Oklahoma Department of Environmental Quality
Air Quality Division

BART Application Analysis — January 19, 2010

COMPANY:	**AEP- Public Service Company of Oklahoma**
FACILITY:	**Comanche Power Station**
FACILITY LOCATION:	**Comanche County, Oklahoma**
TYPE OF OPERATION:	**(2) 94 MW Gas Turbine Electric Generating Units**
REVIEWER:	**Phillip Fielder, Senior Engineering Manager** **Lee Warden, Engineering Manager**

I. PURPOSE OF APPLICATION

On July 6, 2005, the U.S. Environmental Protection Agency (EPA) published the final "Regional Haze Regulations and Guidelines for Best Available Retrofit Technology Determinations" (the "Regional Haze Rule" 70 FR 39104). The Regional Haze Rule requires certain States, including Oklahoma, to develop programs to assure reasonable progress toward meeting the national goal of preventing any future, and remedying any existing, impairment of visibility in Class I Areas. The Regional Haze Rule requires states to submit a plan to implement the regional haze requirements (the Regional Haze SIP). The Regional Haze SIP must provide for a Best Available Retrofit Technology (BART) analysis of any existing stationary facility that might cause or contribute to impairment of visibility in a Class I Area.

II. BART ELIGIBILITY DETERMINATION

BART-eligible sources include those sources that:

(1) have the potential to emit 250 tons or more of a visibility-impairing air pollutant;
(2) were in existence on August 7, 1977 but not in operation prior to August 7, 1962; and
(3) whose operations fall within one or more of the specifically listed source categories in 40 CFR 51.301 (including fossil-fuel fired steam electric plants of more than 250 mmBtu/hr heat input and fossil-fuel boilers of more than 250 mmBtu/hr heat input).

Comanche Units 1 and 2 are fossil-fuel fired steam electric plants with heat inputs greater than 250-mmBtu/hr. The units were in existence prior to August 7, 1977, but not in operation prior to August 7, 1962. Based on a review of existing emissions data, the units have the potential to emit more than 250 tons per year of NO_X, a visibility impairing pollutant. Therefore, Comanche Units 1 and 2 meet the definition of a BART-eligible source.

BART is required for any BART-eligible source that emits any air pollutant which may reasonably be anticipated to cause or contribute to any impairment of visibility in a Class I Area. DEQ has determined that an individual source will be considered to "contribute to visibility impairment" if emissions from the source result in a change in visibility, measured as a change in deciviews (Δ-dv), that is greater than or equal to 0.5 dv in a Class I area. Visibility impact modeling conducted by AEP-PSO determined that the maximum predicted visibility impacts from Comanche Units 1 and 2 exceeded the 0.5 Δ-dv threshold at the Wichita Mountains Class I Area. Therefore, Comanche Units 1 and 2 were determined to be BART applicable sources, subject to the BART determination requirements.

III. DESCRIPTION OF BART SOURCES

Baseline emissions from Comanche Units 1 and 2 were developed based on a combination of CEM data and operating records. In accordance with EPA guidelines in 40 CFR 51 Appendix Y Part III, emission estimates used in the modeling analysis to determine visibility impairment impacts should reflect steady-state operating conditions during periods of high capacity utilization. Therefore, baseline emissions (lb/hr) represent the highest 24-hour block emissions reported during the baseline period. Baseline emission rates (lb/mmBtu) were calculated by dividing the maximum hourly mass emission rates for each turbine by the turbine's full heat input at that rate. In addition, the duct burners have not operated for several years, and not over the baseline period. Emissions for the duct burners are not included in the analysis.

Table 1: Comanche Power Station- Operating Parameters for BART Evaluation

Parameter	Comanche Unit 1		Comanche Unit 2	
Plant Configuration	Combustion Turbine with Integrated Heat Recovery Steam Genertor		Combustion Turbine with Integrated Heat Recovery Steam Genertor	
Gross Output (nominal)	94 MW		94 MW	
Maximum Input to Turbine	1,250 mmBtu/hr		1,250 mmBtu/hr	
Primary Fuel	Natural gas		Natural gas	
Existing NO_X Controls	None		None	
Existing PM_{10} Controls	NA		NA	
Existing SO_2 Controls	NA		NA	
Baseline Emissions Pollutant	**Baseline Actual Emissions**		**Baseline Actual Emissions**	
	lb/hr	**lb/mmBtu**	**lb/hr**	**lb/mmBtu**
NO_X	**870.0**	**0.696**	**766.3**	**0.613**
SO_2	**0.75**	**--**	**0.75**	**--**
PM_{10}	**8.25**	**--**	**8.25**	**--**

IV. BEST AVAILABLE RETROFIT TECHNOLOGY (BART)

Guidelines for making BART determinations are included in Appendix Y of 40 CFR Part 51 (Guidelines for BART Determinations under the Regional Haze Rule). States are required to use the Appendix Y guidelines to make BART determinations for fossil-fuel-fired generating plants having a total generating capacity in excess of 750 MW. The BART determination process described in Appendix Y includes the following steps:

Step 1. Identify All Available Retrofit Control Technologies.
Step 2. Eliminate Technically Infeasible Options.
Step 3. Evaluate Control Effectiveness of Remaining Control Technologies.
Step 4. Evaluate Impacts and Document the Results.
Step 5. Evaluate Visibility Impacts.

Because the units fire natural gas, emissions of sulfur dioxide (SO_2) and particulate matter (PM) are minimal. There are no SO_2 or PM post-combustion control technologies with a practical application to natural gas-fired turbines. BART is good combustion practices. A full BART analysis was conducted for NO_X.

Table 2: Proposed BART Controls and Limits

Unit	NO_X BART Emission Limit	BART Technology
Comanche Unit 1	0.15 lb/mmBtu (30-day average)	Dry Low NO_X Burners (DLNB)
Comanche Unit 2	0.15 lb/mmBtu (30-day average)	Dry Low NO_X Burners (DLNB)

A. NO_X

IDENTIFY AVAILABLE RETROFIT CONTROL TECHNOLOGIES

Potentially available control options were identified based on a comprehensive review of available information. NO_X control technologies with potential application to Comanche Units 1 and 2 are listed in Table 3.

Table 3: List of Potential Control Options

Control Technology
Combustion Controls
Dry Low NO_X Burners (DLNB)
Post Combustion Controls
Selective Catalytic Reduction (SCR)

In support of the Regional Haze Rule, EPA also prepared a cost-effectiveness analysis for retrofit control technologies on oil- and gas-fired units. EPA's analysis concluded that, although a number of oil- and gas-fired units could make significant cost-effective reductions in NO_X emissions using currently available combustion control technologies, for a number of units the use of combustion controls did not appear to be cost effective. As a result, EPA determined that it would be inappropriate to establish a general presumption regarding likely BART limits for oil- and natural gas fired units.

ELIMINATE TECHICALLY INFEASIBLE OPTIONS (NO_X)
Combustion Controls:
Dry Low NO_X burners (DLNB)
Low NO_X burners (DLNB) limit NO_X formation through the restriction of oxygen, lowering of flame temperature, and/or reduced residence time. LNB is a staged combustion process that is designed to split fuel combustion into two zones. In the primary zone, NO_X formation is limited by either one of two methods. Under staged fuel-rich conditions, low oxygen levels limit flame temperature resulting in less NO_X formation. The primary zone is then followed by a secondary zone in which the incomplete combustion products formed in the primary zone act as reducing agents. Alternatively, under staged fuel-lean conditions, excess air will reduce flame temperatures to reduce NO_X formation. In the secondary zone, combustion products formed in the primary zone act to lower the local oxygen concentration, resulting in a decrease in NOX formation.

When utilized in new turbine designs, reductions of up to 60 percent may result. A similar level of effectiveness is expected with retrofit installations. This technology is considered a technically feasible option.

Post Combustion Controls:
Selective Catalytic Reduction
Selective Catalytic Reduction (SCR) involves injecting ammonia into turbine flue gas in the presence of a catalyst to reduce NO_X to N2 and water. Anhydrous ammonia injection systems may be used, or ammonia may be generated on-site from a urea feedstock. The units at the Comanche Station employ combustion turbines with integrated Heat Recovery Steam Generators (HRSG) that are very unique in their designs. AEP-PSO contends that it is technically infeasible to retrofit post combustion SCR NO_X control without rebuilding the generating units. Therefore SCR is not evaluated further.

EFFECTIVENESS OF REMAINING CONTROL TECHNOLOGIES (NO_X)

Table 4: Technically Feasible NO_X Control Technologies- Comanche Station

Control Technology	Comanche Unit 1 Approximate NO_X Emission Rate (lb/mmBtu)	Comanche Unit 2 Approximate NO_X Emission Rate (lb/mmBtu)
DLNB	0.15	0.15
Baseline	0.696	0.613

EVALUATE IMPACTS AND DOCUMENT RESULTS (NO_X)

AEP evaluated the economic, environmental, and energy impacts associated with the proposed control option. In general, the cost estimating methodology followed guidance provided in the EPA Air Pollution Cost Control Manual. Capital costs associated with implementing the evaluated control system was provided to AEP-PSO by an after-market vendor. As LNB are not expected to incur any additional significant direct operating costs, total direct operating costs were assumed to be $0. Indirect operating costs are consistent with control manual guidance.

The capital recovery factor used to estimate the annual cost of control was based on an 8% interest rate and a control life of 20 years. Annual operating costs and annual emission reductions were calculated assuming a capacity factor of 53%.

Table 5: Economic Cost for Units 1 and 2

Cost	Control Option: DLNB
Control Equipment Capital Cost ($)	$34,660,000
Capital Recover Factor ($/Yr)	$3,530,198
Annual O&M Costs ($/Yr)	$1,386,400
Annual Cost of Control ($)	$4,916,598

Table 6: Environmental Costs for Units 1 and 2

	Unit	Baseline	DLNB
NO_X Emission Rate (lb/mmBtu)	Unit 1	0.48	0.15
	Unit 2	0.46	0.15
Annual NO_X Emission (TPY)[1]	Unit 1	1,393	435
	Unit 2	1,385	452
Annual NO_X Reduction (TPY)	Unit 1	--	958
	Unit 2	--	933
Annual Cost of Control	Units 1 & 2		$4,916,598
Cost per Ton of Reduction	--		$2,600

(1) Emissions for the BART analysis are based on maximum heat inputs of 1,250 mmBtu/hr. Annual emissions were calculated assuming a 53% capacity factor for unit 1 and a 55% capacity factor for unit 2.

B. VISIBILITY IMPROVEMENT DETERMINATION

The fifth of five factors that must be considered for a BART determination analysis, as required by a 40 CFR part 51- Appendix Y, is the degree of Class I area visibility improvement that would result from the installation of the various options for control technology. This factor was evaluated for the Comanche Power Station by using an EPA-approved dispersion modeling system (CALPUFF) to predict the change in Class I area visibility. The Division had previously determined that the Comanche Power Station was subject to BART based on the results of initial screening modeling that was conducted using current (baseline) emissions from the facility. The screening modeling, as well as more refined modeling conducted by the applicant, is described in detail below.

Wichita Mountain Wildlife Refuge, Caney Creek, Upper Buffalo and Hercules Glade are the closest Class I areas to the Comanche Generating Station, as shown in Figure 1 below.

Only those Class I areas most likely to be impacted by the Comanche Generating Station were modeled, as determined by source/Class I area locations, distances to each Class I area, and professional judgment considering meteorological and terrain factors. It can be reasonably assumed that areas at greater distances and in directions of less frequent plume transport will experience lower impacts than those predicted for the four modeled areas.

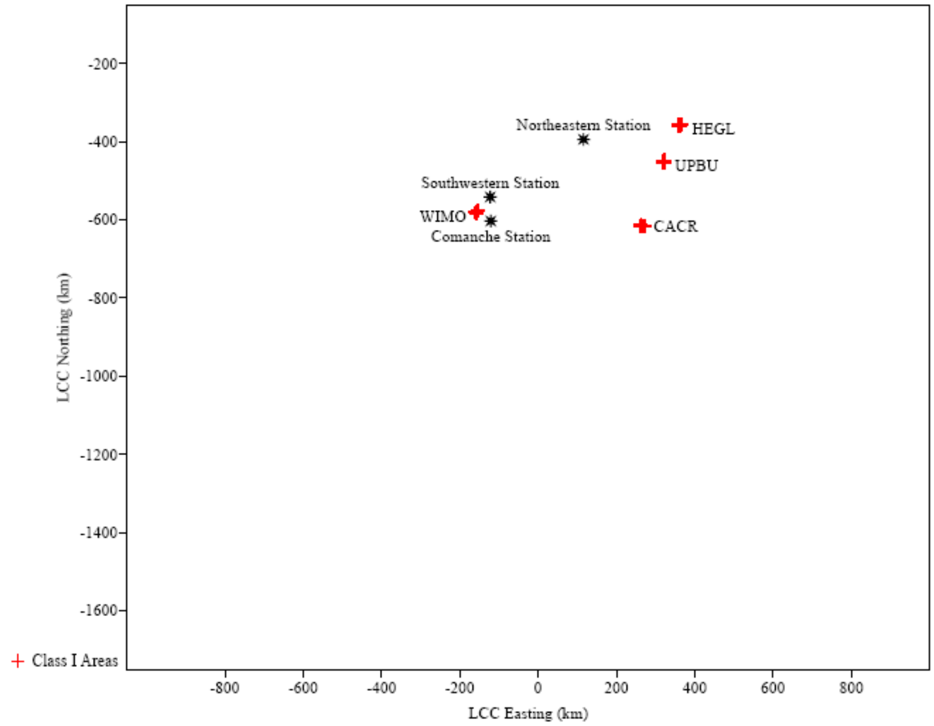

Figure 1: Plot of Facility location in relation to nearest Class I areas

REFINED MODELING:

Because of the results of the applicants screening modeling for the Comanche Generating Station, AEP-PSO was required to conduct a refined BART analysis that included CALPUFF visibility modeling for the facility. The modeling approach followed the requirements described in the Division's BART modeling protocol, *CENRAP BART Modeling Guidelines (Alpine Geophysics, December 2005)* with refinements detailed the applicants CALMET modeling protocol, *CALMET Data Processing Protocol (Trinity Consultants, August 2008)*

CALPUFF System

Predicted visibility impacts from the Comanche Generating Station were determined with the EPA CALPUFF modeling system, which is the EPA-preferred modeling system for long-range transport. As described in the EPA Guideline on Air Quality Models (Appendix W of 40 CFR Part 51), long-range transport is defined as modeling with source-receptor distances greater than 50 km. Because most modeled areas are located more than 50 km from the sources in question and the Wichita Mountains are just under the threshold at 40 km, the CALPUFF system was appropriate to use.

The CALPUFF modeling system consists of a meteorological data pre-processor (CALMET), an air dispersion model (CALPUFF), and post-processor programs (POSTUTIL, CALSUM, CALPOST). The CALPUFF model was developed as a non-steady-state air quality modeling system for assessing the effects of time- and space-varying meteorological conditions on pollutant transport, transformation, and removal.

CALMET is a diagnostic wind model that develops hourly wind and temperature fields in a three-dimensional, gridded modeling domain. Meteorological inputs to CALMET can include surface and upper-air observations from multiple meteorological monitoring stations. Additionally, the CALMET model can utilize gridded analysis fields from various mesoscale models such as MM5 to better represent regional wind flows and complex terrain circulations. Associated two-dimensional fields such as mixing height, land use, and surface roughness are included in the input to the CALMET model. The CALMET model allows the user to “weight” various terrain influences parameters in the vertical and horizontal directions by defining the radius of influence for surface and upper-air stations.

CALPUFF is a multi-layer, Lagrangian puff dispersion model. CALPUFF can be driven by the three-dimensional wind fields developed by the CALMET model (refined mode), or by data from a single surface and upper-air station in a format consistent with the meteorological files used to drive steady-state dispersion models. All far-field modeling assessments described here were completed using the CALPUFF model in a refined mode.

CALPOST is a post-processing program that can read the CALPUFF output files, and calculate the impacts to visibility.

All of the refined CALPUFF modeling was conducted with the version of the CALPUFF system that was recognized as the EPA-approved release at the time of the application submittal. Version designations of the key programs are listed in the table below.

Table 7: Key Programs in CALPUFF System

Program	Version	Level
CALMET	5.53a	040716
CALPUFF	5.8	070623
CALPOST	5.51	030709

Meteorological Data Processing (CALMET)

As required by the Division’s modeling protocol, the CALMET model was used to construct the initial three-dimensional wind field using data from the MM5 model. Surface and upper-air data were also input to CALMET to adjust the initial wind field.

The following table lists the key user-defined CALMET settings that were selected.

Table 8: CALMET Variables

Variable	Description	Value
PMAP	Map projection	LCC (Lambert Conformal Conic)
DGRIDKM	Grid spacing (km)	4
NZ	Number of layers	12
ZFACE	Cell face heights (m)	0, 20, 40, 60, 80, 100, 150, 200, 250, 500, 1000, 2000, 3500
RMIN2	Minimum distance for extrapolation	-1
IPROG	Use gridded prognostic model outputs	14 km (MM5 data)
RMAX1	Maximum radius of influence (surface layer, km)	20 km

Variable	Description	Value
RMAX2	Maximum radius of influence (layers aloft, km)	50 km
TERRAD	Radius of influence for terrain (km)	10 km
R1	Relative weighting of first guess wind field and observation (km)	10 km
R2	Relative weighting aloft (km)	25 km

The locations of the upper air stations with respect to the modeling domain are shown in Figure 2.

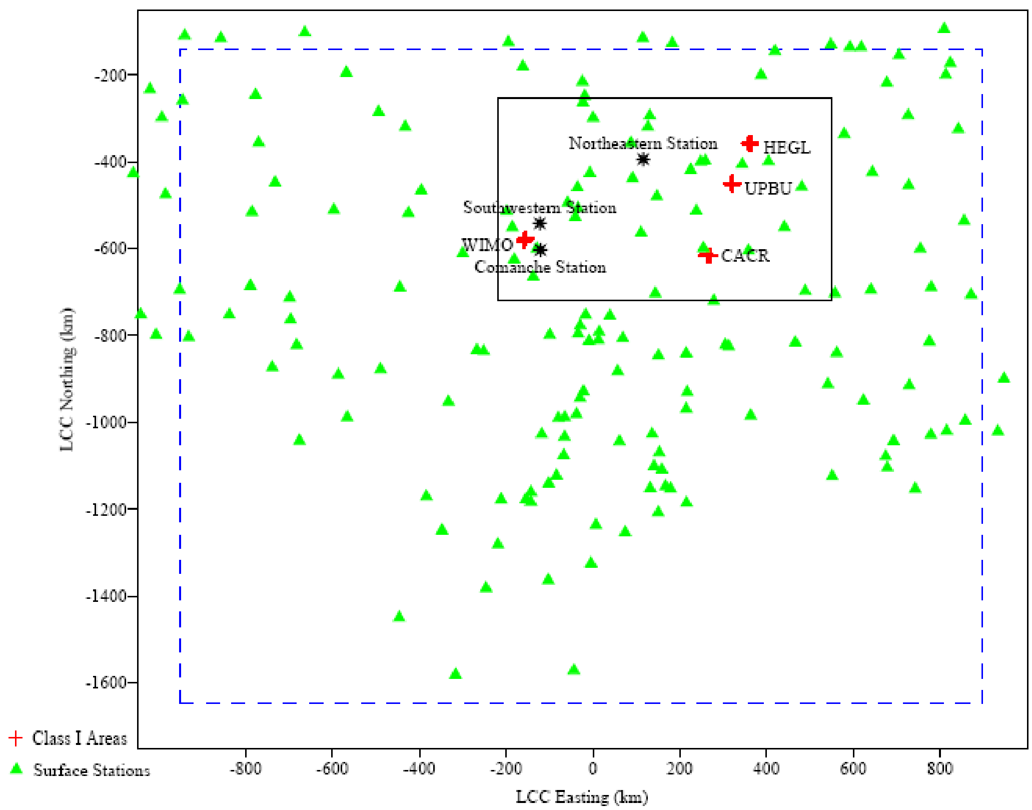

Figure 2: Plot of surface station locations

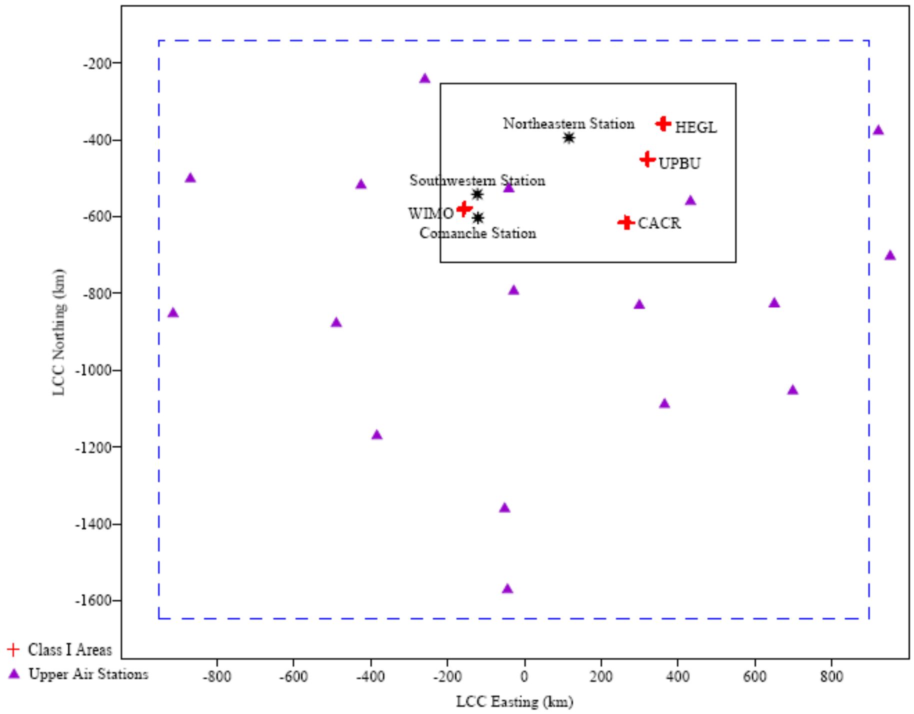

Figure 3: Plot of upper air station locations

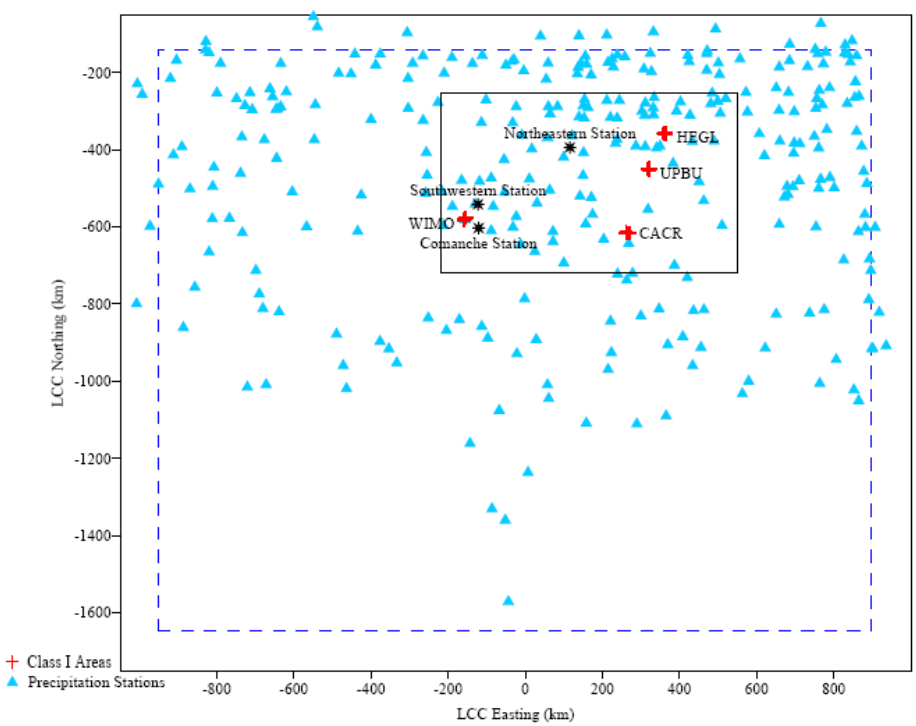

Figure 4. Plot of precipitation observation stations

CALPUFF Modeling Setup

To allow chemical transformations within CALPUFF using the recommended chemistry mechanism (MESOPUFF II), the model required input of background ozone and ammonia. CALPUFF can use either a single background value representative of an area or hourly ozone data from one or more ozone monitoring stations. Hourly ozone data files were used in the CALPUFF simulation. As provided by the Oklahoma DEQ, hourly ozone data from the Oklahoma City, Glenpool, and Lawton monitors over the 2001-2003 time frames were used. Background concentrations for ammonia were assumed to be temporally and spatially invariant and were set to 3 ppb.

Latitude and longitude coordinates for Class I area discrete receptors were taken from the National Park Service (NPS) Class I Receptors database and converted to the appropriate LCC coordinates.

CALPUFF Inputs- Baseline and Control Options

The first step in the refined modeling analysis was to perform visibility modeling for current (baseline) operations at the facility. Emissions of NO_X for the baseline runs were established based on CEM data and the highest 24-hour emissions averages for years 2001 to 2005. All particulate emissions (PM) were based on emission rates of 0.0066 lb/mmBtu with 25% filterable (coarse PM) and 75% condensable treated as (fine PM) within CALPUFF and CALPOST.

Baseline source release parameters and emissions are shown in the table below, followed by tables with data for the various control options.

Table 9: Baseline Source Parameters

	Baseline	
Parameter	Unit 1	Unit 2
Heat Input (mmBtu/hr)	1,250	1,250
Base Elevation (m)	338	338
Stack Height (m)	16	16
Stack Diameter (m)	3.11	3.11
Stack Temperature (K)	453	455
Exit Velocity (m/s)	44.82	44.82
SO2 Emissions (TPY)	0.75	0.75
NOX Emissions[1] (lb/mmBtu)	0.696	0.613
NOX Emissions TPY	870	766.3
PM_{10} Emissions Coarse (TPY)	2.06	2.06
PM_{10} Emissions Fine (TPY)	6.19	6.19

[1]Baseline NOx emissions were based on the maximum 24-hr average emission rate (lb/hr) reported by each unit during the baseline period 2003-2005. Baseline emissions data were provided by AEP-PSO. Baseline emission rates (lb/mmBtu) were calculated by dividing the maximum 24-hr lb/hr emission rate by the heat input to the turbine at that rate.

[2]PM emissions are based on AP-42 emission factors for stationary gas turbines with filterable/condensable speciation based on NPS guidance.

Visibility Post-Processing (CALPOST) Setup

The changes in visibility were calculated using Method 6 with the CALPOST post-processor. Method 6 requires input of monthly relative humidity factors [f(RH)] for each Class I area that is being modeled. Monthly f(RH) factors that were used for this analysis are shown in the table below.

Table 11: Relative Humidity Factors for CALPOST

Month	Wichita Mountains	Caney Creek	Upper Buffalo	Hercules Glade
January	2.7	3.4	3.3	3.2
February	2.6	3.1	3.0	2.9
March	2.4	2.9	2.7	2.7
April	2.4	3.0	2.8	2.7
May	3.0	3.6	3.4	3.3
June	2.7	3.6	3.4	3.3
July	2.3	3.4	3.4	3.3
August	2.5	3.4	3.4	3.3
September	2.9	3.6	3.6	3.4
October	2.6	3.5	3.3	3.1
November	2.7	3.4	3.2	3.1
December	2.8	3.5	3.3	3.3

EPA's default average annual aerosol concentrations for the U.S. that are included in Table 2-1 of EPA's *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program* were to develop natural background estimates for each Class I area.

Visibility Post-Processing Results

Table 12: CALPUFF Visibility Modeling Results for Comanche Units 1 and 2

Class I Area	2001 98th Percentile Value (Δdv)	2002 98th Percentile Value (Δdv)	2003 98th Percentile Value (Δdv)	3-Year Average 98th Percentile Value (Δdv)
Baseline				
Wichita Mountains	1.83	1.619	1.66	1.703
Caney Creek	0.103	0.097	0.08	0.093
Upper Buffalo	0.092	0.066	0.062	0.073
Hercules Glade	0.076	0.068	0.044	0.063
Scenario- Combustion Control- DLNB				
Wichita Mountains	0.47	0.395	0.406	0.424
Caney Creek	0.024	0.022	0.018	0.021
Upper Buffalo	0.021	0.015	0.014	0.017
Hercules Glade	0.017	0.015	0.010	0.014

C. BART DETERMINATION

After considering: (1) the costs of compliance, (2) the energy and non-air quality environmental impacts of compliance, (3) any pollutant equipment in use or in existence at the source, (4) the remaining useful life of the source, and (5) the degree of improvement in visibility (all five statutory factors) from each proposed control technology, the Division determined BART for the two units at the Comanche Generating Station.

New DLNB is determined to be BART for NO_X control for Units 1 and 2 based, in part, on the following conclusions:

1. Installation of new DLNB was cost effective, with a capital cost of $34,660,000 for units 1 and 2 and an average cost effectiveness of $2,600 per ton of NO_X removed for each unit over a twenty year operational life.

2. Combustion control using the LNB does not require non-air quality environmental mitigation for the use of chemical reagents (i.e., ammonia or urea) and there is minimal energy impact.

3. After careful consideration of the five statutory factors, especially the costs of compliance and existing controls, NO_X control levels on 30-day rolling averages of 0.15 lb/mmBtu for Unit 1 and 2 are justified.

4. Annual NO_X emission reductions from new LNB on Units 1, and 2 are a total of 1,891 tons.

The Division considers the installation and operation of the BART determined NO_X controls, new DLNB, to meet the statutory requirements of BART.

V. CONSTRUCTION PERMIT

Prevention of Significant Deterioration (PSD)
Comanche Power Station is a major source under OAC 252:100-8 Permits for Part 70 Sources. AEP-PSO should comply with the permitting requirements of Subchapter 8 as they apply to the installation of controls determined to meet BART.

The installation of controls determined to meet BART will not change NSPS or NESHAP/MACT applicability for the gas-fired units at the Comanche Station.

With installation of the BART controls, the duct burners will no longer be authorized to operate.

VI. OPERATING PERMIT

The Comanche Generating Station is a major source under OAC 252:100-8 and has submitted an application to modify their existing Title V permit to incorporate the requirement to install controls determined to meet BART. The Permit will contain the following specific conditions:

1. The turbines in EUG 1 and 2 are subject to the Best Available Retrofit Technology (BART) requirements of 40 CFR Part 51, Subpart P, and shall comply with all applicable requirements including but not limited to the following: [40 CFR §§ 51.300-309 & Part 51, Appendix Y]

a. Affected facilities. The following sources are affected facilities and are subject to the requirements of this Specific Condition, the Protection of Visibility and Regional Haze Requirements of 40 CFR Part 51, and all applicable SIP requirements:

EU ID#	Point ID#	EU Name	Heat Capacity (MMBTUH)	Construction Date
1G1	1G1	Westinghouse /W-501B	1250	1971
1G2	1G2	Westinghouse /W-501B	1250	1971

b. Each existing affected facility shall install and operate the SIP approved BART as expeditiously as practicable but in no later than five years after approval of the SIP incorporating the BART requirements.

c. The permittee shall apply for and obtain a construction permit prior to modification of the turbines. If the modifications will result in a significant emission increase and a significant net emission increase of a regulated NSR pollutant, the applicant shall apply for a PSD construction permit.

d. The affected facilities shall be equipped with Dry Low-NO_X Burners, as determined in the submitted BART analysis, to reduce emissions of NO_X to below the emission limits below:

e. The permittee shall maintain the combustion controls (Low-NO_X burners) and establish procedures to ensure the controls are properly operated and maintained.

f. Within 60 days of achieving maximum power output from each affected facility, after modification or installation of BART, not to exceed 180 days from initial start-up of the affected facility the permittee shall comply with the emission limits established in the construction permit. The emission limits established in the construction permit shall be consistent with manufacturer's data and an agreed upon safety factor. The emission limits established in the construction permit shall not exceed the following emission limits:

EU ID#	Point ID#	NO_X Emission Limit	Averaging Period
1G1	1G1	0.15 lb/MMBTU	30-day rolling
1G2	1G2	0.15 lb/MMBTU	30-day rolling

g. Within 60 days of achieving maximum power output from each turbine, after modification of the turbines, not to exceed 180 days from initial start-up, the permittee shall conduct performance testing and furnish a written report to Air Quality. Such report shall document compliance with BART emission limits for the affected facilities.
[OAC 252:100-8-6(a)]

1. A testing protocol describing how the testing will be performed shall be provided to the AQD for review and approval at least 30 days prior to the start of such testing.
2. The permittee shall also provide notice of the actual test date to AQD.