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January 17, 2014

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BELL BEND NUCLEAR POWER PLANT
REVIEW OF BEST AVAILABLE TECHNOLOGY (BAT)
BNP-2014-006

Reference: 1) BNP-2011-127, T. L. Harpster (PPL Bell Bend, LLC) to Ray Kempa (Pennsylvania DEP Northeast Regional Office) "Plan Approval Application", dated July 18, 2011.

In Reference 1, PPL Bell Bend, LLC (PPL) submitted the Plan Approval Application (PAA) for the proposed Bell Bend Nuclear Power Plant. The PADEP subsequently submitted a verbal request for a review of the control technology analysis to assure that the Best Available Technology (BAT) analysis provided is current with an assessment of control technology and source emission levels conducted today. PPL contracted with ALL4 Inc. (ALL4) to provide a review to assure that the BAT analyses submitted with the PAA result in the minimum emissions attainable. The ALL4 report, "Review of the BAT, BACT and LAER Analysis for the Bell Bend Nuclear Power Plant (BBNPP)", is provided in the Enclosure.

PPL had already completed a Prevention of Significant Determination (PSD) and determined that the Plan Approval is not subject to either New Source Review (NSR) or PSD requirements, Therefore the attached report does not examine Best Available Control Technology (BACT) under PSD and compliance with Lowest Achievable Emission rate (LAER) under Non-attainment NSR. PPL will be implementing the recommendations found in the Conclusion section and tracking the stated emission values as a project commitment.

If you have any questions regarding this letter or need any further information, please contact Mike Detamore of my staff at (610) 774-6385 or mbdetamore@pplweb.com.

Respectfully,

Rocco R. Sgarro

RRS/kw

Enclosure: Document # All4.BB.001, Review of the BAT, BACT and LAER Analysis for the Bell Bend Nuclear Power Plant (BBNPP), Revision 0

cc: w/ Enclosure

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Enclosure

Document AII4.BB.001, Review of the BAT, BACT and LAER Analysis for the Bell Bend Nuclear Power Plant (BBNPP), Revision 0

Review of the BAT, BACT and LAER Analysis for the Bell Bend Nuclear Power Plant (BBNPP)

Prepared by ALL4 Inc.

ALL4

for

PPL Bell Bend, LLC

Report # All4.BB.0001

Revision 0, December 20, 2013

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BACKGROUND

The Pennsylvania Department of Environmental Protection (PADEP) asked PPL to review the control technology analysis that was submitted for the proposed Bell Bend Nuclear Power Plant (BBNPP) project in its Plan Approval Application (PAA) submitted on July 18, 2011 to assure that the Best Available Technology (BAT) analyses provided is current with an assessment of control technology and source emission levels conducted today.

PPL contracted ALL4 Inc. (ALL4) to review the following sources to assure that the BAT analysis submitted with the PAA meets the regulatory requirements in Title 25, Chapter 127, Section 127.12(a)(5) that the emissions from a new source will be the minimum attainable through the use of the best available technology:

1. four (4) emergency diesel generators (EDG), each rated at 10,130 kilowatts (kW) driven by diesel-fired engines with a cylinder displacement of 30 liters or greater;
2. two (2) Station Blackout diesel generators (SBO), each rated at 5,000 kW driven by diesel-fired engines with cylinder displacements of greater than 10 liters per cylinder but less than 30 liters per cylinder;
3. two (2) fire water pumps (FWP), each rated at 440 brake horsepower (bhp) driven by diesel-fired engines;
4. Cooling towers;
    - two (2) Circulating Water System cooling towers (CWS), each with a maximum circulating water flow rate of 360,000 gallons per minute (gpm);
    - four (4) Essential Service Water System cooling towers (ESWS), each with a maximum circulating water flow rate of 19,075 gpm;
5. one (1) Sponge-Jet media blasting unit with a maximum media throughput of 360 pounds per hour.;
6. one (1) Concrete Batch Plant with integrated 20 MMBtu/hr boiler; and
7. Roadway Emissions.

STATE BAT REVIEW AND COMMENTS

Reciprocating Internal Combustion Engines (RICE)

The emission standards proposed in the PAA do represent BAT for these engines. While the submitted PAA provided an extensive discussion of potentially available engine control systems for the RICE emission sources listed in Numbers 1 through 3 above, as stated in the PAA the appropriate emission controls and emission standards for RICE qualifying as "emergency stationary internal combustion engines" and "fire pump engines" have been recently established by the U.S. Environmental Protection Agency (U.S. EPA) in New Source Performance Standards (NSPS) under 40 CFR Part 60, Subpart IIII for Stationary Compression Ignition (CI) Internal Combustion Engines (ICE). The NSPS applicable emission standards are summarized below. In

addition to emission standards, 40 CFR Part 60, Subpart IIII also establishes work practices for these RICE to assure proper operation with minimal emissions. PPL will comply with all applicable emission standards, work practices, recordkeeping and reporting requirements that are applicable as specified in 40 CFR Part 60, Subpart IIII as presented below for the RICE emission sources listed in Numbers 1 through 3 above. As the RICE in the PAA will only be used for emergency electric supply and emergency water pumping operations, and for readiness testing for such emergencies; compliance with the following applicable new source performance standards for RICE as specified in 40 CFR Part 60, Subpart IIII represents BAT for these RICE sources.

1. **The four (4) emergency diesel generators (EDG), each rated at 10,130 kilowatts (kW) with a cylinder displacement of 30 liters or greater:**

40 CFR §60.4205 –
(d) Owners and operators of emergency stationary CI engines with a displacement of greater than or equal to 30 liters per cylinder must meet the requirements in this section.

(2) For engines installed on or after January 1, 2012, limit the emissions of NO_X in the stationary CI internal combustion engine exhaust to the following:

(i) 14.4 g/KW-hr (10.7 g/HP-hr) when maximum engine speed is less than 130 rpm;

(ii) 44 $n^{-0.23}$ g/KW-hr (33 · $n^{-0.23}$ g/HP-hr) when maximum engine speed is greater than or equal to 130 but less than 2,000 rpm and where n is maximum engine speed; and

(iii) 7.7 g/KW-hr (5.7 g/HP-hr) when maximum engine speed is greater than or equal to 2,000 rpm.

(3) Limit the emissions of PM in the stationary CI internal combustion engine exhaust to 0.40 g/KW-hr (0.30 g/HP-hr).

PPL will purchase engines that meet the regulatory requirements of 40 CFR Part 60, Subpart IIII, §60.4205 and will assure that these generator/engine sets comply with the definition of emergency stationary internal combustion engine as defined in 40 CFR Part 60, Subpart IIII, §60.4219.

2. **Two (2) Station Blackout diesel generators (SBO), each rated at 5,000 KW with cylinder displacements of greater than 10 liters per cylinder but less than 30 liters per cylinder:**

40 CFR §60.4205 –

(b) Owners and operators of 2007 model year and later emergency stationary CI ICE with a displacement of less than 30 liters per cylinder that are not fire pump engines must comply with the emission standards for new nonroad CI engines in §60.4202, for all pollutants, for the same model year and maximum engine power for their 2007 model year and later emergency stationary CI ICE.

40 CFR §60.4202 –

(e) Stationary CI internal combustion engine manufacturers must certify the following emergency stationary CI ICE that are not fire pump engines to the certification emission standards for new marine CI engines in 40 CFR Part 94, §94.8, as applicable, for all pollutants, for the same displacement and maximum engine power:

(2) Their 2013 model year and later emergency stationary CI ICE with a maximum engine power greater than or equal to 3,700 kW (4,958 HP) and a displacement of greater than or equal to 10 liters per cylinder and less than 15 liters per cylinder;

(3) Their 2013 model year emergency stationary CI ICE with a displacement of greater than or equal to 15 liters per cylinder and less than 30 liters per cylinder; and

(4) Their 2014 model year and later emergency stationary CI ICE with a maximum engine power greater than or equal to 2,000 kW (2,682 HP) and a displacement of greater than or equal to 15 liters per cylinder and less than 30 liters per cylinder.

PPL will purchase RICE that meet the regulatory requirements of 40 CFR Part 60, Subpart IIII, §§60.4202 and 60.4205, and will assure that these generator/engine sets comply with the definition of emergency stationary internal combustion engine as per Subpart IIII, §60.4219.

3. **Two (2) fire water pumps (FWP), each rated at 440 brake horsepower (bhp): 40 CFR §60.4205 –**

(c) Owners and operators of fire pump engines with a displacement of less than 30 liters per cylinder must comply with the emission standards in table 4 to Subpart IIII for all pollutants.

Part 60, Subpart IIII - TABLE 4

Maximum engine power	Model year(s)	NMHC + NO_X g/KW-hr (g/HP-hr)	CO g/KW-hr (g/HP-hr)	PM g/KW-hr (g/HP-hr)
225≤KW<450 (300≤HP<600)	2008 and earlier	10.5 (7.8)	3.5 (2.6)	0.54 (0.40)
	2009+ [3]	4.0 (3.0)		0.20 (0.15)

PPL will purchase RICE that meet the regulatory requirements of 40 CFR Part 60, Subpart IIII, Section 60.4205 for fire pump engines and will assure that these generator/engine sets comply with the definition of fire pump engine as per 40 CFR Part 60, Subpart IIII, §60.4219 for fire pump engines.

4. Cooling Towers

- Two (2) Circulating Water System cooling towers (CWS), each with a maximum circulating water flow rate of 360,000 gallons per minute (gpm)and
- Four (4) Essential Service Water System cooling towers (ESWS), each with a maximum circulating water flow rate of 19,075 gpm:

As specified in the PAA, the CWS and ESWS cooling towers for the proposed project will be equipped with the highest efficiency drift eliminators available for control of $PM/PM_{10}/PM_{2.5}$ emissions for the specific cooling water tower design. Therefore, the proposed drift eliminators and their drift control rates for the cooling towers do represent BAT for PM, PM_{10} and $PM_{2.5}$ for the specified cooling towers.

- The proposed BAT limits for the CWS cooling towers for PM, PM_{10}, and $PM_{2.5}$emissions is the use of drift eliminators designed by the tower manufacturer to have a drift rate not to exceed 0.0005% which is the lowest drift rate which will be guaranteed by cooling tower vendors.
- The proposed BAT limits for the ESWS cooling towers for PM, PM_{10} and $PM_{2.5}$ is a drift rate not to exceed 0.005% which is the lowest drift rate which will be guaranteed by cooling tower vendors for stainless steel mist eliminators which are required to be used for the ESWS cooling towers. Nuclear power station ESWS cooling water towers must be made of fire proof materials, which results in those drift eliminators being constructed of stainless steel. Because metal drift eliminators cannot be fabricated to be as efficient in removing water droplets as the complex conventional PVC material designs, the ESWS drift eliminators have a higher drift rate of 0.005%.

With regard to the emission limits for the cooling water towers, the plan approval application references an emissions estimation technique that speciates the PM_{10} and $PM_{2.5}$ portions of the total particulate matter for each tower through a calculation that uses the percentages of the different water droplet drift sizes as provided by the tower manufacturer, and then makes a calculation of the size of the solid particle that would result after evaporation of the water in the droplet. Such an estimation method requires specific cooling tower efficiency curves and droplet size loading to the drift eliminators. None of that specific data was supplied in the plan approval application to complete the demonstration of the particle size percentages for PM_{10} and $PM_{2.5}$.

However, since the total estimated particulate matter emissions from all of the cooling towers operating 8760 hours per year is only 9.08 tpy, there is no need for the permitting analysis to estimate the percentages of PM_{10} and $PM_{2.5}$. A conservative assumption can be made that particulate matter, PM_{10} and $PM_{2.5}$are all equivalent. Utilizing the most efficient drift eliminators available from cooling tower manufacturers for the specific tower design that meets the plant cooling water needs is by definition BAT for the particular cooling tower.

Appendix C of the PAA, specifically pages 8 and 9, detail the calculation of particulate matter emissions utilizing U.S. EPA AP-42 calculation methodology and then apply the factors discussed above to calculate smaller fractions of PM_{10} and $PM_{2.5}$. As discussed above, ALL4 suggests a more conservative, but more substantiated emission estimate, which is illustrated in Attachments 1 and 2. Attachments 1 and 2 build off of the Appendix C cooling tower emissions tables, and are solely based on utilizing U.S. EPA AP-42 calculation methodology. Based on this approach, it is recommended that the BAT particulate emission levels for the CWS cooling towers be PM, PM_{10} and $PM_{2.5}$ at 4.76 tpy and 5.04 tpy PM, PM_{10} and $PM_{2.5}$ for the ESWS cooling towers.

5. One (1) Sponge-Jet media blasting unit with a maximum media throughput of 360 pounds per hour.

The PAA proposes enclosure of the sponge-jet media blasting unit, recovery of the sponge media, and control of PM emissions from the vacuum ejector used to recover and recycle the sponge media with a baghouse vented to the atmosphere as BAT. The baghouse will have a guaranteed grain loading of not greater than 0.002 grains per actual cubic foot (gr/acf) of exhaust. The particles released from the baghouse are almost entirely less than 2.5 microns in diameter. This emission rate is consistent with the RBLC findings, and therefore does represent PM BAT for the sponge-jet media blasting unit.

6. One (1) Concrete Batch Plant:

During the construction phase of the project, there will be a concrete batch plant located at the facility which will utilize a No. 2 fuel oil-fired boiler with a maximum heat input capacity of 20 million Btu per hour (MMBtu/hr). Although the boiler is dedicated for use with the concrete batch plant, it is considered a separate air emission source.

In the PAA BBNPP proposed using flue gas recirculation (FGR) in combination with low-NOx burners (LNB) on the boiler to achieve a NO_X emissions rate of no greater than 0.14 lb/MMBtu.

ALL4 conducted a review of the U.S. EPA RBLC database and found a new relevant entry dated April 9, 2013, for the U.S. Department of Energy (DOE), Hanford facility. The NO_X BACT-PSD emission level for that boiler was identified as 0.09 lb/MMBtu (on a 24-hr avg.) using a low-NOx burner with no additional controls. The Hanford facility does consist of six(6) identical 50 MMBtu/hr boilers versus the proposed BBNPP boiler at 20 MMBtu/hr.

ALL4 contacted the Washington State Department of the Ecology Air Quality Program that issued the air quality permit to the DOE Hanford Facility to determine the status of the construction permit for these boilers. While these six boilers have been constructed, the boilers have not as yet begun operation and have not been tested for compliance with the permitted NO_X emission rate. Therefore the Hanford Facility boiler emission rate of 0.09 lb NO_X/MMBtu (on a 24-hr avg.) has not been verified and does not represent a final BAT/BACT emission rate that has been demonstrated in practice.

However, based on the information for the Hanford facility it was determined that the boiler supplier for the Hanford facility, Cleaver-Brooks, should be contacted in order to determine if lower NO_X emission rates are available for boilers such as that proposed for the BBNPP concrete plant. The local representative for Cleaver-Brooks Boilers for the Berwick, Pennsylvania area was contacted to obtain the NO_X emission rate that would be available from Cleaver Brooks for the boiler size required for the BBNPP concrete plant. Attached is an emissions specification sheet (Attachment 3) for a Cleaver-Brooks boiler appropriately sized for the PPL batch concrete plant. The expected NO_X emissions performance for that boiler while firing #2 fuel oil for NO_X is 0.115 lb/MMBtu. Therefore PPL is now proposing for the BBNPP's PAA for the concrete batch plant boiler to still employ FGR in combination with low-NOx burners, as originally proposed in the PAA, but with a NO_X BAT emissions rate of not greater than 0.115 lb/MMBtu.

BBNPP is also proposing to utilize good combustion practices to achieve a maximum VOC emission rate of 0.0024 lb/MMBtu to satisfy VOC BAT requirements for the boiler for the concrete batch plant.

As reflected by existing permits and the noted RBLC entries, the most stringent CO emission limits are based on utilizing good combustion practices with no add-on control technology. BBNPP is proposing utilizing good combustion practices to achieve a maximum CO stack emission rate of 0.04 lb/MMBtu to satisfy CO BAT requirements for the boiler for the concrete batch plant.

The proposed BAT SO_2 fuel oil sulfur content of 0.0015%, equivalent to an SO_2 emission rate of 0.0015 lb/MMBtu, is among the lowest levels listed in RBLC.

The BBNPP plan approval application proposes the use of ultra low sulfur fuel with a maximum sulfur content of 0.0015% and employing good combustion practices as BAT for

PM/PM_{10} emissions from the boiler. The proposed PM/PM_{10} limit for the concrete batch plant boiler is 0.01 lb/MMBtu for filterable and condensable particulate matter.

For particulate matter emissions, BBNPP proposes BAT as use of fabric filters with a minimum 99% control efficiency to control emissions from pneumatic transfer of cement to silos, use of watering and other equivalent techniques to control emissions from sand and aggregate material transfer operations, and use of water curtains and water sprays or equivalent techniques to control emissions from weigh hopper and truck loading operations. This is consistent with the most stringent limit found in the RBLC database.

Hazardous air pollutants (HAPs) emitted during liquid fuel combustion are estimated inAppendix C of the PAA. Most of these HAPs are emitted as either PM-HAP or VOC-HAP. Since the project is implementing BAT controls for PM and VOC, the project would also meet BAT for the control of the particulate and organic forms of HAPs.

The PAA proposed emissions controls and emission rates for the concrete batch plant does still represent BAT.

7. Roadway Emissions

Fugitive particulate emissions from vehicle traffic on unpaved roadways associated with the concrete batch plant will be controlled by water spraying of the roadways and graveling of the unpaved roads, which represents BAT.

CONCLUSION

Based on ALL4's review of the BBNPP BAT analysis presented in the submitted PAA, ALL4 concludes that the proposed BAT controls and emissions rates do satisfy Title 25, Chapter 127, Section 127.12(a)(5) in that the emissions from these proposed new sources will be the minimum attainable through the use of the best available technology analysis with the following modification of proposed emission rates for the cooling towers:

1. The BAT particulate matter emission rate for the proposed cooling towers is now presented assuming that PM, PM_{10} and PM2.5 are all equivalent and calculated via the standard U.S. EPA AP-42 emission factor methods. Therefore the proposed cooling water tower particulate emission rates are:

    - (2) Circulating Water Supply (CWS) Cooling Towers 2.38 TPY (each), 4.76 TPY (total)
    - (4) Essential Service Water System (ESWS) Cooling Towers 1.26 TPY (each), 5.04 TPY (total)

2. The NO_X BAT emissions rate for the BBNPP concrete batch plant boiler is now proposed to be not greater than 0.115 lb/MMBtu.

Attachments 1, 2 and 3

Attachment 1

(based on Appendix C of PAA, page 8 of 14)

PPL Bell Bend Nuclear Power Plant
Calculation of Cooling Tower Drift & Particulate Matter Emissions
Circulating Water Supply (CWS) Cooling Towers

Parameters:

Number of Cooling Towers:	2	
Cooling Tower Circulating Water Flow Rate, Q:	360,000	
Cooling Tower Circulating Water Density:	8.34	lb/gal

per PPL

Make-up TDS =	201	ppm
Cycles of concentration =	3	
Max. TDS Concentration =	603	ppm

per PPL

Drift % =	0.0005%	
Drift Rate, D = Q x 0.000005 =	1.80	gpm

from AP-42, Section 13.4
Total Particulate Emissions (PM)

PM =	0.009	lb/min, per tower
=	0.54	lb/hr, per tower

Full Year Operation, 2 towers PM = 4.76 TPY

Attachment 2

(based on Appendix C of PAA, page 9 of 14)

PPL Bell Bend Nuclear Power Plant
Calculation of Cooling Tower Drift & Particulate Matter Emissions
Essential Service Water System (ESWS) Cooling Towers

Parameters:

Number of Cooling Towers:	4	
Cooling Tower Circulating Water Flow Rate, Q:	19,075	gpm
Cooling Tower Circulating Water Density:	8.34	lb/gal

per PPL

Make-up TDS =	201	ppm	
Cycles of concentration =	3		
Max. TDS Concentration =	603	ppm	= Make-up TDS x Cycles of Concentration

per PPL

Drift % = <	0.0050%	
Drift Rate, D = Q x 0.00005 =	0.95375	gpm

from AP-42, Section 13.4

Total Particulate Emissions (PM)

= Water Circulation Rate x Drift % x TDS x Water density x 10-6 = Drift Rate x TDS x Water density x 10-6

PM =	0.005	lb/min, per tower
=	0.29	lb/hr, per tower

Full Year Operation, 4 towers PM =	**5.04 TPY**

ATTACHMENT 3

Cleaver-Brooks Boiler Expected Emission Data

Producing Steam Firin #2 Oil

BACKGROUND INFORMATION

Date	12/10/13	Boiler Model	CB(LE)
Author	L.C. Banks	Altitude (feet)	700
Customer	Berwick Concrete	Operating Pressure (psig)	135
City & State	Pennsylvania	Furnace Volume (cuft)	167.31
		Furnace Heat Release (btu/hr/cu ft)	115,660
		Heating Surface (sqft)	2500
		Nox System	30

#2 Oil		Firing Rate			
		25%	50%	75%	100%
Horsepower		125	250	375	500
Input , Btu/hr		4,914,000	9,671,000	14,492,000	19,351,000
CO	ppm	50	50	50	50
	lb/MMBtu	0.039	0.039	0.039	0.039
	lb/hr	0.192	0.378	0.566	0.756
	tpy	0.841	1.655	2.480	3.311
NOx	ppm	90	90	90	90
	lb/MMBtu	0.115	0.115	0.115	0.115
	lb/hr	0.57	1.12	1.67	2.23
	tpy	2.486	4.892	7.331	9.789
NO	ppm	85.5	85.5	85.5	85.5
	lb/MMBtu	0.110	0.110	0.110	0.110
	lb/hr	0.54	1.06	1.59	2.12
	tpy	2.361	4.647	6.964	9.299
NO_2	ppm	4.5	4.5	4.5	4.5
	lb/MMBtu	0.006	0.006	0.006	0.006
	lb/hr	0.03	0.06	0.08	0.11
	tpy	0.124	0.245	0.367	0.489
SOx	ppm	270	270	270	270
	lb/MMBtu	0.483	0.483	0.483	0.483
	lb/hr	2.373	4.671	6.999	9.345
	tpy	10.395	20.457	30.655	40.933
VOCs	ppm	4	4	4	4
(Non-Methane Only)	lb/MMBtu	0.0020	0.0020	0.0020	0.0020
	lb/hr	0.010	0.019	0.029	0.039
VOCs does not include any	tpy	0.043	0.085	0.127	0.170
background VOC emissions.					
PM10(Filterable)	ppm	N/A	N/A	N/A	N/A
	lb/MMBtu	0.018	0.018	0.018	0.018
	lb/hr	0.089	0.18	0.263	0.35
	tpy	0.390	0.767	1.150	1.535
PM10(Condensable)	lb/MMBtu	0.002	0.002	0.002	0.002
	tpy	0.010	0.09	0.010	0.18
PM2.5(Filtable)	lb/MMBtu	0.018	0.018	0.018	0.018
	tpy	0.079	0.77	0.079	1.54
PM2.5(Condensable)	lb/MMBtu	0.002	0.002	0.002	0.002
	tpy	0.010	0.09	0.010	0.18
Exhaust Data					
Temperature, F		365	375	380	390
Flow	ACFM	1,722	2,951	4,449	6,013
	SCFM (70 Degrees Fah.)	1,133	1,917	2,873	3,836
	DSCFM	1,063	1,779	2,666	3,560
	lb/hr	5,098	8,626	12,927	17,261
Velocity	ft/sec	9	16	24	32
	ft/min	548	939	1,416	1,914

Notes:

1) All ppm levels are corrected to dry at 3% oxygen.

Oil emission levels are based on the following fuel constituent levels:

Ash Content	**0.0100**	%, by weight
Conradson Carbon Residue	**0.0000**	%, by weight
Fuel-bound Nitrogen Content	**0.01500**	%, by weight
Sulfur Content	**0.5000**	%, by weight

2) If any of the actual fuel constituent levels are different than indicated above, the emissions will change.

3.) Boilers rated above 40 hp , emission data is based on a burner turndown of 4 to 1.

4) Emission data based on actual boiler efficiency.

5) % H2O , by volume in exhaust gas is **11.50** % O2, by volume **2.56**

6) Percent water vapor in exhaust gas is **64.05** lbs/MMBtu of fuel fired

7) CO2 produced is **159.95** lbs/MMBtu of fuel fired

8) Particulate is exclusive of any particulates in combustion air or other sources of residual particulates from material.

9) Heat input is based on high heating value (HHV).

10.) Emission produced in tons per year (tpy) is based on 24 hours per day for 365 days = 8,760 hours per year

11.) Exhaust data is based on a clean and properly sealed boiler.