental analysis methods 3A for O_2 and CO_2, and 7E, 10 and 6C for NO_X, CO and SO_2 respectively. Actual Stack Flow was determined using US EPA Methods 1-4. The instrumental analysis results are referred to as the reference method results, which were measured on a dry concentration basis. The results of the RATA program for the AES CEMS Unit 1 are presented in Table 2-1 for O_2, CO_2 (wet) and Flow, Table 2-2 for NO_X, Table 2-3 for CO and Table 2-4 for SO_2. The results for the AES CEMS Unit 2 are presented in Table 2-5 for O_2, CO_2 (wet) and Flow, Table 2-6 for NO_X, Table 2-7 for CO and Table 2-8 for SO_2. ENSR field data sheets are presented in Appendix A. Facility test data are presented in Appendix B.

2.2 Stack Opacity Monitor Audit

The Spectrum System Model 41 Opacity monitor for Unit 1 and Unit 2 was audited according to EPA Document 450/4-92-010 "Performance Audit Procedures for Opacity Monitors," April 1992. The opacity audit procedure was comprised of an instrument inspection, calibration check, dirty window check procedure, alignment check, calibration error test and response time test. The calibration error test checked the opacity monitor's responses to three neutral density audit filters over a series of five repetitions. The calibration error criterion for each audit filter is $\leq$ 3%. Both opacity monitors passed the audit procedure. Table 2-9 presents a summary of the audit results for Unit 1 and Table 2-10 presents a summary of the audit results for Unit 2. Appendix B provides the facility data sheets for the opacity device response to the audit filters. Appendix C provides the Opacity Filter Certification Form

2.3 Discussion of the Audit Results

The results of the relative accuracy tests indicate that each analyzer was operating within their relative accuracy criteria. The CEMS were certified on both an individual analyzer basis and a system basis. The system emission calculations reported for the relative accuracy determination were calculated from O_2, CO_2, NOx, CO, SO_2 and Stack Flow values for each run. Emissions and Stack Flow logged from the AES CEMS should be considered representative of stack emissions. Opacity data generated from the COMS for each unit should be considered representative as well.

Table 2-1 Relative Accuracy Results for O_2, CO_2 and Flow – Unit 1

Analyzers::		Ranges:					Client:	AES	
Pollutant:		0-200 ppm dry					Site:	Guayama, PR	
Diluent:		0-25%, dry					Source:	Coal Fired Boiler No. 1	
		O2%, dry			CO2%, wet			Flow, kswcfm	
Date	Run No.	AES	ENSR	Difference (X)	AES	ENSR	Difference (X)	AES	ENSR	Difference (X)
11/6/2007	1	5.69	5.90	-0.21	12.20	11.88	-0.320	625.8	671.2	45.4
11/6/2007	2	5.68	5.89	-0.21	12.19	11.90	-0.290	625.3	672.4	47.1
11/6/2007	3	5.69	5.81	-0.12	12.17	11.87	-0.300	624.5	666.6	42.1
11/6/2007	4	5.69	5.69	0.00	12.05	11.87	-0.180	624.5	667.8	43.3
11/6/2007	5	5.71	5.78	-0.07	12.13	11.83	-0.300	624.8	672.2	47.4
11/6/2007	6	5.75	5.77	-0.02	12.09	11.81	-0.280	625.0	667.7	42.7
11/6/2007	7	5.71	5.86	-0.15	12.13	11.75	-0.380	625.0	669.9	44.9
11/6/2007	8	5.67	5.77	-0.10	12.00	11.79	-0.210	625.9	666.5	40.6
11/6/2007	9	5.65	5.72	-0.07	12.18	11.88	-0.300	625.0	666.9	41.9
Averages:		**5.69**	**5.80**	**-0.11**	**12.13**	**11.84**	**-0.28**	**625.1**	**669.0**	**43.9**
Intermediate Calculations:										
			X Avg. =	-0.1056		X Avg. =	-0.2844		X Avg. =	43.9333
			X Sum =	-0.95		X Sum =	-2.56		X Sum =	395.40
			[X Sum]^2 =	0.902		[X Sum]^2 =	6.554		[X Sum]^2 =	156341.160
			[Sum X^2] =	0.15		[Sum X^2] =	0.76		[Sum X^2] =	17416.90
			CC =	0.06		CC =	0.05		CC =	1.84
			Applicable Std. (ppm) =	None		Applicable Std. =	None		Applicable Std. =	None
Relative Accuracy Calculations:										
			Absolute Method, RA (%) =	**0.16**		Absolute Method, RA (%) =	**0.33**		Regular Method, RA (%) =	**6.84**
Limits: <1% Oxygen absolute					**Limits: <1% CO2 absolute**			**<20%RA or 10% of the applicable standard**		

Table 2-2 Relative Accuracy Results for NO_X – Unit 1

Analyzers::		Ranges:					Client:	AES
Pollutant:		0-50 ppm dry					Site:	Guayama, PR
							Source:	Coal Fired Boiler No. 1
		NOx, @7%O2			NOx, lb/MMBtu			
Date	Run No.	AES	ENSR	Difference (X)	AES	ENSR	Difference (X)	
11/6/2007	1	57.70	55.40	-2.30	0.093	0.097	0.004	
11/6/2007	2	58.18	55.71	-2.47	0.094	0.098	0.004	
11/6/2007	3	58.23	55.49	-2.74	0.094	0.097	0.003	
11/6/2007	4	60.30	57.08	-3.22	0.097	0.100	0.003	
11/6/2007	5	59.44	56.76	-2.68	0.096	0.100	0.004	
11/6/2007	6	58.76	56.20	-2.56	0.095	0.099	0.004	
11/6/2007	7	57.16	55.99	-1.17	0.092	0.098	0.006	
11/6/2007	8	56.14	54.57	-1.57	0.090	0.096	0.006	
11/6/2007	9	57.35	55.34	-2.01	0.092	0.097	0.005	
Averages:		**58.14**	**55.84**	**-2.30**	**0.094**	**0.098**	**0.00433**	
Intermediate Calculations:								
			X Avg. =	-2.3022		X Avg. =	0.0043	
			X Sum =	-20.72		X Sum =	0.0390	
			[X Sum]^2 =	429.318		[X Sum]^2 =	0.00152	
			[Sum X^2] =	50.88		[Sum X^2] =	0.00018	
			CC =	0.4842		CC =	0.00086	
			Applicable Std. (ppm*) =	57		Applicable Std. (lb/MMBtu) =	0.1	
Relative Accuracy Calculations:								
			Regular Method, RA (%) =	**4.99**		Regular Method, RA (%) =	**5.30**	
			Applicable Std. Method, RA (%) =	**4.89**		Applicable Std. Method, RA (%) =	**5.19**	
Limits:		*<20% RA or 10% of the applicable standard*			*<20% RA or 10% of the applicable standard*			

Table 2-3 Relative Accuracy Results for CO – Unit 1

Analyzers::		Ranges:						Client:	AES
Pollutant:		0-200 ppm dry						Site:	Guayama, PR
Diluent:		0-25%, dry						Source:	Coal Fired Boiler No. 1
Date	Run No.	CO, @7%O2 AES	CO, @7%O2 ENSR	CO, @7%O2 Difference (X)	CO, lb/MMBtu AES	CO, lb/MMBtu ENSR	CO, lb/MMBtu Difference (X)		
11/6/2007	1	41.21	40.73	0.48	0.041	0.043	0.002		
11/6/2007	2	43.50	42.86	0.64	0.044	0.046	0.002		
11/6/2007	3	45.47	44.62	0.85	0.046	0.048	0.002		
11/6/2007	4	47.01	45.80	1.21	0.041	0.049	0.008		
11/6/2007	5	49.05	47.99	1.06	0.049	0.051	0.002		
11/6/2007	6	51.00	49.97	1.03	0.051	0.053	0.002		
11/6/2007	7	51.05	50.54	0.51	0.051	0.054	0.003		
11/6/2007	8	51.89	51.29	0.60	0.052	0.055	0.003		
11/6/2007	9	50.31	49.13	1.18	0.051	0.052	0.001		
Averages:		**47.83**	**46.99**	**0.84**	**0.047**	**0.050**	**0.003**		
Intermediate Calculations:									
			X Avg. =	0.8400		X Avg. =	0.0028		
			X Sum =	7.56		X Sum =	0.03		
			[X Sum]^2 =	57.154		[X Sum]^2 =	0.001		
			[Sum X^2] =	7.02		[Sum X^2] =	0.00		
			CC =	0.22		CC =	0.00		
			Applicable Std. (ppm) =	94		Applicable Std. =	0.1		
Relative Accuracy Calculations:									
			Regular Method, RA (%) =	**2.26**		Regular Method, RA (%) =	**8.68**		
			Applicable Std. Method, RA (%) =	**1.13**		Applicable Std. Method, RA (%) =	**4.35**		
Limits:		**<10% RA or 5% of the applicable standard**			**<10% RA or 5% of the applicable standard**				

Table 2-4 Relative Accuracy Results for SO_2 – Unit 1

Analyzers::		Ranges:						Client:	AES
Pollutant:		0-20 ppm dry						Site:	Guayama, PR
Diluent:		0-25%, dry						Source:	Coal Fired Boiler No. 1
Date	Run No.	SO2, @7%O2 AES	SO2, @7%O2 ENSR	SO2, @7%O2 Difference (X)	SO2, lb/MMBtu AES	SO2, lb/MMBtu ENSR	SO2, lb/MMBtu Difference (X)		
11/6/2007	1	6.29	5.97	0.32	0.015	0.015	0.000		
11/6/2007	2	6.26	5.85	0.41	0.015	0.014	-0.001		
11/6/2007	3	5.31	4.69	0.62	0.013	0.011	-0.002		
11/6/2007	4	4.68	4.21	0.47	0.012	0.010	-0.002		
11/6/2007	5	4.35	3.97	0.38	0.011	0.010	-0.001		
11/6/2007	6	3.78	3.75	0.03	0.009	0.009	0.000		
11/6/2007	7	4.89	4.73	0.16	0.012	0.012	0.000		
11/6/2007	8	4.42	3.95	0.47	0.011	0.010	-0.001		
11/6/2007	9	6.44	6.42	0.02	0.016	0.016	0.000		
Averages:		**5.16**	**4.84**	**0.32**	**0.013**	**0.012**	**-0.001**		
Intermediate Calculations:									
		X Avg. =		0.3200	X Avg. =		-0.0008		
		X Sum =		2.88	X Sum =		-0.01		
		[X Sum]^2 =		8.294	[X Sum]^2 =		0.000		
		[Sum X^2] =		1.27	[Sum X^2] =		0.00		
		CC =		0.16	CC =		0.00		
		Applicable Std. (ppm) =		9	Applicable Std. =		0.022		
Relative Accuracy Calculations:									
		Regular Method, RA (%) =		**9.92**	Regular Method, RA (%) =		**11.93**		
		Applicable Std. Method, RA (%) =		**5.33**	Applicable Std. Method, RA (%) =		**6.45**		
Limits:		*<20% RA or 10% of the applicable standard*			*<20% RA or 10% of the applicable standard*				

Table 2-5 Relative Accuracy Results for O_2, CO_2 and Flow – Unit 2

Analyzers::		Ranges:			Client:	AES	
Pollutant:		0-200 ppm dry			Site:	Guayama, PR	
Diluent:		0-25%, dry			Source:	Coal Fired Boiler No. 2	

Date	Run No.	O2%, dry AES	O2%, dry ENSR	O2%, dry Difference (X)	CO2%, wet AES	CO2%, wet ENSR	CO2%, wet Difference (X)	Flow, kswcfm AES	Flow, kswcfm ENSR	Flow, kswcfm Difference (X)
12/5/2007	1	6.03	6.13	-0.10	12.28	12.20	-0.080	581.4	652.4	71.0
12/5/2007	2	6.11	6.22	-0.11	12.13	12.09	-0.040	584.6	652.9	68.3
12/5/2007	3	6.15	6.11	0.04	11.86	12.11	0.250	582.4	656.7	74.3
12/5/2007	4	6.11	6.01	0.10	13.13	12.46	-0.670	581.1	649.8	68.7
12/5/2007	5	6.24	6.12	0.12	13.16	12.43	-0.730	584.7	665.6	80.9
12/5/2007	6	6.20	6.07	0.13	13.04	12.45	-0.590	583.4	652.6	69.2
12/5/2007	7	6.10	5.96	0.14	13.26	12.43	-0.830	581.8	656.2	74.4
12/5/2007	8	6.01	5.95	0.06	13.09	12.48	-0.610	581.7	644.2	62.5
12/5/2007	9	6.02	5.97	0.05	13.05	12.47	-0.580	578.9	645.5	66.6
Averages:		**6.11**	**6.06**	**0.05**	**12.78**	**12.35**	**-0.43**	**582.2**	**652.9**	**70.7**

Intermediate Calculations:

X Avg. =	0.0478	X Avg. =	-0.4311	X Avg. =	70.6556		
X Sum =	0.43	X Sum =	-3.88	X Sum =	635.90		
[X Sum]^2 =	0.185	[X Sum]^2 =	15.054	[X Sum]^2 =	404368.810		
[Sum X^2] =	0.09	[Sum X^2] =	2.80	[Sum X^2] =	45156.69		
CC =	0.07	CC =	0.29	CC =	4.09		
Applicable Std. (ppm) =	None	Applicable Std. =	0.1	Applicable Std. =	None		

Relative Accuracy Calculations:

Absolute Method, RA (%) =	**0.12**	Absolute Method, RA (%) =	**0.72**	Regular Method, RA (%) =	**11.45**
Limits: <1% Oxygen absolute		**Limits: <1% CO2 absolute**		**<20%RA or 10% of the applicable standard**	

Table 2-6 Relative Accuracy Results for NO_X – Unit 2

Analyzers::		Ranges:						Client:	AES
Pollutant:		0-50 ppm dry						Site:	Guayama, PR
								Source:	Coal Fired Boiler No. 2
Date	Run No.	NOx, @7%O2 AES	NOx, @7%O2 ENSR	NOx, @7%O2 Difference (X)	NOx, lb/MMBtu AES	NOx, lb/MMBtu ENSR	NOx, lb/MMBtu Difference (X)		
12/5/2007	1	45.16	47.24	2.08	0.079	0.083	0.004		
12/5/2007	2	44.12	46.94	2.82	0.077	0.082	0.005		
12/5/2007	3	43.11	45.60	2.49	0.076	0.080	0.004		
12/5/2007	4	44.58	46.50	1.92	0.078	0.082	0.004		
12/5/2007	5	46.33	48.18	1.85	0.081	0.085	0.004		
12/5/2007	6	44.87	46.83	1.96	0.079	0.082	0.003		
12/5/2007	7	44.03	45.66	1.63	0.077	0.080	0.003		
12/5/2007	8	42.27	44.27	2.00	0.074	0.078	0.004		
12/5/2007	9	41.34	43.59	2.25	0.073	0.077	0.004		
Averages:		**43.98**	**46.09**	**2.11**	**0.077**	**0.081**	**0.00389**		
Intermediate Calculations:									
		X Avg. =	2.1111		X Avg. =	0.0039			
		X Sum =	19.00		X Sum =	0.0350			
		[X Sum]^2 =	361.000		[X Sum]^2 =	0.00123			
		[Sum X^2] =	41.15		[Sum X^2] =	0.00014			
		CC =	0.2768		CC =	0.00046			
		Applicable Std. (ppm*) =	57		Applicable Std. (lb/MMBtu) =	0.1			
Relative Accuracy Calculations:									
		Regular Method, RA (%) =	**5.18**		Regular Method, RA (%) =	**5.37**			
		Applicable Std. Method, RA (%) =	**4.19**		Applicable Std. Method, RA (%) =	**4.35**			
Limits:		**<20% RA or 10% of the applicable standard**			**<20% RA or 10% of the applicable standard**				

Table 2-7 Relative Accuracy Results for CO – Unit 2

Analyzers::		Ranges:						Client:	AES
Pollutant:		0-200 ppm dry						Site:	Guayama, PR
Diluent:		0-25%, dry						Source:	Coal Fired Boiler No. 2
		CO, @7%O2			CO, lb/MMBtu				
Date	Run No.	AES	ENSR	Difference (X)	AES	ENSR	Difference (X)		
12/5/2007	1	61.59	63.01	-1.42	0.062	0.067	0.005		
12/5/2007	2	62.39	63.71	-1.32	0.062	0.068	0.006		
12/5/2007	3	60.59	61.21	-0.62	0.061	0.065	0.004		
12/5/2007	4	61.67	61.97	-0.30	0.062	0.066	0.004		
12/5/2007	5	63.06	63.49	-0.43	0.063	0.068	0.005		
12/5/2007	6	60.67	60.38	0.29	0.061	0.064	0.003		
12/5/2007	7	58.83	58.45	0.38	0.059	0.062	0.003		
12/5/2007	8	58.61	58.76	-0.15	0.059	0.063	0.004		
12/5/2007	9	60.70	61.10	-0.40	0.061	0.065	0.004		
Averages:		**60.90**	**61.34**	**-0.44**	**0.06**	**0.07**	**0.00**		
Intermediate Calculations:									
			X Avg. =	-0.4411		X Avg. =	0.0042		
			X Sum =	-3.97		X Sum =	0.04		
			[X Sum]^2 =	15.761		[X Sum]^2 =	0.001		
			[Sum X^2] =	4.83		[Sum X^2] =	0.00		
			CC =	0.48		CC =	0.00		
			Applicable Std. (ppm) =	94		Applicable Std. =	0.1		
Relative Accuracy Calculations:									
			Regular Method, RA (%) =	**1.50**		Regular Method, RA (%) =	**7.61**		
			Applicable Std. Method, RA (%) =	**0.98**		Applicable Std. Method, RA (%) =	**4.97**		
Limits:		**<10% RA or 5% of the applicable standard**			**<10% RA or 5% of the applicable standard**				

Table 2-8 Relative Accuracy Results for SO_2 – Unit 2

Analyzers::		Ranges:						Client:	AES
Pollutant:		0-20 ppm dry						Site:	Guayama, PR
Diluent:		0-25%, dry						Source:	Coal Fired Boiler No. 2
		SO2, @7%O2			SO2, lb/MMBtu				
Date	Run No.	AES	ENSR	Difference (X)	AES	ENSR	Difference (X)		
12/5/2007	1	3.04	3.25	-0.21	0.008	0.008	0.000		
12/5/2007	2	3.86	4.00	-0.14	0.009	0.010	0.001		
12/5/2007	3	6.46	6.40	0.06	0.016	0.016	0.000		
12/5/2007	4	4.59	4.12	0.47	0.011	0.010	-0.001		
12/5/2007	5	3.34	3.23	0.11	0.008	0.008	0.000		
12/5/2007	6	5.54	5.90	-0.36	0.014	0.014	0.000		
12/5/2007	7	5.69	6.14	-0.45	0.014	0.015	0.001		
12/5/2007	8	6.80	6.30	0.50	0.017	0.015	-0.002		
12/5/2007	9	5.42	4.91	0.51	0.013	0.012	-0.001		
Averages:		**4.97**	**4.92**	**0.05**	**0.01**	**0.01**	**0.00**		
Intermediate Calculations:									
			X Avg. =	0.0544		X Avg. =	-0.0002		
			X Sum =	0.49		X Sum =	0.00		
			[X Sum]^2 =	0.240		[X Sum]^2 =	0.000		
			[Sum X^2] =	1.14		[Sum X^2] =	0.00		
			CC =	0.29		CC =	0.00		
			Applicable Std. (ppm) =	9		Applicable Std. =	0.022		
Relative Accuracy Calculations:									
			Regular Method, RA (%) =	**6.95**		Regular Method, RA (%) =	**8.08**		
			Applicable Std. Method, RA (%) =	**3.79**		Applicable Std. Method, RA (%) =	**4.41**		
Limits:		<20% RA or 10% of the applicable standard			<20% RA or 10% of the applicable standard				

Table 2-9 Summary for Opacity Audit Results – Unit 1

Opacity Calibration Error Test

Service Engineer:	Robert Sicard	Source Name:	AES Puerto Rico
Date:	12/7/2007	Unit Number:	1
Monitor Pathlength, L1:	16	Installation Location:	Guayama, PR.
Emission Outlet Pathlength, L2:	16	Model Number:	Spectrum 41
Clearpath Distance:	19' 7 5/8"	Transceiver S/N:	0045-8008
System Output PLCF Corrected?	Yes	Reflector S/N:	0045-8008
Internal Span Cell Percent Opacity:	45	Control Unit S/N:	0045-8008
OPLR:	0.5	PLCF(L_2/L_1):	1.00

	Attenuator Serial Number	Attenuator Value (OP1)	Path Length Corrected Opacity (OP2)
Low Range	SH-30	13.55%	13.55%
Mid Range	GP-01	27.65%	27.65%
High Range	RP-65	46.58%	46.58%

Run Number	Calibration Filter Value Path-Adjusted % Opacity	Instrument Reading Percent Opacity	Arithmetic Difference Percent Opacity		
			Low	Mid	High
1- Low	13.55%	13.20%	-0.35%		
2- Mid	27.65%	27.40%		-0.25%	
3- High	46.58%	46.20%			-0.38%
4- Low	13.55%	13.30%	-0.25%		
5- Mid	27.65%	27.50%		-0.15%	
6- High	46.58%	46.20%			-0.38%
7- Low	13.55%	13.30%	-0.25%		
8- Mid	27.65%	27.50%		-0.15%	
9- High	46.58%	46.20%			-0.38%
10- Low	13.55%	13.30%	-0.25%		
11- Mid	27.65%	27.50%		-0.15%	
12- High	46.58%	46.30%			-0.28%
13- Low	13.55%	13.20%	-0.35%		
14- Mid	27.65%	27.50%		-0.15%	
15- High	46.58%	46.70%			0.12%
		Arithmetic Mean:	-0.29%	-0.17%	-0.26%
		Confidence Coefficient:	0.07%	0.06%	0.27%
		Calibration Error:	0.36%	0.23%	0.53%

Formula's

$$OP_2 = 1 - (1 - OP_1)^{\frac{L_2}{L_1}}$$

Table 2-10 Summary for Opacity Audit Results – Unit 2

Opacity Calibration Error Test

Service Engineer:	Robert Sicard	Source Name:	AES Puerto Rico
Date:	12/6/2007	Unit Number:	2
Monitor Pathlength, L1:	16	Installation Location:	Guayama, PR.
Emission Outlet Pathlength, L2:	16	Model Number:	Sepctrum 41
Clearpath Distance:	19' 7 5/8"	Transceiver S/N:	0045-8003
System Output PLCF Corrected?	Yes	Reflector S/N:	0045-8003
Internal Span Cell Percent Opacity:	45	Control Unit S/N:	0045-8003
OPLR:	0.5	PLCF(L_2/L_1):	1.00

	Attenuator Serial Number	Attenuator Value (OP1)	Path Length Corrected Opacity (OP2)
Low Range	SH-30	13.55%	13.55%
Mid Range	GP-01	27.65%	27.65%
High Range	RP-65	46.58%	46.58%

Run Number	Calibration Filter Value Path-Adjusted % Opacity	Instrument Reading Percent Opacity	Arithmetic Difference Percent Opacity		
			Low	Mid	High
1- Low	13.55%	13.30%	-0.25%		
2- Mid	27.65%	27.60%		-0.05%	
3- High	46.58%	46.30%			-0.28%
4- Low	13.55%	13.70%	0.15%		
5- Mid	27.65%	27.70%		0.05%	
6- High	46.58%	46.40%			-0.18%
7- Low	13.55%	13.70%	0.15%		
8- Mid	27.65%	27.70%		0.05%	
9- High	46.58%	46.40%			-0.18%
10- Low	13.55%	13.70%	0.15%		
11- Mid	27.65%	27.70%		0.05%	
12- High	46.58%	46.30%			-0.28%
13- Low	13.55%	13.80%	0.25%		
14- Mid	27.65%	27.60%		-0.05%	
15- High	46.58%	46.50%			-0.08%
		Arithmetic Mean:	0.09%	0.01%	-0.20%
		Confidence Coefficient:	0.24%	0.07%	0.10%
		Calibration Error:	0.33%	0.08%	0.30%

Formula's

$$OP_2 = 1 - (1 - OP_1)^{\frac{L_2}{L_1}}$$

3.0 Facility and CEM System Descriptions

3.1 Process Description

The AES Puerto Rico Total Energy Plant in Guayama, Puerto Rico operates two 227 MW (net) generating units. Each generating unit consists of one coal-fired, circulating fluidized bed, balanced draft boiler. Each generating unit is also equipped with an electrostatic precipitator, circulating dry scrubber, selective non-catalytic reduction (SNCR), one reheat turbine generator set and one single pressure condenser. One cooling tower is used to manage the total heat load from both generating units.

3.2 Sampling Locations

The test locations for the two generating units (Units 1 and 2) are at an elevation of 220 feet above ground level within a single stack. The inside diameter of the stacks at the sampling platform elevation is 216 inches. The sample locations are located 9.4 diameters downstream of the stack breaching and 12.5 diameters upstream of the stack exhaust.

3.3 Facility CEM System Description

One Continuous Emissions Measurements System (CEMS) is installed on each 227 MW generating unit. Each CEMS consists of the following devices: volumetric flow monitor, oxygen (O_2) monitor, carbon dioxide (CO_2) monitor, sulfur dioxide (SO_2) monitor, oxides of nitrogen (NO_x) monitor, carbon monoxide (CO) monitor and opacity monitor. The CEMS System was assembled by Spectrum Systems. The portion of the CEMS used to measure gaseous constituents of the flue gas stream consists of the following major components: sample extraction probe, sample line umbilical, sample conditioner and/or dilution controller (specific to the type of measurement, calibration gas system, analyzers, system controller, and data acquisition system. The opacity and flow rate monitoring systems consist of flue-mounted monitors, remote control units, and interconnecting cables.

The CEMS use both the fully extractive and dilution-extraction methods to monitor gaseous emissions. The fully extractive design is incorporated for CO and O_2 due to low levels of CO that must be monitored according to the site permit. The dilution method of monitoring emissions is used for SO_2, NO_X and CO_2. The SO_2, NO_X CO and O_2 measurements are all made on a dry basis to facilitate comparison with facility's O_2-corrected ppmvd permit limits. In contrast, CO_2 and volumetric flow are both measured wet to facilitate the calculation of heat input rate.

The CEMS includes a common data acquisition system to perform monitoring system control, data acquisition, data storage, calculations, and reporting functions. Measurement results for SO_2, NO_x and CO are reported in ppmvd corrected to 7% O_2, lb/mmBtu and lb/hr, corresponding to the units that appear in the facilities permit limits.

The NO_x monitors are Thermo Environmental Instruments Inc. (TECO) Model 42C chemiluminescence analyzers which operate 0-200 ppm range. The TECO 42C houses a self-contained internal converter for the dissociation of nitrogen dioxide to nitric oxide. The CO monitors are Siemens Model Ultramat/Oxymat 6E non-dispersive infrared analyzers operating 0-200 ppm range. The CO_2 monitors are Siemens Model Ultramat 6E non-dispersive infrared operating at 0-20% range and the O2 monitors are Siemens Ultramat/Oxymat 6E paramagnetic analyzers operating 0-22% range. The stack flow monitors are Monitor Labs Ultraflow 100

ultrasonic analyzers operating on a scale 0-1075 kscfm. The SO_2 monitors are Thermo Environmental Instruments Inc (TECO) Model 43C pulsed fluorescence analyzers operating at 0-50 ppm range. Stack opacity is measured by the Spectrum System Model 41 opacity monitor.

Data acquisition and reporting are performed by the SpectraPak data acquisition and control modules with SpectraView. It provides multi-user, multi-tasking operation using a UNIX system, plus a window-based operator interface. SpectraView automatically provides audit logs, alarm logs, calibration check results, compliance reports, trending displays and other on-line functions to assist the CEMS operator and administrator.

4.0 RATA Test Procedures

The following is a list of the testing that was completed to fulfill the requirements of 40 CFR Part 60, Appendix B and F, Performance Specification Tests 2, 3 and 4A.

4.1 Stack Flow, O_2, CO_2, SO_2, NO_X, and CO Relative Accuracy Tests

ENSR followed EPA procedures specified in EPA Methods 1, 2, 3A, 4, 6C, 7E and 10, 40 CFR Part 60, Appendix A, for the determination of Stack Flow, O_2, CO_2, SO_2, NO_X, and CO respectively. The following subsections describe the sample procedures in more detail.

ENSR conducted a minimum of nine 21-minute test periods using the audit CEMS as described in the later part of this section. Ten runs of data were collected and 9 of the 10 were used to determine Relative Accuracy for this program. Data from all ten runs are presented in Appendix A for informational purposes. An average dry O_2, CO_2, NO_x, CO and SO_2 concentration was determined for each test run. The NO_x CO and SO_2 pollutant values were corrected to 7% O_2 for comparison to facility data. Relative accuracy determinations are calculations delineated in PST's 2 and 3 for NO_x, SO_2 CO_2 and O_2, respectively and PS4A for CO. The relative accuracy criterion for 40 CFR Part 60, Appendix B for the O_2 and CO_2 analyzers is $\leq$ 1.0 percent O_2/CO_2 absolute. The relative accuracy criterion for 40 CFR Part 60, Appendix B for the Stack Flow, NO_X and SO_2 analyzers is $\leq$ 20 percent of the reference method or 10 percent of the applicable standard, whichever is less restrictive. The relative accuracy criterion for 40 CFR Part 60, Appendix B for the CO analyzer is < 10 percent of the reference method or 5 ppm in units of the emission standard (ppm @ 7% O_2).

4.2 ENSR's Portable CEMS

A portable continuous emission monitoring system was used to monitor O_2, CO_2, NO_x CO and SO_2 on a dry basis. The ENSR CEMS is a portable system that was delivered to the site and set up at the sample port elevation prior to the start of the audit program. The sample delivery system consisted of an in-stack stainless steel sintered particulate filter, a stainless steel sample probe, a three-way valve assembly for delivery of calibration gases to the system, a refrigerated gas conditioning system (for moisture and particulate removal), a sample gas manifold and a sample pump. The clean dry sample was then delivered to the gas analyzers for the determination of O_2, CO_2, NO_X, CO and SO_2. Moisture results were used to convert dry CO2 results to a wet percent basis.

The output signals from each analyzer were transferred to a data acquisition system (DAS) with Workbench for Windows software, by Strawberry Tree. The DAS then stored the data in engineering units and provided 1-minute averages based upon 60 readings per minute. The NO_x analyzer was a Thermo Electron Model 42H chemiluminescent instrument operated in the 0-100 ppmvd range. The oxygen analyzer was a Servomex Model 1400 paramagnetic instrument operated in the range of 0-25%. The CO_2 monitor was a Servomex Model 1440 Infrared instrument operated on a 0-20% range. The CO analyzer was a TECO 48 infrared instrument operated in the 0-100 ppmvd range. The SO_2 analyzer was a Bovar Model 721-M ultraviolet instrument operated on a 0-50 ppmvd range.

4.2.1 CEMS Calibration Procedures

The initial phase of the instrumental analysis methods (3A, 6C, 7E and 10) requires calibration of all involved analyzers. At the beginning of each day, ENSR conducted direct instrument calibrations for zero, mid range (40% to 60% of full scale) and high range (80% to 100% of full scale) prior to initiation of testing. Following these direct calibrations, system calibrations were performed both prior to and following each run using zero

and the mid range calibration gas which was close to the proposed NO_x and CO emission limits. Following completion of the required runs, final system and final direct calibrations were performed. These procedures allowed for the determination of initial and final system bias, as well as system drift. All calibration gases used during this program were prepared in accordance with EPA Protocol G1 procedures as specified by the National Institute of Technology and Standards. The NO_X, O_2, CO and SO_2 calibration standards were in a nitrogen gas balance. Gas cylinder certificates are provided in Appendix C.

4.3 Stack Opacity Monitor Audit Description

The Spectrum System Model 41 opacity monitor was audited according to EPA Document 450/4-92-010 "Performance Audit Procedures for Opacity Monitors," April 1992. The opacity audit procedure was comprised of an instrument inspection, calibration check, dirty window check procedure, alignment check and a calibration error test. The calibration error test checked the opacity monitor's responses to three neutral density audit filters over a series of five repetitions. The calibration error criterion for each audit filter is $\leq$ 3%. Appendix C provides the opacity audit filter certification form.

5.0 Quality Assurance / Quality Control Measures

5.1 Overview

During the monitoring phase of the program, a strict quality assurance/quality control (QA/QC) program was adhered to. Portions of the RATA were witnessed by an inspector from the EQB. The QA/QC aspects of the program are discussed below.

5.2 Leak Check Procedure

Prior to conducting the RATA, ENSR's CEMS was leak checked and verified to be leak free. Following the initial leak check, the drift criteria as specified in EPA Method 6C, 40 CFR Part 60, Appendix A served as a continuous sample integrity check.

5.3 System Calibrations

During the test program ENSR utilized EPA instrumental analyzer methods 3A, 6C, 7E and 10, 40 CFR Part 60, Appendix A for the measurement of O_2, CO_2, SO_2, NO_x, and CO respectively. The initial phase of instrumental analysis requires calibration of all involved monitors. At the beginning of each day, direct instrument calibrations for zero and two upscale gases were performed prior to performing the test. Following these direct calibrations, system calibrations were performed both prior to and following each run using zero and one upscale gas concentration. These procedures allow for the determination of calibration error, initial, and final system bias, as well as system drift. All calibration gases used during this program were prepared to EPA Protocol G1/G2 standards. Certificates of analysis for the calibration gases are presented in Appendix C. The measurement system performance criteria in 40 CFR Part 60, Appendix A, Methods 3A, 6C, 7E and 10 are listed below and was the performance criteria for the reference method CEMS during this program.

Procedure	Performance Criterion
Zero drift	<±3% of the calibration span
Calibration drift	<±3% of the calibration span
Response time	≤ 90 seconds
Calibration error	<±2% of the calibration span
System bias	<±5% of the calibration span

The instrumental analysis methods also require correction of data for calibration drift and/or bias. All values used for the determination of relative accuracy were corrected for system drift and bias observed during each test run. System drift and bias calibration data are presented in the Appendix A of this report.

5.4 NO_X Converter Efficiency Test

Prior to the field program, ENSR's NO_x analyzer was subjected to a NO_x converter efficiency test in accordance with Sections 5.6 of EPA Method 20, 40 CFR Part 60, Appendix A. A copy of the instrument specific test results were available onsite during the test program and are presented in Appendix C.

6.0 Data Reduction

The objective of the monitoring program was to determine the relative accuracy of the existing NO_X, SO_2, CO_2, O_2 and CO CEM systems. Results have been reported on an individual analyzer basis as well as a system basis (ppvmd @ 7%O_2 and lb/MMBtu) for NO_X, CO and SO_2. Photocopies of the raw field data sheets and data printouts from the facility CEMS are presented in the Appendices. A discussion of the data reduction process is presented below.

6.1 NO_X Emission Rates – Corrected to 7% Oxygen

The facility operating permit required the correction of all measured NO_X concentrations to 7% oxygen. The equation used to calculate this correction is presented below:

(1) Correction to 7% O_2

$$NO_X(corr) = NO_X(meas.) \times \frac{13.9\%}{20.9\% - \%O_2(meas)}$$

where:

$NO_X(corr)$ = NO_x concentration (ppmvd) corrected to 7% O_2

$NO_x(meas.)$ = NO_x concentration (ppmvd) measured, dry basis

13.9% = 20.9% O_2 - 7%, the defined O_2 correction basis

$\%O_2(meas)$ = Percent O_2 measured, dry basis

6.2 CO Emission Rates – Corrected to 7% Oxygen

The facility operating permit required the correction of all measured CO concentrations to 7% oxygen. The equation used to calculate this correction is presented below:

(1) Correction to 7% O_2

$$CO(corr) = CO(meas) \times \frac{13.9\%}{20.9\% - \%O_2(meas)}$$

where:

CO(corr) = CO concentration (ppmvd) corrected to 7% O_2

CO(meas) = CO concentration (ppmvd) measured, dry basis

13.9% = 20.9% O_2 - 7%, the defined O_2 correction basis

$\%O_2(meas)$ = Percent O_2 measured, dry basis

6.3 SO_2 Emission Rates – Corrected to 7% Oxygen

The facility operating permit required the correction of all measured SO_2 concentrations to 7% oxygen. The equation used to calculate this correction is presented below:

(1) Correction to 7% O_2

$$SO_2(corr) = SO_2(meas) \times \frac{13.9\%}{20.9\% - \%O_2(meas)}$$

where:

$SO_2(corr)$ = SO_2 concentration (ppmvd) corrected to 7% O_2

$SO_2(meas)$ = SO_2 concentration (ppmvd) measured, dry basis

13.9% = 20.9% O_2 - 7%, the defined O_2 correction basis

$\%O_2(meas)$ = Percent O_2 measured, dry basis

6.4 Emission Rates – Pounds per Million Btu

Emission rates were calculated in units of pollutant mass per quantity of heat input (lb/MMBtu). Lb/MMBtu was calculated using the pollutant and diluent concentrations and the F-factor contained in EPA Method 19, 40 CFR 60, Appendix A. The measured concentrations units of parts per million (ppm) were first converted to mass per unit volume (lb/scf) for these calculations. The conversion factor for ppm to lb/scf, as stated in EPA Methods 19 and 20 is:

lb/scf = ppm (meas) x CF

where:

CF for NO_X	=	1.194E-07
CF for CO	=	7.26E-08
CF for SO_2	=	1.66E-07

Next, the lb/scf were converted to a mass emission rate in terms of lb/MMBtu as follows:

$$E = lb/scf \times F_d \times \frac{20.9}{20.9 - \%O_2}$$

where:

E = Mass emission rate in terms of lb/MMBtu

F_d = ratio of the volume of dry effluent gas to the gross caloric value of the as-fired fuel (from EPA Method 19, Table 19-1 (coal = 9780).

APPENDIX A

ENSR Field Data Sheets

ENSR
UNIT 1 FIELD DATA