

Trump Towers Emissions Testing – December 19, 2011

As part of the NYSERDA REAP Multifamily Performance Program (MPP), combined heat and power (CHP) systems must meet exhaust emission requirements for nitric oxide (NOx) and carbon monoxide (CO). The systems are tested at the end of each performance year, and passing the emissions level is a requirement for receiving the performance portion of the NYSERDA incentive.

Each CHP unit at Trump Towers was tested using a recently calibrated Testo T350 XL portable flue gas analyzer. The analyzer was provided by and calibrated by Clear Air Engineering¹.

As part of the corrective action plan, a technician from Aegis Energy Services was on site to perform engine tuning in an attempt to meet the program emission requirements. Fuel air mixture on each engine was adjusted to meet the program NOx target.

The environmental testing occurred over a period of two hours, between 9:00 AM EDT and 11:00 AM EDT. The clock for the Testo350 XL was set to CST, resulting in a one-hour offset from the data logger data. Each engine was set to operate at full load of 75 kW during the test period, and power output and engine RPM was not observed to fluctuate substantially during the test period.

¹ Clean Air Engineering, Inc.
500 W. Wood Street
Palatine, IL 60067, USA
USA 800-223-3977
Fax: 847-991-8924
<http://express.cleanair.com/PortableGasAnalyzers/testo.html>

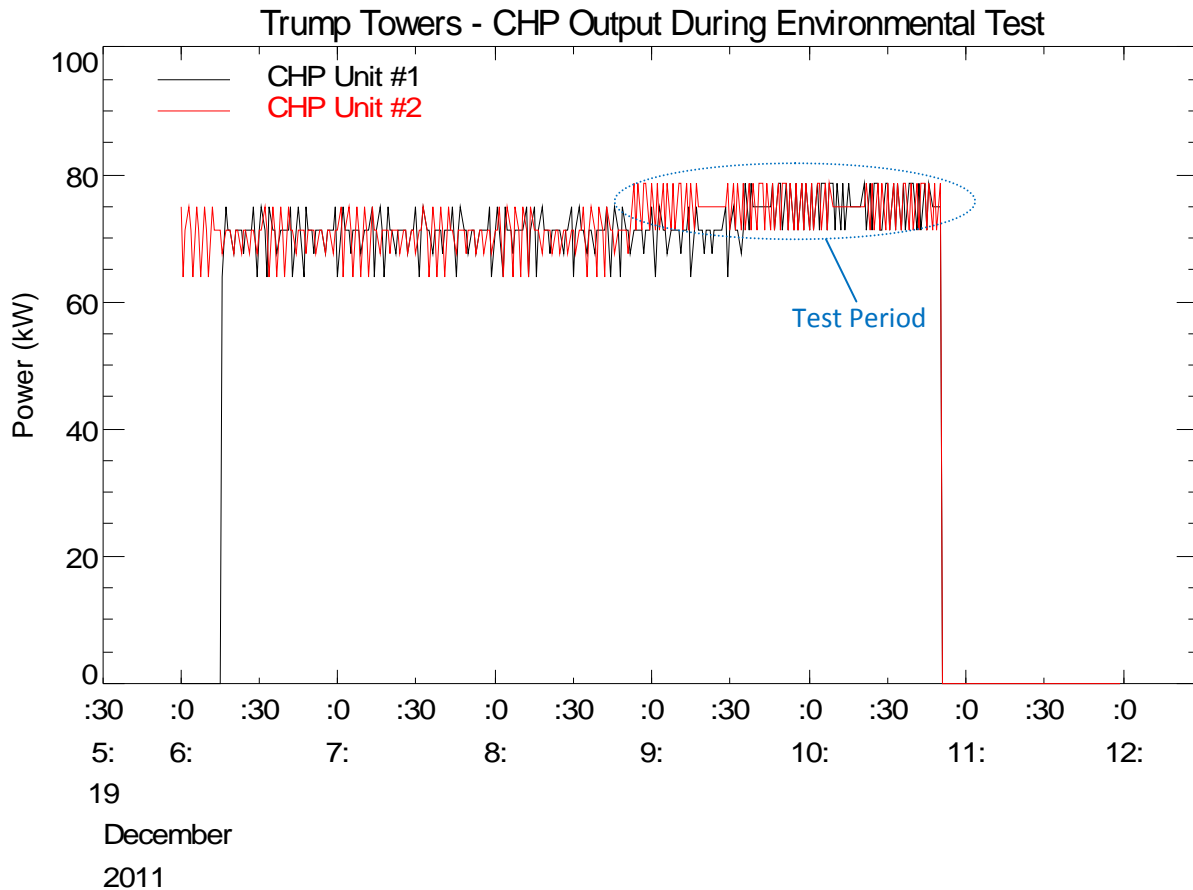


Figure 1. CHP Unit Power Output – December 19, 2011

The NYSERDA emissions limits, the resulting calculated exhaust concentrations, and the test results for each CHP unit are shown in Table 1. Test data, including an ambient air reading taken on site and the test probe calibration runs performed by Clean Air Engineering are found at the end of this report.

Table 1. Results of Emissions Testing

Date/Time (CST)	Test Reading	O2 (%)	NOX (PPM)	NOX Limit (PPM)	Pass/Fail (-)	CO (PPM)	CO Limit (PPM)	Pass/Fail (-)
12/19/2011 6:59	Room Air Cold Probe	20.88%	0	n/a	n/a	0	n/a	n/a
12/19/2011 7:15	Pre-test Purge	20.85%	0	n/a	n/a	0	n/a	n/a
12/19/2011 8:04	Room Air Heated Probe	20.45%	0	n/a	n/a	0	n/a	n/a
12/19/2011 8:36	Engine #1 Reading 1	-0.70%	102	126	PASS	29,806	819	FAIL
12/19/2011 8:39	Engine #1 Reading 2	-0.37%	110	126	PASS	29,768	819	FAIL
12/19/2011 8:42	Engine #1 Reading 3	-0.36%	123	126	PASS	27,844	819	FAIL
12/19/2011 8:46	Engine #1 Reading 4	-0.36%	121	126	PASS	33,776	819	FAIL
12/19/2011 8:52	Pre-test Purge	20.45%	0	n/a	n/a	0	n/a	n/a
12/19/2011 9:04	Engine #2 Reading 1	-0.31%	119	126	PASS	52,633	819	FAIL
12/19/2011 9:10	Engine #2 Reading 2	-0.28%	68	126	PASS	40,127	819	FAIL
12/19/2011 9:13	Engine #2 Reading 3	-0.28%	100	126	PASS	41,450	819	FAIL
12/19/2011 9:16	Engine #2 Reading 4	-0.27%	116	126	PASS	37,223	819	FAIL
12/19/2011 9:17	Engine #2 Reading 5	-0.26%	122	126	PASS	36,547	819	FAIL
12/19/2011 9:18	Engine #2 Reading 6	-0.25%	124	126	PASS	36,825	819	FAIL
12/19/2011 9:48	Post-test Purge	20.79%	0	n/a	n/a	0	n/a	n/a

Even after tuning for NOx, both CHP units did not meet the NYSERDA program emissions limits on CO. As the next step in the corrective action plan, Aegis is recommending changing the catalyst to correct the CO emissions.

Test Notes:

Aegis located a test port inside the engine compartment, where the TESTO 350XL probe was placed.



Figure 2. Test Port with Testo 350 XL Probe In Place

TESTO 350 XL
Calibration Sheet
From Clean Air Engineering

Asset #207618
Testo t350 XL
SN: 01948945 /USA
NONAME
12/14/11 13:58:13
Ambient
Fuel: Test Gas
20.94 % Oxygen
ppm CO 0
ppm SO2 0
ppm NO 0
ppm NO2 0
ppm NOX 0
0.0
29.2 °C Ta
28.1 °C Tt
9.9 V Batt.
1.25 1/m Pump
% Efficiency
% Excess air
Heat transf. °F: --- °F
www.cleanair.com

Asset #207618
Testo t350 XL
SN: 01948945 /USA
NONAME
12/14/11 14:06:29
Leak Test 6" H2O
Fuel: Test Gas
0.06 % Oxygen
ppm CO 0
ppm SO2 0
ppm NO 0
ppm NO2 0
ppm NOX 0
0.0
30.1 °C Ta
25.0 °C Tt
9.9 V Batt.
1.18 1/m Pump
% Efficiency
% Excess air
Heat transf. °F: --- °F
www.cleanair.com

Asset #207618
Testo t350 XL
SN: 01948945 /USA
NONAME
12/14/11 15:06:27
2.90 ppm SO2
Fuel: Test Gas
2.80 % Oxygen
ppm CO 1
ppm SO2 2
ppm NO 1
ppm NO2 0
ppm NOX 1
0.00
29.8 °C Ta
25.3 °C Tt
9.8 V Batt.
1.25 1/m Pump
% Efficiency
% Excess air
Heat transf. °F: --- °F
www.cleanair.com

Asset #207618
Testo t350 XL
SN: 01948945 /USA
NONAME
12/14/11 14:20:15
250 ppm CO
Fuel: Test Gas
0.01 % Oxygen
ppm CO 251
ppm SO2 0
ppm NO 0
ppm NO2 0
ppm NOX 0
0.00
29.7 °C Ta
25.8 °C Tt
9.9 V Batt.
1.24 1/m Pump
% Efficiency
% Excess air
Heat transf. °F: --- °F
www.cleanair.com

Asset #207618
Testo t350 XL
SN: 01948945 /USA
NONAME
12/14/11 15:07:22
Sensor information
O2 :
Sensor ser. # 08605107 %
Cal gas val. 2.80 %
sensor val. 2.85 %
Calibr. date: 12/14/11
CO :
Sensor ser. # 08295126
Cal gas val. 250 ppm
sensor val. 249 ppm
Calibr. date: 12/14/11
NO :
Sensor ser. # 16545833
Cal gas val. 250 ppm
sensor val. 252 ppm
Calibr. date: 12/14/11
NO2 :
Sensor ser. # 07308259
Cal gas val. 51.0 ppm
sensor val. 51.1 ppm
Calibr. date: 12/14/11
SO2 :
Sensor ser. # 06837525
Cal gas val. 230 ppm
sensor val. 230 ppm
Calibr. date: 12/14/11
www.cleanair.com

Asset #207618
Testo t350 XL
SN: 01948945 /USA
NONAME
12/14/11 14:26:50
250 ppm NO
Fuel: Test Gas
0.04 % Oxygen
ppm CO 1
ppm SO2 0
ppm NO 250
ppm NO2 0
ppm NOX 250
0.00
29.4 °C Ta
26.0 °C Tt
9.8 V Batt.
1.24 1/m Pump
% Efficiency
% Excess air
Heat transf. °F: --- °F
www.cleanair.com

Asset #207618
Testo t350 XL
SN: 01948945 /USA
NONAME
12/14/11 14:46:42
Slipstream
Fuel: Test Gas
1.03 % Oxygen
ppm CO 1
ppm SO2 7
ppm NO 1
ppm NO2 51.0
ppm NOX 52
0.00
29.3 °C Ta
25.5 °C Tt
9.8 V Batt.
1.23 1/m Pump
% Efficiency
% Excess air
Heat transf. °F: --- °F
www.cleanair.com

Asset #207618
Testo t350 XL
SN: 01948945 /USA
NONAME
12/14/11 14:58:19
230 ppm SO2
Fuel: Test Gas
-0.00 % Oxygen
ppm CO 1
ppm SO2 230
ppm NO 1
ppm NO2 0
ppm NOX 1
0.00
29.9 °C Ta
25.1 °C Tt
9.8 V Batt.
1.24 1/m Pump
% Efficiency
% Excess air
Heat transf. °F: --- °F
www.cleanair.com

Asset #207618
Testo t350 XL
SN: 01948945 /USA
NONAME
12/14/11 14:20:15
250 ppm CO
Fuel: Test Gas
0.01 % Oxygen
ppm CO 251
ppm SO2 0
ppm NO 0
ppm NO2 0
ppm NOX 0
0.00
29.7 °C Ta
25.8 °C Tt
9.9 V Batt.
1.24 1/m Pump
% Efficiency
% Excess air
Heat transf. °F: --- °F
www.cleanair.com

Testo 350XL
STANDARD
Analyzer # 207618
Control Unit # 207619
Probe # 207575
DATE 12.14.11
Tech J. Green

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 06:59:06

Fuel: Test Gas

20.88	%	Oxygen
0	ppm	CO
0	ppm	SO2
0	ppm	NO
0.0	ppm	NO2
0	ppm	NOx
-----	%	CO2
11.5	°C	Ta
-----	°C	Tf
8.3	V	Batt.
1.18	l/m	Pump
-----	%	Efficiency
-----	%	Excess air

Heat transf. °F: --- °F

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Room Air

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 07:15:19

Fuel: Test Gas

20.85	%	Oxygen
0	ppm	CO
-----	ppm	SO2
0	ppm	NO
0.2	ppm	NO2
0	ppm	NOx
-----	%	CO2
22.5	°C	Ta
-----	°C	Tf
8.3	V	Batt.
1.18	l/m	Pump
-----	%	Efficiency
-----	%	Excess air

Heat transf. °F: --- °F

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Room

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 08:04:38

Fuel: Test Gas

20.45	%	Oxygen
0	ppm	CO
0	ppm	SO2
0	ppm	NO
0.0	ppm	NO2
0	ppm	NOx
-----	%	CO2
31.0	°C	Ta
39.1	°C	Tf
8.3	V	Batt.
1.21	l/m	Pump
-----	%	Efficiency
-----	%	Excess air

Heat transf. °F: --- °F

Asset #207618

Testo t350 XL

SN: 01948945 /USA

12/14/11 15:08:39

Sensor information

O2 :
 Sensor ser. # 08605107
 Cal gas val. 2.80 %
 sensor val. 2.85 %
 Calibr. date: 12/14/11

CO :
 Sensor ser. # 08295126
 Cal gas val. 250 ppm
 sensor val. 249 ppm
 Calibr. date: 12/14/11

NO :
 Sensor ser. # 16545833
 Cal gas val. 250 ppm
 sensor val. 252 ppm
 Calibr. date: 12/14/11

NO2 :
 Sensor ser. # 07308259
 Cal gas val. 51.0 ppm
 sensor val. 51.1 ppm
 Calibr. date: 12/14/11

SO2 :
 Sensor ser. # 06837525
 Cal gas val. 230 ppm
 sensor val. 230 ppm
 Calibr. date: 12/14/11

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Ambient/Room Air Readings showing reference points for each combustion product

ENG #1

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 08:36:39

Fuel: Test Gas

-0.70	% Oxygen
29806	ppm CO
0	ppm SO2
102	ppm NO
0.2	ppm NO2
102	ppm NOx
0.00	% CO2
32.5	°C Ta
96.3	°C Tf
8.3	V Batt.
1.28	l/m Pump
100.0	% Efficiency
-7.7	% Excess air

Heat transf.°F: --- °F

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ENG #2

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 08:39:47

Fuel: Test Gas

-0.37	% Oxygen
29768	ppm CO
0	ppm SO2
110	ppm NO
0.2	ppm NO2
110	ppm NOx
0.00	% CO2
32.3	°C Ta
97.4	°C Tf
8.3	V Batt.
1.28	l/m Pump
100.0	% Efficiency
-6.7	% Excess air

Heat transf.°F: --- °F

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ENG #2

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 08:42:20

Fuel: Test Gas

-0.36	% Oxygen
27844	ppm CO
0	ppm SO2
123	ppm NO
0.2	ppm NO2
123	ppm NOx
0.00	% CO2
32.2	°C Ta
96.3	°C Tf
8.3	V Batt.
1.28	l/m Pump
100.0	% Efficiency
-6.3	% Excess air

Heat transf.°F: --- °F

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ENG ENCL

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 08:46:56

Fuel: Test Gas

-0.36	% Oxygen
33776	ppm CO
0	ppm SO2
121	ppm NO
0.0	ppm NO2
121	ppm NOx
0.00	% CO2
32.3	°C Ta
96.3	°C Tf
8.3	V Batt.
1.28	l/m Pump
100.0	% Efficiency
-7.3	% Excess air

Heat transf.°F: --- °F

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Engine #1 Test Results
 Engine tuned to meet NOx limit,
 but excessive CO occurs

Eng #2

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 09:13:07

Fuel: Test Gas

-0.28	% Oxygen
41450	ppm CO
0	ppm SO2
100	ppm NO
0.5	ppm NO2
100	ppm NOx
0.00	% CO2
32.3	°C Ta
92.3	°C Tf
8.3	V Batt.
1.03	l/m Pump
100.0	% Efficiency
-8.4	% Excess air

Heat transf.°F: --- °F

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Eng #2

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 09:18:41

Fuel: Test Gas

-0.25	% Oxygen
36825	ppm CO
0	ppm SO2
124	ppm NO
0.0	ppm NO2
124	ppm NOx
0.00	% CO2
33.0	°C Ta
92.5	°C Tf
8.3	V Batt.
1.04	l/m Pump
100.0	% Efficiency
-7.5	% Excess air

Heat transf.°F: --- °F

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Purge Eng #2

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 08:52:23

Fuel: Test Gas

20.45	% Oxygen
0	ppm CO
0	ppm SO2
0	ppm NO
0.2	ppm NO2
0	ppm NOx
---	% CO2
28.8	°C Ta
28.4	°C Tf
8.3	V Batt.
1.23	l/m Pump
---	% Efficiency
---	% Excess air

Heat transf.°F: --- °F

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Eng #2

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 09:16:04

Fuel: Test Gas

-0.27	% Oxygen
37223	ppm CO
0	ppm SO2
116	ppm NO
0.2	ppm NO2
116	ppm NOx
0.00	% CO2
32.5	°C Ta
92.4	°C Tf
8.3	V Batt.
1.03	l/m Pump
100.0	% Efficiency
-7.6	% Excess air

Heat transf.°F: --- °F

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Purge

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 09:48:15

Fuel: Test Gas

20.79	% Oxygen
0	ppm CO
0	ppm SO2
0	ppm NO
0.2	ppm NO2
0	ppm NOx
---	% CO2
31.2	°C Ta
21.4	°C Tf
8.3	V Batt.
0.99	l/m Pump
---	% Efficiency
---	% Excess air

Heat transf.°F: --- °F

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Eng #2

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 09:04:20

Fuel: Test Gas

-0.31	% Oxygen
52633	ppm CO
0	ppm SO2
119	ppm NO
0.5	ppm NO2
119	ppm NOx
0.00	% CO2
31.0	°C Ta
93.2	°C Tf
8.3	V Batt.
1.03	l/m Pump
100.0	% Efficiency
-10.3	% Excess air

Heat transf.°F: --- °F

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Eng #2

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 09:17:46

Fuel: Test Gas

-0.26	% Oxygen
36547	ppm CO
0	ppm SO2
122	ppm NO
0.2	ppm NO2
122	ppm NOx
0.00	% CO2
32.6	°C Ta
92.3	°C Tf
8.3	V Batt.
1.03	l/m Pump
100.0	% Efficiency
-7.5	% Excess air

Heat transf.°F: --- °F

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Engine #2 Test Results
 Engine tuned to meet
 NOx limit,
 but excessive CO occurs

Eng #2

Asset #207618

Testo t350 XL

SN: 01948945 /USA

NONAME

12/19/11 09:10:54

Fuel: Test Gas

-0.28	% Oxygen
40127	ppm CO
0	ppm SO2
68	ppm NO
0.2	ppm NO2
68	ppm NOx
0.00	% CO2
32.6	°C Ta
92.6	°C Tf
8.3	V Batt.
1.03	l/m Pump
100.0	% Efficiency
-8.1	% Excess air

Heat transf.°F: --- °F

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Nominal Emissions Rate Calculation - lb/MWh to PPM

Equipment rating 75 kw/hr
 convert to MW Hr 0.075 Mw/hr
 Exhaust flowrate 133 scf/min

red input value
blue Calculated value

Note - flowrate based on information provided by Aegis on CHP.6 Form in DEA
 133 SCFM = 170 ACFM / (0.0763264 lb/CF @ 60 F) x (0.0587918 lb/CF @ 215 F)

NYSERDA Nox limit 1.6 lb/MW hr
 NYSERDA CO limit 6.33 lb/MW hr

Equivalent hourly Nox limit for unit 0.12 lb/hr
 Equivalent hourly CO limit for unit 0.47475 lb/hr

Convert lbs per hour to ppm conversion - estimate

$$\text{emission rate } \frac{\text{lb}}{\text{hour}} = \text{measured conc.} \times \frac{1 \text{ ppm}}{1 \times E6} \times \text{exhaust flow } \frac{\text{scf}}{\text{min}} \times \frac{60 \text{ min}}{\text{hour}} \times \frac{1 \text{ lb mol}}{385.5 \text{ scf}} \times \frac{\text{Molecular weight } \text{lbs}}{\text{lb mol}}$$

Constants

molar vol	385.5 scf/lbmol
Nox MW	46 lb/lbmol
CO MW	28 lb/lbmol

Pollutant	equiv limit	MW	molar vol		flowrate		convert	Approx Max concentration (PPM) to meet the limit
	lb/hr		LB/LBMOL	scf/mole	min/hr	dscf/min	to ppm	
Nox	0.12	46	385.5	60	133.00	1.00E+06	126	
CO	0.47475	28	385.5	60	133.00	1.00E+06	819	