Section 10

Written Description of the Routine Operations of the Facility

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A written description of the routine operations of the facility. Include a description of how each piece of equipment will be operated, how controls will be used, and the fate of both the products and waste generated. For modifications and/or revisions, explain how the changes will affect the existing process. In a separate paragraph describe the major process bottlenecks that limit production. The purpose of this description is to provide sufficient information about plant operations for the permit writer to determine appropriate emission sources.

HGS is a natural gas fueled, nominal 604 MW net output power plant with two advanced firing temperature, Mitsubishi 501F CTGs, each provided with its own HRSG including duct burners, a single condensing, reheat STG, and an air cooled condenser serving the STG. The plant generates electricity for sale to Southwestern Public Service Company, its successors or assigns. The facility is located approximately 9 miles West of Hobbs, New Mexico in Lea County.

The exhaust from each CTG is delivered to a HRSG that produces the steam to drive the STG. Supplemental firing, using duct burners, is employed during periods of peak demand to increase HRSG steam production.

A surface condenser (heat exchanger) is used to condense the steam exhaust from the STG. Condensing the steam produces a slight vacuum, thus increasing the pressure differential that drives the steam turbine and increasing the overall efficiency of the power plant. Dry cooling is utilized to condense the steam exhaust from the steam turbine.

Several small emission sources are used at HGS, including 3 inlet chillers, 3 auxiliary cooling towers, 3 natural gas fuel heaters, a firewater pump, a standby generator and a number of storage tanks. The inlet air chilling system consists of three crossflow cooling towers that serve to enhance the overall output of the plant by lowering the temperature of the air entering the CTGs during periods of high ambient temperature (November through May). The auxiliary cooling towers consist of three crossflow closed-circuit wet cooling towers. The natural gas fuel heaters are used to pretreat the natural gas before it is fed to the CTGs. The firewater pump diesel engine is used to provide fire protection water for the plant and operates under 100 hours per year. The standby diesel generator operates under 500 hours per year and is used to provide the plant electrical requirements during complete black-out situations. Both engines fire low sulfur diesel fuel only.

Storage tanks at the site include two diesel tanks for the firewater pump diesel engine and the standby generator diesel engine, two additional diesel storage tanks, one gasoline storage tank, an aqueous ammonia storage tank for the SCR NO_x emissions control unit, a caustic storage tank and an aqueous sulfuric acid storage tank for the cooling towers pH control, a neutralization tank that serves the wastewater facility, and several water storage tanks.

Section 11

Source Determination

Source submitting under 20.2.70, 20.2.72, 20.2.73, and 20.2.74 NMAC

Sources applying for a construction permit, PSD permit, or operating permit shall evaluate surrounding and/or associated sources (including those sources directly connected to this source for business reasons) and complete this section. Responses to the following questions shall be consistent with the Air Quality Bureau's permitting guidance, Single Source Determination Guidance, which may be found on the Applications Page in the Permitting Section of the Air Quality Bureau website.

Typically, buildings, structures, installations, or facilities that have the same SIC code, that are under common ownership or control, and that are contiguous or adjacent constitute a single stationary source for 20.2.70, 20.2.72, 20.2.73, and 20.2.74 NMAC applicability purposes. Submission of your analysis of these factors in support of the responses below is optional, unless requested by NMED.

A. Identify the emission sources evaluated in this section (list and describe)**:**

B. Apply the 3 criteria for determining a single source:

SIC Code: Surrounding or associated sources belong to the same 2-digit industrial grouping (2-digit SIC code) as this facility, OR surrounding or associated sources that belong to different 2-digit SIC codes are support facilities for this source.

☒ **Yes** ☐ **No**

Common Ownership or Control: Surrounding or associated sources are under common ownership or control as this source.

☒ **Yes** ☐ **No**

Contiguous or Adjacent: Surrounding or associated sources are contiguous or adjacent with this source.

☒ **Yes** ☐ **No**

C. Make a determination:

☒ The source, as described in this application, constitutes the entire source for 20.2.70, 20.2.72, 20.2.73, or 20.2.74 NMAC applicability purposes. If in "A" above you evaluated only the source that is the subject of this application, all "**YES**" boxes should be checked. If in "A" above you evaluated other sources as well, you must check **AT LEAST ONE** of the boxes "**NO**" to conclude that the source, as described in the application, is the entire source for 20.2.70, 20.2.72, 20.2.73, and 20.2.74 NMAC applicability purposes.

☐ The source, as described in this application, **does not** constitute the entire source for 20.2.70, 20.2.72, 20.2.73, or 20.2.74 NMAC applicability purposes (A permit may be issued for a portion of a source). The entire source consists of the following facilities or emissions sources (list and describe):

Section 12

Section 12.A
PSD Applicability Determination for All Sources

(Submitting under 20.2.72, 20.2.74 NMAC)

A PSD applicability determination for all sources. For sources applying for a significant permit revision, apply the applicable requirements of 20.2.74.AG and 20.2.74.200 NMAC and to determine whether this facility is a major or minor PSD source, and whether this modification is a major or a minor PSD modification. It may be helpful to refer to the procedures for Determining the Net Emissions Change at a Source as specified by Table A-5 (Page A.45) of the EPA New Source Review Workshop Manual to determine if the revision is subject to PSD review.

A. This facility is:

- ☐ **a minor PSD source before and after this modification (if so, delete C and D below).**
- ☐ **a major PSD source before this modification. This modification will make this a PSD minor source.**
- ☐ **an existing PSD Major Source that has never had a major modification requiring a BACT analysis.**
- ☒ **an existing PSD Major Source that has had a major modification requiring a BACT analysis**
- ☐ **a new PSD Major Source after this modification.**

B. **This facility is one of the listed 20.2.74.501 Table I – PSD Source Categories. The "project" emissions for this modification are significant as proposed project increases exceed the PSD Significant Emission Rate (SER) for TSP/PM_{10}/$PM_{2.5}$ and GHG (CO_2e) (refer to Table 12-1 below). The "project" emissions listed below do only result from changes described in this permit application, thus no emissions from other revisions or modifications, past or future to this facility. Also, specifically discuss whether this project results in "de-bottlenecking", or other associated emissions resulting in higher emissions. The project emissions (before netting) for this project are as follows [see Table 2 in 20.2.74.502 NMAC for a complete list of significance levels]:**

a. **NOx: 193.8 TPY**
b. **CO: 286.4 TPY**
c. **VOC: 97.9 TPY**
d. **SOx: 53.4 TPY**
e. **TSP (PM): 97.9 TPY**
f. **PM_{10}: 96.6 TPY**
g. **$PM_{2.5}$: 95.4 TPY**
h. **Fluorides: N/A**
i. **Lead: N/A**
j. **Sulfur compounds (listed in Table 2): N/A**
k. **GHG: 1,989,930 TPY CO_2e**

C. **Netting - Applicant is submitting a PSD Major Modification and chooses not to net.**

D. **BACT is required, as this application is a major modification. List pollutants subject to BACT review and provide a full top down BACT determination. (See Table 12-1 below)**

E. If this is an existing PSD major source, or any facility with emissions greater than 250 TPY (or 100 TPY for 20.2.74.501 Table 1 – PSD Source Categories), determine whether any permit modifications are related, or could be considered a single project with this action, and provide an explanation for your determination whether a PSD modification is triggered.

Hobbs is located in Lea County, an area that is classified by the U.S. EPA as attainment with the NAAQS for all regulated pollutants. The facility is included as one of the 28-named sources under PSD rules and is a major source as defined by the PSD rules (40 CFR §52.21). The estimated annual emission rate increases for the facility proposed upgrade are summarized in Table 12–1.

Table 12-1: PSD Applicability Analysis Both Units Combined

Pollutant	Past Actuals (tpy)	Proposed Project Annual w/o SSM (tpy)	Proposed Project Increase (tpy)	PSD SER (tpy)	PSD Review Required?
NO_x	89.9	124.9	35.0	40	No
CO	9.5	76.0	66.5	100	No
VOC	3.9	13.1	9.2	40	No
SO_2	17.2	50.7	33.5	40	No
H_2SO_4 (mist)	2.6	7.77	5.1	7	No
TSP/PM_{10}	48.6	90.5	41.9	15	Yes
$PM_{2.5}$	48.6	90.5	41.9	10	Yes
CO_2e	1,604,421	1,985,998	381,577	75,000	Yes

Since no emission rate decreases occurred during the contemporaneous period, the net emission rate increases are based on the proposed project emission rate increases, which exceed the PSD Significant Emission Rate (SER) for TSP, PM_{10}, $PM_{2.5}$ and CO_2e. Consequently, the proposed modification constitutes a major modification of an existing major source and PSD review is required for each regulated pollutant with significant emissions, as defined in 40 CFR 52 (§52.21(b)(23)).

Section 12.B
Special Requirements for a PSD Application

(Submitting under 20.2.74 NMAC)

Prior *to Submitting a PSD application*, the permittee shall:

- ☒ Submit the BACT analysis for review prior to submittal of the application. No application will be ruled complete until the final determination regarding BACT is made, as this determination can ultimately affect information to be provided in the application. A pre-application meeting is recommended to discuss the requirements of the BACT analysis.
  A BACT analysis for the proposed upgrade project was submitted to NMED on May 30, 2018.
- ☒ Submit a modeling protocol prior to submitting the permit application. **[Except for GHG]**
  An Air Dispersion Modeling Protocol and Partial Modeling Waiver was submitted to NMED on May 30, 2018.
- ☒ Submit the monitoring exemption analysis protocol prior to submitting the application. **[Except for GHG]**
  An Air Monitoring Exemption analysis protocol was submitted to NMED on May 30, 2018.

For PSD applications, the permittee shall also include the following:

- ☒ Documentation containing an analysis on the impact on visibility. **[Except for GHG]**
- ☒ Documentation containing an analysis on the impact on soil. **[Except for GHG]**
- ☒ Documentation containing an analysis on the impact on vegetation, including state and federal threatened and endangered species. **[Except for GHG]**
- ☒ Documentation containing an analysis on the impact on water consumption and quality. **[Except for GHG]**
- ☒ Documentation that the federal land manager of a Class I area within 100 km of the site has been notified and provided a copy of the application, including the BACT and modeling results. The name of any Class I Federal area located within one hundred (100) kilometers of the facility.

The full BACT Analysis is presented on the following pages.

VISIBILITY IMPAIRMENT ANALYSIS

Visibility impairment may occur as a result of the scattering and absorption of light by particles and gases in the atmosphere. To assess the potential impact on Class I and Class II areas, industrial facilities are required to complete a visibility impairment analysis for their proposed sources.

Three Class I areas—the Carlsbad Caverns National Park (CCNP), Guadalupe Mountains National Park (GMNP) and Salt Creek Wilderness Area (SCWA) are located within 300 kilometers of the Hobbs Generating Station. Correspondence with the National Park Service (NPS) and with the U.S. Fish and Wildlife Service (USFWS), during initial construction permitting process (October 2006), concur that a Class I Impact Analysis was not required due to the distance to these areas.

The nearest Class I area to the HGS is the Carlsbad Caverns National Park located in Eddy County, NM, 117 km southwest of Hobbs. Since this Class I area is located at a distance greater than 100 km from the site, it may be assumed that the HGS has negligible impact at this distance. However, to assure that there are no impacts at "nearby" Class I areas, and based on pre-application meeting discussions with NMED, it is proposed to perform a Class I impacts analysis within 300km of the site. The Q/D test for Class I areas up to 300km was performed to assure that there will not be any issues with the Federal Land Managers mandate.

According to the "Federal Land Managers' Air Quality Related Values Work Group (FLAG) *Phase 1 Report—Revised (2010)*" (https://www.nature.nps.gov/air/Permits/flag/index.cfm) report, the initial screening criteria includes calculating a fixed Q/D factor for sources located greater than 50km from a Class I area; where "Q" is the total annual emission rate of the site's SO_2, NO_x, PM_{10}, and H_2SO_4 and "D" is the distance (in km) from the site to the Class I area. If Q/D is less than 10, the impacts on the Class I area are negligible.

Total proposed site-wide annual emission rates in tons per year (tpy):

SO_2:	21.5 lb/hr => 94 tpy
NO_x:	50.5 lb/hr => 221 tpy
PM_{10}:	36.3 lb/hr => 159 tpy
H_2SO_4:	34.0 lb/hr => 8 tpy
Total:	482 tpy

Total distance from the HGS to the nearest Class I area (Carlsbad Caverns National Park): 117km

Therefore Q/D = 482/117 = 4.1

Since Q/D is less than 10, the impacts of the HGS on the Carlsbad Caverns or any other Class 1 Areas (greater distance from HGS) is negligible.

SOIL AND VEGETATION ANALYSES

Sensitive soil and vegetation may be affected by the emission of certain air pollutants. The EPA developed the secondary NAAQS as a reference value for the protection from environmental damage that could be caused by certain air pollutants, including NO_x, particulate matter and sulfur dioxide (SO_2). It is considered that most soil types and vegetation will not be harmed by ground-level concentrations below the secondary NAAQS.

As detailed in Section 6, NO_x short-term emission rates will not be increased above the currently permitted levels due to the proposed turbine upgrade. However, there will be an increase in annual emission rates. Air Dispersion Modeling results discussed in Form UA4 show that projected impact concentrations are below the significant Impact Level (SIL).

WATER CONSUMPTION AND QUALITY ANALYSIS

The proposed upgrade will not require an increase in the number of regular staff that operates and maintains the facility, nor will it require any additional industrial development. Therefore, the proposed project is not expected to have any effect on the water consumption or the quality of the water.




Lea Power Partners, LLC

Hobbs Generating Station
BACT Analysis

Major Modification to PSD Permit 3449-M4

July, 2018

Prepared for:

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Lea Power Partners, LLC
Hobbs Generating Facility F4 GT Compressor Upgrade
BACT Analysis

INTRODUCTION

Lea Power Partners, LLC (LPP) is the owner of Hobbs Generating Station (HGS) located eight miles west of Hobbs, New Mexico. The facility consists of two natural gas fired Mitsubishi Model M501F gas turbines in a 2x1 configuration with Heat Recovery Steam Generators (HRSGs), Forney duct burners, and a GE D-11 steam turbine. LPP steam is condensed using a 35 cell SPX Air Cooled Condenser and has a maximum net capacity of 604MW.

The site holds both a New Source Review (NSR)/Prevention of Significant Deterioration (PSD) and a Federal Title V Operating permit in the State of New Mexico: PSD3449-M4 and P244-R1/P244-AR2. Emissions for each unit are controlled using carbon monoxide (CO) catalyst and Selective Catalytic Reduction (SCR) with injection of 28% aqueous ammonia.

Mitsubishi Hitachi Power System Americas (MHPSA) proposes to upgrade the two combustion turbines to the F4+ compressor upgrade. The upgrade consists of replacing the Inlet Guide Vanes (IGVs) and first six stages of the compressor, resulting in increased air flow. The expected impact of the upgrade on performance is an increase of 5% in output, no change in heat rate, and a 6.7% increase in turbine exhaust flow.

BACKGROUND

The subject units are three-pressure level reheat HRSG's originally designed for NEPCO in 2000 and then moved to the Hobbs site in 2007. The site consists of two triangular pitch, dual train, outdoor HRSGs. Combustion turbines are Mitsubishi 501F machines fueled by natural gas. The HRSG's supply steam to a single steam turbine and operate in floating pressure mode based on steam turbine conditions.

Each HRSG is triple pressure level with reheat, natural circulation, and equipped with auxiliary heat input via a Forney Corporation duct burner. The duct burner system is located between the secondary and primary stages of superheater and reheater heat transfer sections. The HRSG has been designed for duct firing with gas turbine near full load operation. The heat transfer sections are composed of extended surface, triangular pitched, finned tubes.

PROPOSED PROJECT REVIEW

The proposed project at LPP allows for an upgrade to both combustion turbine generators (CTGs), which is expected to increase power output by approximately 5% and increase the turbine flow rate by 6.7%. This change is expected to result in an increase in fuel consumption, exhaust flow rate, and temperature. The F4+ upgrade project is a completely stand-alone project, not tied in any way to previous projects that required a permit modification, including the permit modifications dated 9-23-2011 and 9-5-2014. It is our understanding that this compressor upgrade package has only been made available for commercial use by MHPSA since 2017.

Due to the increased exhaust flow rate, short term (lb/hr) and/or long term (tpy) emission rates for oxides of nitrogen (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), volatile organic compounds (VOC), particulate matter (PM_{10} and $PM_{2.5}$), sulfuric acid mist (H_2SO_4 mist), and carbon dioxide equivalent (CO_2e) will increase. However, a review of anticipated emission rate changes shows that the currently permitted short term emission rates for NO_2 and CO will not have to be changed or increased. Stack exhaust NO_x emissions will continue to be controlled to 2 parts per million volume dry basis corrected to 15 percent oxygen (ppmvdc) on a 24-hour average basis, using selective catalytic reduction (SCR) with aqueous ammonia (NH_3). Stack exhaust CO and VOC emissions will continue to be controlled to 2 ppmvdc on a 1-hour average basis and to 1 ppmvdc on a 24-hour average basis, respectively, by means of oxidation catalyst. SO_2 emissions will continue to be controlled using pipeline quality natural gas.

Hobbs, NM is located in Lea County, an area that is classified by the US EPA as in attainment with the National Ambient Air Quality Standards (NAAQS) for all regulated pollutants. The facility is included as one of the 28-named sources under PSD rules and is a major source as defined by the PSD rules under 40 CFR §52.21. The estimated annual emission rate increases and PSD applicability analysis for the proposed compressor upgrade project are summarized in Table 1 below:

Table 1: PSD Applicability Analysis Both Units Combined

Pollutant	Past Actuals (tpy)	Proposed Project Annual w/o SSM (tpy)	Proposed Project Increase (tpy)	PSD SER (tpy)	PSD Review Required?
NO_x	89.9	124.9	35.0	40	No
CO	9.5	76.0	66.5	100	No
VOC	3.9	13.1	9.2	40	No
SO_2	17.2	50.7	33.5	40	No
H_2SO_4 (mist)	2.6	7.77	5.1	7	No
TSP/PM_{10}	48.6	90.5	46.5	15	Yes
$PM_{2.5}$	48.6	90.5	46.5	10	Yes
CO_2e	1,604,421	1,985,998	381,577	75,000	Yes

Since no emission rate decreases occurred during the contemporaneous period, the net emission rate increases are based on the proposed project emission rate increases. The PSD Significant Emission Rate (SER) is exceeded for TSP/PM_{10}/$PM_{2.5}$ and CO_2e. Therefore, this modification constitutes a major modification of the existing major source and a PSD review is required for the pollutants with significant emissions per 40 CFR §52.21(b)(23)(i) and New Mexico Administrative Code (NMAC) 20.2.74.302. The main reason why a PSD review for TSP/PM_{10}/$PM_{2.5}$ and CO_2e is being triggered, is because the actual emissions from the past five (5) years are much lower than the permitted emission rates, thus the delta between the post-project allowable and the pre-project actual emission rates are greater than the SER.

PSD regulations call for Best Available Control Technology (BACT) to be used to minimize emissions of pollutants subject to PSD review from a major modification of an existing major source. BACT must be applied to each modified emission unit for the pollutants subject to PSD review and is determined on a case-by-case basis taking into consideration technical feasibility, environmental, economic, and energy impacts.

A BACT analysis is based on “top to bottom” approach as recommended by the US EPA. Five steps are evaluated as follows:

- Step 1: Identify all available control technologies
- Step 2: Eliminate options that are not technically feasible
- Step 3: Rank the remaining control technologies
- Step 4: Evaluate the most effective control technologies
- Step 5: Select BACT

The identification of control technologies is performed through knowledge of the industry and specific facility and previous regulatory requirements for identical or similar sources. A search of EPA’s Reasonable Available Control Technology (RACT), BACT, and Lowest Achievable Emission Rate (LAER) Clearinghouse database, the California Air Resources Board Guidance for Power plant Siting and BACT, and the South Coast Air Quality Management District LAER/BACT Guidelines was performed for natural gas fired combined cycle units. Infeasible alternatives were eliminated and the remaining alternatives are ranked beginning with the most stringent control and creating a control technology grading summary. These technologies were then evaluated for their environmental, energy and economic impact. If the top ranked technology was deemed not achievable, this step was repeated for the remaining, lower ranked control technologies.

It is predicted that the current permitted BACT will continue to be considered BACT after this compressor upgrade. The following BACT analysis for TSP/PM_{10}/$PM_{2.5}$ and CO_2e for this proposed upgrade of the two combustion turbines to the F4+ compressor upgrade was evaluated:

Table 2: Summary of BACT Control Methods for Hobbs CTGs/HRSG Duct Burners

Pollutant	**Proposed BACT**
TSP/PM_{10}/$PM_{2.5}$	Use of pipeline quality natural gas only. Follow good combustion practices.
CO_2e	Combined cycle power generation technology. Use of pipeline quality natural gas only. 2x1 configuration with 1x1 and simple cycle options. Efficient CTGs design and practices. Efficient HRSG design and practices. Fuel Flow meter calibration according to 40 CFR 75.

BACT ANALYSIS FOR TSP/PM_{10}/$PM_{2.5}$

Particulate emissions from the turbines and duct burners result primarily from inert solids contained in the fuel, combustion air and water (when water injection is used), and from sulfur compounds and unburned fuel hydrocarbons that agglomerate to form particles. These particles pass through the system and are emitted with the exhaust gas. All particulates emitted by the turbines and duct burners are fine particulate, and essentially all will be less than 2.5 microns in size.

Particulate emissions from gas turbines and duct burners are inherently low when using clean fuels, such as pipeline grade natural gas. In addition, turbines are designed and operated to combust the fuel as completely as possible in order to attain the highest possible thermal efficiency, which maintains particulates at very low levels.

Step 1: Identify all available control technologies:

Per the current EPA RACT/BACT/LAER Clearinghouse database, the California Air Resources Board Guidance for Power plant Siting and BACT, and the South Coast Air Quality Management District LAER/BACT Guidelines, the following are control technologies in order of increased efficiency.

Baghouse/Fabric Filter/Scrubbers

Process exhaust gas passes through a tightly woven or felted fabric arranged in sheets, cartridges, or bags that collect PM via sieving and other mechanisms. The dust cake that accumulates on the filters decreases collection efficiency. Various cleaning techniques include pulse-jet, reverse air flow, and shaker technologies. Operating conditions include: up to 500 ^{o}F (typical); inlet flows of 100 to 100,000 scfm (typical), 100,000 to 1,000,000 scfm (custom); inlet PM concentrations of 0.5 to 10 gr/dscf (typical), 0.05 to 100 gr/dscf (achievable).

This control option is not included in the current EPA RACT/BACT/LAER Clearinghouse database for the control of PM emissions from natural gas-fired combustion turbines. Fabric filters are susceptible to corrosion and blinding by moisture. Appropriate fabrics must be selected for specific process conditions. Natural gas-fired combustion turbines generate low PM emissions and have large flow rates, resulting in very low concentrations of PM. Add-on control devices would not provide any measurable PM emission reduction; therefore, this control technology is deemed not technically feasible. For reference, see attached document "US EPA, Office of Air Quality Planning and Standards, "Air Pollution Control Technology Fact Sheet (Fabric Filter – Pulse-Jet Cleaned Type)", EPA-452/F-03-025 and (Fabric Filter – Reverse Air Cleaned Type)", EPA-452/F-03-026.

Electrostatic Precipitators (ESP)

Electrodes stimulate the waste gas and induce an electrical charge in the entrained particles. The resulting electrical field forces char particles to collector walls from which the material may be mechanically dislodged and collected in dry systems or washed with water deluge in wet systems. Operating conditions include: up to 1,300 ^{o}F (dry), lower than 170 to 190 ^{o}F (wet); inlet flow o f1,000 to 100,000 scfm (wire-pipe), 100,000 to 1,000,000 scfm (wire-plate); inlet PM concentration 0.5 to 5 gr/dscf (wire-pipe), 1 to 50 gr/dscf (wire-plate).

Dry ESP efficiency varies significantly with dust resistivity. Air leakage and acid condensation may cause corrosion. This control option is not included in the current EPA RACT/BACT/LAER Clearinghouse database for the control of PM emissions from natural gas-fired combustion turbines. Natural gas-fired combustion turbines generate low PM emissions and have large flow rates, resulting in very low concentrations of PM. Add-on control devices would not provide any measurable PM emission reduction; therefore, this control technology is deemed not technically feasible. For reference, see attached document "US EPA, Office of Air Quality Planning and Standards, "Air Pollution Control Technology Fact Sheet (Dry Electrostatic Precipitator – Wire-Pipe Type)", EPA-452/F-03-027, "Air Pollution Control Technology Fact Sheet (Dry Electrostatic Precipitator – Wire-Plate Type)", EPA-452/F-03-028, and "Air Pollution Control Technology Fact Sheet (Dry Electrostatic Precipitator – Wire-Pipe Type)", EPA-452/F-03-029.

Cyclones/Mini-Cyclones

Centrifugal forces drive particles in the gas stream toward the cyclone walls as waste gas flows through the conical unit. The captured particles are collected in a material hopper below the unit. Operating conditions include: up to 1,000 ^oF; inlet flow of 1.1 to 63,500 scfm (single) and up to 106,000 scfm (in parallel); inlet PM concentrations of 0.44 to 7,000 gr/dscf.

Cyclones exhibit lower efficiencies when collecting smaller particles, High-efficiency units may require substantial pressure drop. This control option is not included in the current EPA RACT/BACT/LAER Clearinghouse database for the control of PM emissions from natural gas-fired combustion turbines. Natural gas-fired combustion turbines generate low PM emissions and have large flow rates, resulting in very low concentrations of PM. Add-on control devices would not provide any measurable PM emission reduction; therefore, this control technology is deemed <u>not technically feasible</u>. For reference, see attached document "US EPA, Office of Air Quality Planning and Standards, "Air Pollution Control Technology Fact Sheet (Cyclones)", EPA-452/F-03-005.

Good Combustion Practices:

Good combustion practices refer to design and operational practices that promote the complete combustion of the fuel, leading to lower particulate emissions, such as (1) efficient tuning of the air-to-fuel ratio in the combustion zone to allow minimal generation of unburned carbon; (2) proper combustor design that promotes air/fuel mixing and longer combustion chamber residence times, adequate temperature and turbulence; and (3) diligent maintenance and operation according to manufacturer's specifications.

Use of Clean Fuel:

Use of natural gas, pipeline quality natural gas, and California Public Utility Commission (PUC) quality natural gas that contain very low amounts of sulfur compounds (sulfur content is below 0.25 grain of hydrogen sulfide per 100 standard cubic feet and no more than 5 grains of total sulfur per 100 standard cubic feet, and a minimum of 80% methane by volume).

Step 2: Eliminate options that are not technically feasible:

Baghouses/Filters, Electrostatic Precipitators, and Cyclones are not deemed technical feasible control technologies.

Step 3: Rank the remaining control technologies:

The top level control is considered to be the combination of good combustion practices and the use of clean fuel.

Step 4: Evaluate the most effective control technologies:

Good combustion practices and use of clean fuels represent the only demonstrated particulate control technology for turbines and duct burners firing gaseous fuels. There is no economic penalty associated with these approaches. Good combustion practices and use of clean fuels are employed on combustion turbines throughout the US.

Step 5: Select BACT:

LPP's combined cycle units exclusively fire pipeline quality natural gas and will maintain good combustion practices. This fuel type, as a control technology, has been commonly used as BACT in recent permitting activities (e.g., Entergy Louisiana, LLC St. Charles Power Station (PSD-LA-804_8/31/2016); Southwestern Public Service Company, Gaines County, TX Power Plant (PSD-TX-1470_4/28/2017); Filler City Station LP, Filler City Station (MI-66-17_11/17/2017); Apex Texas

Power LLC, Neches Station (PSD-TX-1428_3/24/2016; Decordova II Power Company LLC, Decordova Steam Electric Station (PSD-TX-1432_3/8/2016)).

In addition, attached are statements from the turbine manufacturer and vendor discussing that no other commercially available post combustion PM control technologies exist for these natural gas fired units. In addition, Mitsubishi Hitachi Power System Americas also provided more detailed good combustion practices and design information.

BACT ANALYSIS FOR CO_2e

The combustion of methane and other minor hydrocarbon constituents of the natural gas in the CTGs and duct burners will result in the generation of greenhouse gases (GHG) including carbon dioxide (CO_2) and small quantities of methane (CH_4) and nitrous oxide (N_2O).

Step 1: Identify all available control technologies:

In order of efficiency, the available GHG control technologies listed for natural gas fired combined cycle units in the current EPA RACT/BACT/LAER Clearinghouse database, the California Air Resources Board Guidance for Power plant Siting and BACT, and the South Coast Air Quality Management District LAER/BACT Guidelines include the following technically feasible options for GHG emission mitigation:

- **Use of combined cycle power generation technology:**

  The most efficient way to generate electricity from a natural gas fuel source is the use of a combined cycle design, in which the HRSG is used to recover waste heat that would otherwise be lost to the atmosphere in the turbine exhaust. The recovered heat and produced steam allows generation of additional electric power by a steam turbine. The overall efficiency may be increased from about 30% for a simple cycle (no heat recovery) unit to about 50% for a combined cycle unit.

- **Use of multiple trains combined cycle units:**

  Combustion turbine efficiency is highest at full design load. The use of multiple trains (e.g. 2x1 configurations) allows one or more trains to be shut down while the remaining unit(s) operate(s) at or near full load, where maximum efficiency is achieved, rather than operating a single unit at lower, less efficient loads to meet market demand. Due to the variability of electricity demand, this flexibility helps maintain operational efficiency.

- **Use of natural gas:**

  Natural gas has the lowest carbon intensity among available fossil fuels. According to the comprehensive analysis by the Center of Climate and Energy Solutions "Leveraging Natural Gas to Reduce Greenhouse Gas Emissions", June 2013, https://www.c2es.org/document/leveraging-natural-gas-to-reduce-greenhouse-gas-emissions/ on average, natural gas combustion releases approximately 50 percent less CO_2 than coal and 33 percent less CO_2 than oil (per unit of useful energy). Therefore, the burning of natural gas only will reduce the carbon footprint when compared to other fossil fuels available.

- **Gas combustion turbine design:**

State-of-the-art combustion turbines operate at high temperatures due to the heat of compression and the thermal heat of combustion. The higher the operating temperature, the higher the turbine efficiency. To minimize the heat loss from the combustion turbines and protect the personnel and equipment around the units, insulation blankets are applied to the combustion turbine casing. These blankets minimize the heat loss through the combustion turbine shell. Improved design elements (e.g., two-bearing, axial exhaust, cold-end drive designs, etc.) have significantly increased overall combustion efficiency.

- **Fuel Pre-Heating:**

  Thermal efficiency of the turbine can be increased by pre-heating the fuel prior to combustion. This is usually accomplished by heat exchange using steam from the HRSG or hot CTGs compressor bleed air.

- **Inlet evaporative cooling or chillers:**

  Use of inlet evaporative coolers or chillers reduces the inlet air temperature, during high ambient temperature conditions, increasing the air density and hence the mass flow through the combustion turbine increases. As the mass flow through the combustion turbine increases, more power is generated, which increases the turbine efficiency.

- **Periodic maintenance and burner tuning:**

  Regularly scheduled maintenance programs are important for the reliable operation of the unit, as well as to maintain optimal efficiency. A periodic maintenance program consisting of inspection and cleaning of key equipment components and tuning of the combustion system will minimize performance degradation and recover thermal efficiency to the maximum extent possible.

- **Instrumentation and control systems:**

  State-of-the-art combustion turbines have sophisticated instrumentation and control systems to automatically control the operation of the combustion turbine, including the fuel feed and burner operations to achieve low-NOx combustion. The control systems monitor the operation of the unit and modulate the fuel flow and turbine operation to achieve optimal high-efficiency low-emission performance for full load and part load conditions.

- **Minimizing HRSG heat transfer surfaces fouling:**

  Fouling of interior and exterior surfaces of the HRSG heat exchanger tubes hinders the transfer of heat from the combustion turbine hot exhaust gases to the boiler feed water. This fouling occurs from contaminants in the turbine inlet air and in the feed water. Fouling is minimized by turbine inlet air filtration, maintaining proper feed water chemistry, and periodic maintenance, including cleaning the tube surfaces as needed during scheduled equipment outages. By reducing the fouling, the efficiency of the unit is maintained.

- **Steam turbine design:**

  State-of-the-art steam turbines are designed to be highly efficient units. The overall efficiency of the unit is primarily affected by the inlet and outlet steam conditions, the blade ring design, the steam turbine seals and the generator efficiency. New unit designs achieve higher overall performance, reducing startup times significantly and consequently increasing the efficiency of the combined cycle unit as a whole.

- **Periodic steam turbine maintenance:**

  Regularly scheduled maintenance programs are important for the reliable operation of the unit, as well as to maintain optimal efficiency. A periodic maintenance program consisting of inspection and cleaning will minimize performance degradation and maintain optimal use of the steam that is delivered from the HRSG.

- **Add-On Controls:**

  CO_2 Capture, Utilization, and Sequestration (CCUS) is an emerging technology that consists of processes to capture (separate) CO_2 from the combustion exhaust gases and then transport and inject it into geologic formations, such as oil and gas reservoirs, un-minable coal seams, and underground saline formations. CCUS could account for up to 90 percent of the emissions mitigation needed to stabilize and ultimately reduce concentrations of CO_2.

Step 2: Eliminate options that are not technically feasible:

All options identified in Step 1 above, with the exception of CCUS, are considered technically feasible for the existing and currently installed combined cycle units and will continue to be technically feasible after the compressor upgrade.

Although CCUS is a promising technology, in order to enable widespread, safe and effective CCUS, large-scale project studies still need to be completed to demonstrate that the capacity required for the purposes of GHG emissions mitigation at a typical power plant is met. The results from the current EPA RACT/BACT/LAER Clearinghouse database, the California Air Resources Board Guidance for Power plant Siting and BACT, and the South Coast Air Quality Management District LAER/BACT Guidelines show no such technology has yet been used for any large commercial natural gas fired combined cycle plant. Each component of CCUS technology (i.e., capture, transport and storage) is discussed in the following paragraphs.

<u>CO_2 Capture:</u>

CCUS could become a viable emission management option as new CO_2 capture technologies are developed. The growth in gas-fired power generation and the shift from coal to gas also means that CCUS technologies are no longer only applicable to coal-fired application. Such carbon capture technologies for natural gas combustion systems have been developed and proven technical feasible with small commercial applications in the energy sector. However, these technologies, which include amine-based solvent systems to separate CO_2 from natural gas generated flue gases at power plants, are too expensive for large scale commercial applications and the capital and operating costs are too expensive.

According to a US Department of Energy (DOE) report from August 2017 "Carbon Capture Opportunities for Natural Gas Fired Power Systems" commercially available CO_2 capture technologies presented that facilities capturing the highest volumes of CO_2 were all associated with gas streams containing relatively high concentrations of CO_2 (25 to 70 percent) such as natural gas processing operations and synthesis gas production. Capturing CO_2 from more dilute streams, such as those generated from power production is less common:

- CO_2 is present at low pressure (15-25 psia) and dilute concentrations (3-4 percent by volume) from the gas-fired turbine exhaust stream. Therefore, a very high volume of gas must be available to achieve CO_2 mass flow necessary to recover CO_2 at a cost efficiency comparable to an application such as natural gas processing.

- Trace impurities (particulate matter, SO_2, NO_x) in the exhaust gas can degrade sorbents and reduce the effectiveness of certain CO_2 capture processes.

Current industrial processes generally involve gas streams that are much lower volumes than that required for the purposes of GHG emissions mitigation at a typical power plant. Scaling up these existing processes represents a significant technical challenge and a potential barrier to widespread commercial deployment in the near term. No references to natural gas fired power plants the size of Lea Power Partners' using CCUS were identified.

The combustion of natural gas at LPP produces an exhaust gas with a maximum CO_2 concentration of less than five volume percent. This low concentration stream will require that a very high volume of gas be treated so that the CO_2 may be captured effectively. However, the CO_2 capture capacities used in current industrial processes are designed for relatively high CO_2 concentration streams (25 percent or higher). As the growth of natural gas use continues, CCUS for gas- power generation will become an important factor in reducing GHG emissions. But continued research and development is needed in order to apply CCUS technologies for full commercial application.

<u>CO_2 Transport:</u>

Even if it is assumed that CO_2 capture could feasibly be achieved at LPP, the high-volume CO_2 stream generated (>63,000 scf/min of CO_2) would need to be transported to a facility capable of storing it. Figure 1 is a map showing the location of current CO_2 pipelines in the Permian Basin (SE New Mexico and West Texas).

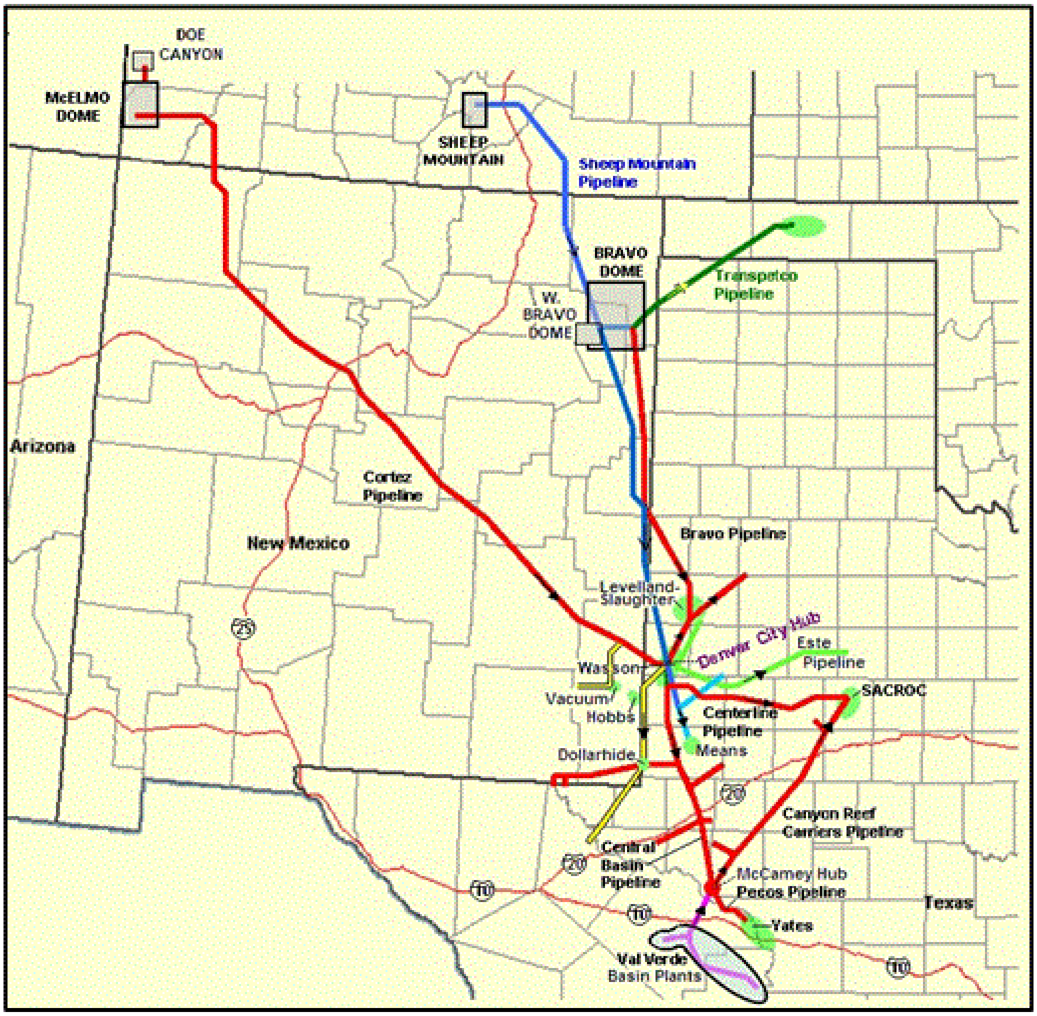


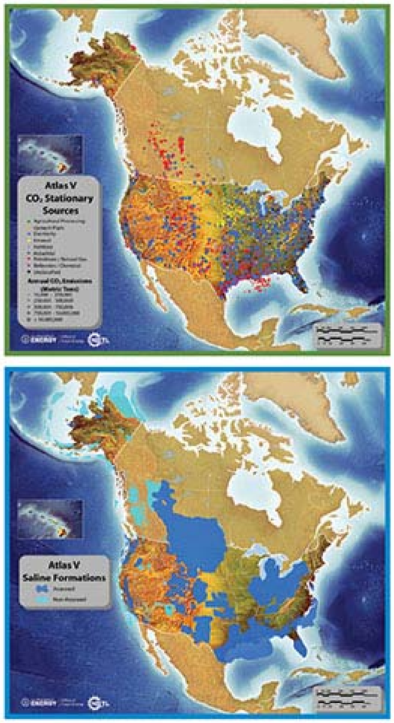
Figure 1: Permian Basin CO_2 Pipeline Infrastructure
[Source: US Department of Energy National Energy Technology Laboratory, Office of Fossil Energy, April 21, 2015]

<u>CO_2 Storage:</u>

As shown on the above map in Figure 1, there are existing pipelines that could potentially transport the CO_2 stream from Hobbs to a storage facility. The largest storage site closest to LPP, with some demonstrated capacity for geological storage of CO_2, is the Scurry Area Canyon Reef Operators (SACROC) oilfield near the eastern edge of the Permian Basin in Scurry County, Texas. This site is over 135 miles away from Hobbs; therefore, a very long and sizable pipeline would be required to transport the large volume of high pressure CO_2 from the plant to the storage facility, which will make CCUS economically infeasible. Several other, much smaller candidate storage reservoirs exist within the Permian Basin; however, none have been confirmed to be viable for large scale CO_2 storage.

Ongoing regional-scale assessments suggest a large resource potential for storage in the United States. According to the DOE's Regional Carbon Sequestration Partnerships (RCSPS) CO_2 storage resources including oil and gas reservoirs, un-minable coal and saline formations in the Southwest Partnership (SWP) area have great potential for large scale CO_2 storage in the future (see Figure 2). The SWP (Southern Wyoming, Utah, Colorado, Kansas, Oklahoma, New Mexico, Arizona, and West

Texas) is one of seven regional partnerships established in 2003 by the DOE to study carbon management strategies. Since then, SWP has completed a number of studies.



Estimates of CO_2 Stationary Source Emissions and Estimates of CO_2 Storage Resources for Geologic Storage Sites

RCSP or Geographic Region	CO_2 Stationary Sources		CO_2 Storage Resource Estimates (billion metric tons of CO_2)								
	CO_2 Emissions (million metric tons per year)	Number of Sources	Saline Formations			Oil and Gas Reservoirs			Unmineable Coal Areas		
			Low	Med***	High	Low	Med***	High	Low	Med***	High
BSCSP	115	301	211	805	2,152	<1	<1	1	<1	<1	<1
MGSC	267	380	41	163	421	<1	<1	<1	2	3	3
MRCSP	604	1,308	108	122	143	9	14	26	<1	<1	<1
PCOR*	522	946	305	583	1,012	2	4	9	7	7	7
SECARB	1,022	1,857	1,376	5,257	14,089	27	34	41	33	51	75
SWP	326	779	256	1,000	2,693	144	147	148	<1	1	2
WESTCARB*	162	555	82	398	1,124	4	5	7	11	17	25
Non-RCSP**	53	232	--	--	--	--	--	--	--	--	--
Total	3,071	6,358	2,379	8,328	21,633	186	205	232	54	80	113

Source: U.S. Carbon Storage Atlas – Fifth Edition (Atlas V); data current as of November 2014

* Totals include Canadian sources identified by the RCSP

** As of November 2014, "U.S. Non-RCSP" includes Connecticut, Delaware, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, and Puerto Rico

*** Medium = p50

Figure 2: Estimates of CO_2 Stationary Source Emissions and Estimates of CO_2 Storage Resources [Source: NETL Carbon Storage Atlas, Fifth Edition (2015)]

According to completed and ongoing studies by the SWP, to enable widespread, safe, and effective CCUS, CO_2 storage should continue to be field-demonstrated for a variety of geologic reservoir classes, with large-scale projects targeted at high-priority reservoir classes and smaller-scale projects covering a wider range of classes that are important regionally.

Small and large-scale field tests in different geological storage classes are being conducted to confirm that CO_2 capture, transportation, and storage can be achieved safely, permanently, and economically. Results from these tests will provide a more thorough understanding of migration and permanent storage of CO_2 within various open and closed depositional systems. The storage types and formations being tested are considered regionally significant and are expected to have the potential to store hundreds of years of CO_2 stationary source emissions.

Accounting that permanent CO_2 storage in geologic formations may not be a viable option for all CO_2 emitters and that this option could result in no environmental benefit at significant cost, the DOE-National Energy Technology Laboratory (NETL) is also researching the development of alternatives that can use captured CO_2 or convert it to a useful product, such as a fuel, chemical, or plastic, with revenue from the CO_2 use offsetting a portion of the CO_2 capture cost.

Based on the reasons provided above, CCUS has only been effectively proven in small scale projects in specific regions, and is therefore considered technically infeasible for this project.

Step 3: Rank the remaining control technologies:

The technically feasible options for GHG emissions mitigation in order of most to least effective include:

- **Use of combined cycle power generation technology;**
- **Use of natural gas;**
- **Instrumentation and control systems;**
- **Gas combustion turbine design;**
- **HRSG design;**
- **Minimizing HRSG heat transfer surfaces fouling;**
- **Inlet evaporative cooling or chillers;**
- **Fuel pre-heating;**
- **Use of multiple trains combined cycle units; and**
- **Periodic maintenance and burner tuning.**

Step 4: Evaluate the most effective control technologies:

All of the technically feasible technologies discussed in Step 1 through Step 3 are being proposed for this project. Therefore, an examination of the energy, environmental, and economic impacts of the efficiency designs is not necessary for this application.

Step 5: Select BACT:

LPP proposes BACT for the combined cycle units the following energy efficiency processes, practices and designs:

- **Use of combined cycle power generation technology;**
- **Use of pipeline quality natural gas only to fire both the CTGs and the HRSG duct burners;**
- **Use of 2x1 configuration, allowing operation with one train full load or two trains full load on demand basis;**
- **Combustion turbines energy efficiency processes, practices and designs, including:**
    - **Efficient design of the turbine compressor, combustor, and blades**

- **Periodic gas turbine burner tuning, following vendor recommended comprehensive inspection and maintenance programs**
- **Reduction of heat loss**
- **Instrumentation and controls, including fuel gas flow rate; exhaust gas temperature monitoring; turbine package temperature and pressure monitoring; combustion dynamics monitoring; vibration monitoring; air/fuel ratio monitoring; and HRSG temperature and pressure monitoring**
- **Inlet chillers**

- **HRSG Energy Efficiency process, Practices, and Designs:**
  - **Efficient heat exchange design**
  - **Insulation of HRSG**
  - **Minimizing fouling of heat exchange surfaces, implementing vendor recommended comprehensive inspection and maintenance program**

- **Calibrate and perform preventive maintenance on the fuel flow meters as required by 40 CFR Part 75, Appendix D, Section 2.1.6 (Quality Assurance)**

Roger Schnabel
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Hobbs – Particulate Matter Controls

Lea Power Partners LLC - Hobbs Generating Station Gas Turbines are equipped with MHPS can-annular dry low NOx combustors. These consist of a pilot nozzle, a main nozzle, and combustor basket to combust natural gas fuel in a lean premix manner to control the formation of nitrogen oxides. The pilot nozzle keeps the flame stable by diffusion combustion using approximately 5% to 7% of the fuel. The remaining fuel is supplied to the main nozzle, which when pre-mixed with air, forms a uniform and low temperature flame. Air enters the pre-mix section in the combustor baskets through turning vanes and metering holes to obtain the proper mixture of air and fuel.

As defined by the US Environmental Protection Agency (EPA) particulate matter (PM) is "a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope."

Particulate Pollution can be divided into size categories as "PM10" which are inhalable particles, with diameters that are generally 10 micrometers and smaller, and PM2.5 which are fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller. EPA method 5 provides a methodology to determine the Particulate Matter Emissions which includes any material that condenses at or above the filtration temperature, PM10 and PM2.5 emissions, include filterable and condensable emissions coming out of the Gas Turbine. It is well understood across the industry that Gas Turbines using Natural Gas as primary fuel does not produce significant amounts of PM.

The current methods used for filterable and condensable PM can have significant error. Such testing methods were developed for higher-PM generating sources such as coal-fired power plants. These same methods used to measure particulate levels on natural gas often have inaccuracies that are equal to or greater than the amount of PM being generated by combustion.

From a combustion standpoint, there is little soot generated in combustion of natural gas, especially with a lean flame, and there is no ash content in natural gas. Measured PM therefore is primarily associated with to external sources (pollen and dirt in the air) which pass through the inlet air filters, and some oxidation of turbine flow path components. Sulfur contained in the fuel, typically measured in grains per 100 standard cubic feet, which is used to make gas leaks detectible by sense of smell, can result in a condensable form of PM such as Sulfuric Acid Mist As a result the combustion system utilized in this GT is able to control NOx emissions, and have minimal contribution of PM material which places the resulting PM levels near the level of accurate measurement detection.

Thank you,

Timor Abu-Jaber
LTSA Program Manager

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2287 Premier Row
Orlando, FL 32809, USA
Tel: 407.688.6800 Fax: 407.688.6990

Martin Schluep

From: MELLISH Thaddeus <thaddeus.mellish@cmigroupe.com>
Sent: Friday, June 08, 2018 9:46 PM
To: Jacqueline Chester
Cc: Roger Schnabel; Richard Shaw; Martin Schluep
Subject: Re: Lea Power Partners, LLC - Hobbs Generating Station PSD Permit No. 3449-M4 Modification Application

Jackie,

CMI confirms that there is no commercially available control technology to lower particulates from combustion turbine power plants with HRSGs.

Thad Mellish
VP Proposals & Aftermarket
CMI Energy

On Jun 8, 2018, at 4:14 PM, Jacqueline Chester <jchester@camsops.com> wrote:

Thank you, Thad. We appreciate your assistance.

Jackie Chester
EH&S and Regulatory Specialist

CAMS New Mexico, LLC
Hobbs Generating Station
98 N. Twombly Lane
Hobbs, NM 88240
Office (575) 397-6731
Cell (575) 263-3105
jchester@camsops.com

From: MELLISH Thaddeus <thaddeus.mellish@cmigroupe.com>
Sent: Friday, June 8, 2018 11:55 AM
To: Jacqueline Chester <jchester@camsops.com>
Cc: Roger Schnabel <rschnabel@camstex.com>; Richard Shaw <rshaw@camstex.com>; Martin Schluep <mschluep@alliantenv.com>
Subject: Re: Lea Power Partners, LLC - Hobbs Generating Station PSD Permit No. 3449-M4 Modification Application

CMI will be able to support your needs. We were just checking internally with our emissions experts.

Best Regards,
Thad

On Jun 8, 2018, at 12:57 PM, Jacqueline Chester <jchester@camsops.com> wrote:

Thad,

If at all possible, we need whatever information you can provide by June 15th. At the latest, we need it the week of June 18th in order to finalize the permit application for submittal.

Thank you,

Jackie Chester
EH&S and Regulatory Specialist

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98 N. Twombly Lane
Hobbs, NM 88240
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From: Roger Schnabel
Sent: Thursday, June 7, 2018 7:03 AM
To: MELLISH Thaddeus <thaddeus.mellish@cmigroupe.com>
Cc: Jacqueline Chester <jchester@camsops.com>; Richard Shaw <rshaw@camstex.com>; Martin Schluep <mschluep@alliantenv.com>
Subject: Lea Power Partners, LLC - Hobbs Generating Station PSD Permit No. 3449-M4 Modification Application

Good morning Thad,

We have been working with NMED (New Mexico Environmental Department) to modify our air permit related to the GT Compressor Upgrade that is scheduled to occur in March 2019. NMED has requested that we provide additional information in regards to the F4+ turbine upgrade permit modification application.

NMED requested the following time sensitive information that we'd like to have CMI provide a statement or response stating that there are no other PM control options post combustion for natural gas powered turbines utilizing HRSGs; or if there are other PM control options offered by CMI please provide that information. I have copied Jackie Chester, our onsite EHS and Regulatory Specialist , Rich Shaw - O&M Supervisor and Martin Schluep (our Environmental Contractor who is preparing the permit application) to streamline the conversation. Please reply to all if you have any additional questions or comments to expedite the response.

1. Please verify with the HRSG manufacturers that there are no other possible post combustion PM controls for natural gas fueled units.

Thank you,

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rschnabel@camsops.com

California Environmental Protection Agency
AIR RESOURCES BOARD

Guidance for Power Plant Siting and Best Available Control Technology

As Approved by the Air Resources Board on July 22, 1999

Stationary Source Division
Issued September 1999

State of California
California Environmental Protection Agency
Air Resources Board

Guidance for Power Plant Siting and Best Available Control Technology

July 22, 1999

Prepared by
Project Assessment Branch
Stationary Source Division

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Table of Contents

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Greg Harris

Reviewed by

D. Aron Livingston, Legal Counsel	Office of Legal Affairs Executive Office
Peter Venturini, Chief	Stationary Source Division

the measured value is less than 1 ppmvd at 15 percent oxygen.[14]

d. More Stringent Control Techniques

Staff is not aware of any additional technologically feasible control techniques, existing or under development, designed to limit VOC emissions from gas turbines.

e. BACT Recommendation

Based on VOC emission levels required for simple-cycle gas turbines, the most stringent BACT requirements are in the range of 1 to 2 ppmvd VOC at 15 percent oxygen. Source tests at Carson Energy Group demonstrate VOC emission levels of no more than 2 ppmvd at 15 percent oxygen can be met on a consistent basis. Therefore, staff recommends a BACT emission level for VOC from simple-cycle gas turbines of 2 ppmvd at 15 percent oxygen averaged over 3 hours.

The most stringent VOC BACT requirements for combined-cycle and cogeneration gas turbines have been in the range of 1 to 2 ppmvd VOC at 15 percent oxygen for power plants equipped with oxidation catalysts. Staff recognizes that accuracy of some test methods performed for VOC emissions is uncertain, but available source tests at Crockett Cogeneration and other gas turbine power plants consistently give emission results of no greater than 2.0 ppmvd VOC at 15 percent oxygen averaged over 1 hour with use of an oxidation catalyst. Based on these findings, staff recommends a BACT level of 2.0 ppmvd VOC at 15 percent oxygen averaged over 1 hour (or equivalent limit of 0.0027 lb VOC/MMBtu, higher heating value).

4. Control of PM_{10} Emissions

a. Current SIP Control Measures

Staff is not aware of any control measures designed specifically to limit PM_{10} emissions from gas turbines.

[14]Personal communications with Ken Lim of the Bay Area Air Quality Management District.

b. Control Techniques Required as BACT

PM_{10} emissions are partially dependent on fuel sulfur and nitrogen content. Natural gas has negligible amounts of fuel-bound nitrogen. As a result, there should be negligible nitrate production from any fuel-bound nitrogen. The production of thermally-induced nitrates and the organic fraction of PM_{10} can best be abated through the use of combustion controls. On new gas turbines with state of the art combustion design, PM_{10} emissions are most effectively reduced through use of fuels with both lower sulfur content and low ash content.

There are no add-on control technologies that can feasibly reduce PM_{10} emissions in gas turbine exhaust. As a result, the lowest PM_{10} emissions are achieved through combustion of low-sulfur natural gas along with combustion design that minimizes NO_X and unburned hydrocarbons. Applicants have the ability to select a low-sulfur fuel, such as natural gas; however, only the gas supplier has the ability to limit fuel sulfur content below PUC-regulated levels.[15] Natural gas utility companies have the ability to specify fuel sulfur content in purchase contracts with gas suppliers. Two major California natural gas utility companies, Pacific Gas & Electric and Southern California Gas, use purchase contracts that specify levels no higher than 1 grain of total sulfur per 100 standard cubic feet (1 gr S/100 scf).

An example of a recent PM_{10} BACT limit on a large combined-cycle gas turbine was applied to the Sutter Power Plant. A PM_{10} limit of 11.5 lb/hr averaged over 24 hours assuming a fuel sulfur content of 0.7 gr S/100 scf and a 10 percent conversion of fuel sulfur to sulfate emissions. Staff's calculations indicate that this limit is equal to an emission concentration of 0.0013 grains per dry standard cubic feet of exhaust gas (gr/dscf) at 3 percent carbon dioxide (CO_2). This determination applied to a Westinghouse 501F gas turbine nominally rated at 170 MW. In this case, the applicant presumed fuel sulfur content is below the 1 gr S/100 scf specified in the local gas utility company purchase contracts.

c. Emission Levels Achieved in Practice

Two consecutive annual source tests at Carson Energy Group in Sacramento County, California, indicate PM_{10} emissions of 0.63 and 0.882 lb/hr (approximately 0.00025 and 0.00035 gr/dscf at 3 percent CO_2) assuming a fuel sulfur content of 1 gr S/100 scf and 6.5 percent conversion of fuel sulfur to sulfate emissions. The results were obtained on a 450 MMBtu/hr General Electric LM6000 simple-cycle gas turbine.

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[15]Under California Public Utilities Commission General Order 58-8, the total sulfur of gas supplied by any gas utility for domestic, commercial, or industrial purposes is limited to 5 grains of total sulfur per 100 standard cubic feet.

5. Control of SO_X Emissions

a. Current SIP Control Measures

Several California districts have SIP control measures limiting sulfur compounds (as sulfur dioxide) from fossil fuel-burning equipment used generally for the production of useful heat or power.[17] The most stringent of these limits restrict sulfur dioxide emissions to no more than 200 pounds per hour. This level of emissions is not approached with gaseous fuel combustion.

b. Control Techniques Required as BACT

SO_X emissions are highly dependent on fuel sulfur content. As a result, the lowest emissions are achieved through the combustion of fuels with the lowest sulfur. Entities regulated by the PUC in California have purchase contracts with an effective maximum total sulfur content for natural gas of 1 gr S/100 scf (equivalent to approximately 17 ppmv sulfur). The most stringent BACT required for a simple-cycle, combined-cycle, or cogeneration gas turbine is firing of low-sulfur natural gas. Natural gas should not contain more than 1 gr S/100 scf if delivered by a California gas utility regulated by the PUC.

The Sutter Power Plant in Sutter County, California, was issued a preconstruction permit for a 170 MW Westinghouse 501F combined-cycle gas turbine. The BACT determination limited SO_2 emissions to no more than 1.0 ppmvd at 15 percent oxygen using 24-hour averaging. This emission level is proposed to be achieved using PUC pipeline quality natural gas for all combustion operations. Staff's calculations indicate that 1.0 ppmvd at 15 percent oxygen is achievable at fuel sulfur contents below 1.8 gr S/100 scf for gaseous fuels assuming full conversion of fuel sulfur to sulfur dioxide.

c. Emission Levels Achieved in Practice

Staff is not aware of any source tests for SO_X conducted on gas turbines that burn natural gas. It appears that source testing is generally not required for gas turbines that burn natural gas exclusively. Because natural gas supplied by a California gas utility regulated by the PUC should not contain more than 1 gr S/100 scf, this represents a limiting factor in SO_X emissions.

d. More Stringent Controls Techniques

SCOSOx is a catalytic sulfur removal system that works in conjunction with the SCONOx system to remove sulfur compounds from combustion exhaust streams. It is nearly identical to

---

[17]Such rules may only apply to cogeneration and combined-cycle units. Others may apply more generally and may cover simple-cycle gas turbines.

Two consecutive annual source tests at Sacramento Power Authority (Campbell Soup) in Sacramento County, California, indicate PM_{10} emissions of 1.93 and 2.98 lb/hr (approximately 0.00027 and 0.00042 gr/dscf at 3 percent CO_2) assuming a fuel sulfur content of 1 gr S/100 scf and 6.5 percent conversion of fuel sulfur to sulfate emissions. The results were obtained on a 102 MW combined-cycle Siemens V84.2 gas turbine.

d. More Stringent Control Techniques

Staff is not aware of any additional technologically feasible control techniques, existing or under development, to reduce PM_{10} emissions from gas turbines**.**

5. BACT Recommendation

The lowest PM_{10} emissions from gas turbines are achieved through combustion of low-sulfur natural gas along with combustion design that minimizes NO_X and unburned hydrocarbons. Applicants have the ability to select a low-sulfur fuel, such as natural gas; however, only the gas supplier has the ability to limit fuel sulfur content below Public Utilities Commission (PUC)-regulated levels.[16] Natural gas utility companies have the ability to specify fuel sulfur content in purchase contracts with gas suppliers. Two major California natural gas utility companies, i.e., Pacific Gas & Electric and Southern California Gas, use purchase contracts that specify levels no higher than 1 gr S/100 scf. Staff believe this represents a limiting circumstance in the maximum emission level of the sulfate portion of PM_{10}.

Considering the above, the default PM_{10} BACT requirement for combined-cycle gas turbines is natural gas containing no more than 1 gr S/100 scf. In addition, staff believes that appropriate combustion controls and low sulfur fuel are essential components of a PM_{10} BACT determination for a gas turbine. Any emission limit required for BACT should correspond with a fuel gas sulfur content of 1 gr S/100 scf. Furthermore, there are "housekeeping measures" that can prevent emissions from the lube oil vent, including a lube oil vent coalescer and an associated opacity limit of 5 percent. These latter provisions were required at Badger Creek Limited on a 457.8 MMBtu/hr General Electric LM-5000 gas turbine cogeneration unit with a 48.5 MW capacity.

[16]Under California Public Utilities Commission General Order 58-8, the total sulfur of gas supplied by any gas utility for domestic, commercial, or industrial purposes is limited to 5 grains of total sulfur per 100 standard cubic feet.

EPA-452/F-03-025

Air Pollution Control Technology Fact Sheet

Name of Technology: Fabric Filter - Pulse-Jet Cleaned Type
(also referred to as Baghouses)

Type of Technology: Control Device - Capture/Disposal

Applicable Pollutants: Particulate Matter (PM), including particulate matter less than or equal to 10 micrometers (•m) in aerodynamic diameter (PM_{10}), particulate matter less than or equal to 2.5 •m in aerodynamic diameter ($PM_{2.5}$), and hazardous air pollutants (HAPs) that are in particulate form, such as most metals (mercury is the notable exception, as a significant portion of emissions are in the form of elemental vapor).

Achievable Emission Limits/Reductions:

Typical new equipment design efficiencies are between 99 and 99.9%. Older existing equipment have a range of actual operating efficiencies of 95 to 99.9%. Several factors determine fabric filter collection efficiency. These include gas filtration velocity, particle characteristics, fabric characteristics, and cleaning mechanism. In general, collection efficiency increases with increasing filtration velocity and particle size.

For a given combination of filter design and dust, the effluent particle concentration from a fabric filter is nearly constant, whereas the overall efficiency is more likely to vary with particulate loading. For this reason, fabric filters can be considered to be constant outlet devices rather than constant efficiency devices. Constant effluent concentration is achieved because at any given time, part of the fabric filter is being cleaned. As a result of the cleaning mechanisms used in fabric filters, the collection efficiency is constantly changing. Each cleaning cycle removes at least some of the filter cake and loosens particles which remain on the filter. When filtration resumes, the filtering capability has been reduced because of the lost filter cake and loose particles are pushed through the filter by the flow of gas. As particles are captured, the efficiency increases until the next cleaning cycle. Average collection efficiencies for fabric filters are usually determined from tests that cover a number of cleaning cycles at a constant inlet loading. (EPA, 1998a)

Applicable Source Type: Point

Typical Industrial Applications:

Fabric filters can perform very effectively in many different applications. Common applications of fabric filter systems with pulse-jet cleaning are presented in Table 1, however, fabric filters can be used in most any process where dust is generated and can be collected and ducted to a central location.

Table 1. Typical Industrial Applications of Pulse-Jet Cleaned Fabric Filters (EPA 1997; EPA, 1998a)

Application	Source Category Code (SCC)
Utility Boilers (Coal)	1-01-002...003
Industrial Boilers (Coal, Wood)	1-02-001...003, 1-02-009
Commercial/Institutional Boilers (Coal, Wood)	1-03-001...003, 1-03-009
Ferrous Metals Processing:	
Iron and Steel Production	3-03-008...009
Steel Foundries	3-04-007,-009
Mineral Products:	
Cement Manufacturing	3-05-006...007
Coal Cleaning	3-05-010
Stone Quarrying and Processing	3-05-020
Other	3-05-003...999
Asphalt Manufacture	3-05-001...002
Grain Milling	3-02-007

Emission Stream Characteristics:

a. **Air Flow:** Baghouses are separated into two groups, standard and custom, which are further separated into low, medium, and high capacity. Standard baghouses are factory-built, off the shelf units. They may handle from less than 0.10 to more than 50 standard cubic meters per second (sm^3/sec) ((“hundreds” to more than 100,000 standard cubic feet per minute (scfm)). Custom baghouses are designed for specific applications and are built to the specifications prescribed by the customer. These units are generally much larger than standard units, i.e., from 50 to over 500 sm^3/sec (100,000 to over 1,000,000 scfm). (EPA, 1998b)

b. **Temperature:** Typically, gas temperatures up to about 260•C (500•F), with surges to about 290•C (550•F) can be accommodated routinely, with the appropriate fabric material. Spray coolers or dilution air can be used to lower the temperature of the pollutant stream. This prevents the temperature limits of the fabric from being exceeded. Lowering the temperature, however, increases the humidity of the pollutant stream. Therefore, the minimum temperature of the pollutant stream must remain above the dew point of any condensable in the stream. The baghouse and associated ductwork should be insulated and possibly heated if condensation may occur. (EPA, 1998b)

c. **Pollutant Loading:** Typical inlet concentrations to baghouses are 1 to 23 grams per cubic meter (g/m^3) (0.5 to 10 grains per cubic foot (gr/ft^3)), but in extreme cases, inlet conditions may vary between 0.1 to more than 230 g/m^3 (0.05 to more than 100 gr/ft^3). (EPA, 1998b)

d. **Other Considerations:** Moisture and corrosives content are the major gas stream characteristics requiring design consideration. Standard fabric filters can be used in pressure or vacuum service, but only within the range of about ± 640 millimeters of water column (25 inches of water column). Well-designed and operated baghouses have been shown to be capable of reducing overall particulate emissions to less than 0.05 g/m^3 (0.010 gr/ft^3), and in a number of cases, to as low as 0.002 to 0.011 g/m^3 (0.001 to 0.005 gr/ft^3). (AWMA, 1992)

Emission Stream Pretreatment Requirements:

Because of the wide variety of filter types available to the designer, it is not usually required to pretreat a waste stream's inlet temperature. However, in some high temperature applications, the cost of high temperature-resistant bags must be weighed against the cost of cooling the inlet temperature with spray coolers or dilution air (EPA, 1998b). When much of the pollutant loading consists of relatively large particles, mechanical collectors such as cyclones may be used to reduce the load on the fabric filter, especially at high inlet concentrations (EPA, 1998b).

Cost Information:

Cost estimates are presented below for pulse-jet cleaned fabric filters. The costs are expressed in 2002 dollars. The cost estimates assume a conventional design under typical operating conditions and do not include auxiliary equipment such as fans and ductwork. The costs for pulse-jet cleaned systems are generated using EPA's cost-estimating spreadsheet for fabric filters (EPA, 1998b).

Costs are primarily driven by the waste stream volumetric flow rate and pollutant loading. In general, a small unit controlling a low pollutant loading will not be as cost effective as a large unit controlling a high pollutant loading. The costs presented are for flow rates of 470 m^3/sec (1,000,000 scfm) and 1.0 m^3/sec (2,000 scfm), respectively, and a pollutant loading of 9 g/m^3 (4.0 gr/ft^3).

Pollutants that require an unusually high level of control or that require the fabric filter bags or the unit itself to be constructed of special materials, such as Gore-Tex or stainless steel, will increase the costs of the system (EPA, 1998b). The additional costs for controlling more complex waste streams are not reflected in the estimates given below. For these types of systems, the capital cost could increase by as much as 75% and the operational and maintenance (O&M) cost could increase by as much as 20%.

- **a. Capital Cost:** \$13,000 to \$55,000 per sm^3/s (\$6 to \$26 per scfm)
- **b. O & M Cost:** \$11,000 to \$50,000 per sm^3/s (\$5 to \$24 per scfm), annually
- **c. Annualized Cost:** \$13,000 to \$83,000 per sm^3/s (\$6 to \$39 per scfm), annually
- **d. Cost Effectiveness:** \$46 to \$293 per metric ton (\$42 to \$266 per short ton)

Theory of Operation:

In a fabric filter, flue gas is passed through a tightly woven or felted fabric, causing PM in the flue gas to be collected on the fabric by sieving and other mechanisms. Fabric filters may be in the form of sheets, cartridges, or bags, with a number of the individual fabric filter units housed together in a group. Bags are most common type of fabric filter. The dust cake that forms on the filter from the collected PM can significantly increase collection efficiency. Fabric filters are frequently referred to as baghouses because the fabric is usually configured in cylindrical bags. Bags may be 6 to 9 m (20 to 30 ft) long and 12.7 to 30.5 centimeters (cm) (5 to 12 inches) in diameter. Groups of bags are placed in isolable compartments to allow cleaning of the bags or replacement of some of the bags without shutting down the entire fabric filter. (STAPPA/ALAPCO, 1996)

Operating conditions are important determinants of the choice of fabric. Some fabrics (e.g., polyolefins, nylons, acrylics, polyesters) are useful only at relatively low temperatures of 95 to 150•C (200 to 300•F). For high-temperature flue gas streams, more thermally stable fabrics such as fiberglass, Teflon®, or Nomex® must be used (STAPPA/ALAPCO, 1996).

Practical application of fabric filters requires the use of a large fabric area in order to avoid an unacceptable pressure drop across the fabric. Baghouse size for a particular unit is determined by the choice of air-to-cloth ratio, or the ratio of volumetric air flow to cloth area. The selection of air-to-cloth ratio depends on the particulate loading and characteristics, and the cleaning method used. A high particulate loading will require the use of a larger baghouse in order to avoid forming too heavy a dust cake, which would result in an excessive pressure drop As an example, a baghouse for a 250 MW utility boiler may have 5,000 separate bags with a total fabric area approaching 46,500 m^2 (500,000 square feet). (ICAC, 1999)

Determinants of baghouse performance include the fabric chosen, the cleaning frequency and methods, and the particulate characteristics. Fabrics can be chosen which will intercept a greater fraction of particulate, and some fabrics are coated with a membrane with very fine openings for enhanced removal of submicron particulate. Such fabrics tend to be more expensive.

Pulse-jet cleaning of fabric filters is relatively new compared to other types of fabric filters, since they have only been used for the past 30 years. This cleaning mechanism has consistently grown in popularity because it can treat high dust loadings, operate at constant pressure drop, and occupy less space than other types of fabric filters. Pulse-jet cleaned fabric filters can only operate as external cake collection devices. The bags are closed at the bottom, open at the top, and supported by internal retainers, called cages. Particulate-laden gas flows into the bag, with diffusers often used to prevent oversized particles from damaging the bags. The gas flows from the outside to the inside of the bags, and then out the gas exhaust. The particles are collected on the outside of the bags and drop into a hopper below the fabric filter. (EPA, 1998a)

During pulse-jet cleaning, a short burst, 0.03 to 0.1 seconds in duration, of high pressure [415 to 830 kiloPascals (kPa) (60 to 120 pounds per square inch gage (psig))] air is injected into the bags (EPA, 1998a; AWMA, 1992). The pulse is blown through a venturi nozzle at the top of the bags and establishes a shock wave that continues onto the bottom of the bag. The wave flexes the fabric, pushing it away from the cage, and then snaps it back dislodging the dust cake. The cleaning cycle is regulated by a remote timer connected to a solenoid valve. The burst of air is controlled by the solenoid valve and is released into blow pipes that have nozzles located above the bags. The bags are usually cleaned row by row (EPA, 1998a).

There are several unique attributes of pulse-jet cleaning. Because the cleaning pulse is very brief, the flow of dusty gas does not have to be stopped during cleaning. The other bags continue to filter, taking on extra duty because of he bags being cleaned. In general, there is no change in fabric filter pressure drop or performance as a result of pulse-jet cleaning. This enables the pulse-jet fabric filters to operate on a continuous basis with solenoid valves as the only significant moving parts. Pulse-jet cleaning is also more intense and occurs with greater frequency than the other fabric filter cleaning methods. This intense cleaning dislodges nearly all of the dust cake each time the bag is pulsed. As a result, pulse-jet filters do not rely on a dust cake to provide filtration. Felted (non-woven) fabrics are used in pulse-jet fabric filters because they do not require a dust cake to achieve high collection efficiencies. It has been found that woven fabrics used with pulse-jet fabric filters leak a great deal of dust after they are cleaned. (EPA, 1998a)

Since bags cleaned by the pulse-jet method do not need to be isolated for cleaning, pulse-jet cleaned fabric filters do not need extra compartments to maintain adequate filtration during cleaning. Also, because of the intense and frequent nature of the cleaning, they can treat higher gas flow rates with higher dust loadings. Consequently, fabric filters cleaned by the pulse-jet method can be smaller than other types of fabric filters in the treatment of the same amount of gas and dust, making higher gas-to-cloth ratios achievable. (EPA, 1998a)

Advantages:

Fabric filters in general provide high collection efficiencies on both coarse and fine (submicron) particulates. They are relatively insensitive to fluctuations in gas stream conditions. Efficiency and pressure drop are relatively unaffected by large changes in inlet dust loadings for continuously cleaned filters. Filter outlet air is very clean and may be recirculated within the plant in many cases (for energy conservation). Collected material is collected dry for subsequent processing or disposal. Corrosion and rusting of components are usually not problems. Operation is relatively simple. Unlike electrostatic precipitators, fabric filter systems do not require the use of high voltage, therefore, maintenance is simplified and flammable dust may be collected with proper care. The use of selected fibrous or granular filter aids (precoating) permits the high-efficiency collection of submicron smokes and gaseous contaminants. Filter collectors are available in a large number of configurations, resulting in a range of dimensions and inlet and outlet flange locations to suit installation requirements. (AWMA, 1992)

Disadvantages:

Temperatures much in excess of 290•C (550•F) require special refractory mineral or metallic fabrics, which can be expensive. Certain dusts may require fabric treatments to reduce dust seepage, or in other cases, assist in the removal of the collected dust. Concentrations of some dusts in the collector, approximately 50 g/m^3 (22 gr/ft^3), may represent a fire or explosion hazard if a spark or flame is accidentally admitted. Fabrics can burn if readily oxidizable dust is being collected. Fabric filters have relatively high maintenance requirements (e.g., periodic bag replacement). Fabric life may be shortened at elevated temperatures and in the presence of acid or alkaline particulate or gas constituents. They cannot be operated in moist environments; hygroscopic materials, condensation of moisture, or tarry adhesive components may cause crusty caking or plugging of the fabric or require special additives. Respiratory protection for maintenance personnel may be required when replacing fabric. Medium pressure drop is required, typically in the range of 100 to 250 mm of water column (4 to 10 inches of water column). (AWMA, 1992)

A specific disadvantage of pulse-jet units that use very high gas velocities is that the dust from the cleaned bags can be drawn immediately to the other bags. If this occurs, little of the dust falls into the hopper and the dust layer on the bags becomes too thick. To prevent this, pulse-jet fabric filters can be designed with separate compartments that can be isolated for cleaning. (EPA, 1998a)

Other Considerations:

Fabric filters are useful for collecting particles with resistivities either too low or too high for collection with electrostatic precipitators. Fabric filters therefore may be good candidates for collecting fly ash from low-sulfur coals or fly ash containing high unburned carbon levels, which respectively have high and low resistivities, and thus are relatively difficult to collect with electrostatic precipitators. (STAPPA/ALAPCO, 1996)

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EPA-452/F-03-026

Air Pollution Control Technology Fact Sheet

Name of Technology: Fabric Filter - Reverse-Air Cleaned Type
- Reverse-Air Cleaned Type with Sonic Horn Enhancement
- Reverse-Jet Cleaned Type

(also referred to as Baghouses)

Type of Technology: Control Device - Capture/Disposal

Applicable Pollutants: Particulate Matter (PM), including particulate matter less than or equal to 10 micrometers (•m) in aerodynamic diameter (PM_{10}), particulate matter less than or equal to 2.5 •m in aerodynamic diameter ($PM_{2.5}$), and hazardous air pollutants (HAPs) that are in particulate form, such as most metals (mercury is the notable exception, as a significant portion of emissions are in the form of elemental vapor).

Achievable Emission Limits/Reductions:

Typical new equipment design efficiencies are between 99 and 99.9%. Older existing equipment have a range of actual operating efficiencies of 95 to 99.9%. Several factors determine fabric filter collection efficiency. These include gas filtration velocity, particle characteristics, fabric characteristics, and cleaning mechanism. In general, collection efficiency increases with increasing filtration velocity and particle size.

For a given combination of filter design and dust, the effluent particle concentration from a fabric filter is nearly constant, whereas the overall efficiency is more likely to vary with particulate loading. For this reason, fabric filters can be considered to be constant outlet devices rather than constant efficiency devices. Constant effluent concentration is achieved because at any given time, part of the fabric filter is being cleaned. As a result of the cleaning mechanisms used in fabric filters, the collection efficiency is constantly changing. Each cleaning cycle removes at least some of the filter cake and loosens particles which remain on the filter. When filtration resumes, the filtering capability has been reduced because of the lost filter cake and loose particles are pushed through the filter by the flow of gas. As particles are captured, the efficiency increases until the next cleaning cycle. Average collection efficiencies for fabric filters are usually determined from tests that cover a number of cleaning cycles at a constant inlet loading. (EPA, 1998a)

Applicable Source Type: Point

Typical Industrial Applications:

Fabric filters can perform very effectively in many different applications. Common applications of fabric filter systems with reverse-air cleaning are presented in Table 1, however, fabric filters can be used in most any process where dust is generated and can be collected and ducted to a central location. Other cleaning-types may also be used in these applications. Sonic horn enhancement of mechanical shaker cleaning is generally used for applications with dense particulates such as utility boilers, metal processing, and mineral products.

Table 1. Typical Industrial Applications of Reverse-Air -Cleaned Fabric Filters (EPA, 1997; EPA, 1998a)

Application	Source Category Code (SCC)
Utility Boilers (Coal)	1-01-002...003
Industrial Boilers (Coal, Wood)	1-02-001...003, 1-02-009
Commercial/Institutional Boilers (Coal, Wood)	1-03-001...003, 1-03-009
Non-Ferrous Metals Processing (Primary and Secondary):	
Copper	3-03-005, 3-04-002
Lead	3-03-010, 3-04-004
Zinc	3-03-030, 3-04-008
Aluminum	3-03-000...002 3-04-001
Other metals production	3-03-011...014 3-04-005...006 3-04-010...022
Ferrous Metals Processing:	
Coke	3-03-003...004
Ferroalloy Production	3-03-006...007
Iron and Steel Production	3-03-008...009
Gray Iron Foundries	3-04-003
Steel Foundries	3-04-007,-009
Mineral Products:	
Cement Manufacturing	3-05-006...007
Coal Cleaning	3-05-010
Stone Quarrying and Processing	3-05-020
Other	3-05-003...999
Asphalt Manufacture	3-05-001...002
Grain Milling	3-02-007

Emission Stream Characteristics:

a. Air Flow: Baghouses are separated into two groups, standard and custom, which are further separated into low, medium, and high capacity. Standard baghouses are factory-built, off the shelf units. They may handle from less than 0.10 to more than 50 standard cubic meters per second (sm^3/sec) ("hundreds" to more than 100,000 standard cubic feet per minute (scfm)). Custom baghouses are designed for specific applications and are built to the specifications prescribed by the customer. These units are generally much larger than standard units, i.e., from 50 to over 500 sm^3/sec (100,000 to over 1,000,000 scfm). (EPA, 1998b)

b. Temperature: Typically, gas temperatures up to about 260•C (500•F), with surges to about 290•C (550•F) can be accommodated routinely, with the appropriate fabric material. Spray coolers or dilution air can be used to lower the temperature of the pollutant stream. This prevents the temperature limits of the fabric from being exceeded. Lowering the temperature, however, increases the humidity of the pollutant stream. Therefore, the minimum temperature of the pollutant stream must remain above the dew point of any condensable in the stream. The baghouse and associated ductwork should be insulated and possibly heated if condensation may occur. (EPA, 1998b)

c. **Pollutant Loading:** Typical inlet concentrations to baghouses are 1 to 23 grams per cubic meter (g/m^3) (0.5 to 10 grains per cubic foot (gr/ft^3)), but in extreme cases, inlet conditions may vary between 0.1 to more than 230 g/m^3 (0.05 to more than 100 gr/ft^3). (EPA, 1998b)

d. **Other Considerations:** Moisture and corrosives content are the major gas stream characteristics requiring design consideration. Standard fabric filters can be used in pressure or vacuum service, but only within the range of about ± 640 millimeters of water column (25 inches of water column). Well-designed and operated baghouses have been shown to be capable of reducing overall particulate emissions to less than 0.05 g/m^3 (0.010 gr/ft^3), and in a number of cases, to as low as 0.002 to 0.011 g/dsm^3 (0.001 to 0.005 gr/dscf). (AWMA, 1992)

Emission Stream Pretreatment Requirements:

Because of the wide variety of filter types available to the designer, it is not usually required to pretreat a waste stream's inlet temperature. However, in some high temperature applications, the cost of high temperature-resistant bags must be weighed against the cost of cooling the inlet temperature with spray coolers or dilution air (EPA, 1998b). When much of the pollutant loading consists of relatively large particles, mechanical collectors such as cyclones may be used to reduce the load on the fabric filter, especially at high inlet concentrations (EPA, 1998b).

Cost Information:

Cost estimates are presented below for reverse-air cleaned fabric filters, for sonic horn enhancement, and for reverse-jet cleaned fabric filters. The costs are expressed in 2002 dollars for reverse-air cleaned and sonic horn enhancement. The cost estimates assume a conventional design under typical operating conditions. The costs do not include auxiliary equipment such as fans and ductwork.

The costs for reverse-air cleaned systems are generated using EPA's cost-estimating spreadsheet for fabric filters (EPA, 1998b). The cost estimate for sonic horn enhancement is obtained from the manufacturer quote given in the OAQPS Control Cost Manual (EPA, 1998b). Sonic horns are presented as an incremental cost to the capital cost for a shaker-cleaned system. The operational and maintenance (O&M) cost for shaker-cleaned systems are reduced by 1% to 3% with the sonic horn enhancement. The capital cost for the reverse-jet cleaned fabric baghouse is based on a manufacturer quote (Carrington, 2000). This quote includes only the baghouse purchased equipment cost. O&M costs, annualized costs, and cost effectiveness were not estimated for reverse-jet. In general, reverse-jet has higher capital costs and O&M costs than reverse-air due to its complexity (see Section 10, Theory of Operation).

Costs are primarily driven by the waste stream volumetric flow rate and pollutant loading. In general, a small unit controlling a low pollutant loading will not be as cost effective as a large unit controlling a high pollutant loading. The costs presented are for flow rates of 470 m^3/sec (1,000,000 scfm) and 1.0 m^3/sec (2,000 scfm), respectively, and a pollutant loading of 9 g/m^3 (4.0 gr/ft^3) . For reverse-jet, the capital cost presented is for a baghouse of 378,000 m^3/sec (800,000 scfm).

Pollutants that require an unusually high level of control or that require the fabric filter bags or the unit itself to be constructed of special materials, such as Gore-Tex or stainless steel, will increase the costs of the system (EPA, 1998b). The additional costs for controlling more complex waste streams are not reflected in the estimates given below. For these types of systems, the capital cost could increase by as much as 40% and the O&M cost could increase by as much as 5%.

a. **Capital Cost:** \$19,000 to \$180,000 per sm^3/s (\$9 to \$85 per scfm), reverse-air
\$1,000 to \$1,300 per m^3/sec (\$ 0.51 to \$0.61 per scfm), additional cost for sonic horns
\$2,000 to \$4,200 per m^3/sec (\$1 to \$2 per scfm), reverse-jet purchased equipment cost

b. **O & M Cost:** \$14,000 to \$58,000 per sm^3/s (\$6 to \$27 per scfm), annually

c. **Annualized Cost:** \$17,000 to \$106,000 per sm^3/s (\$8 to \$50 per scfm), annually

d. **Cost Effectiveness:** \$58 to \$372 per metric ton (\$53 to \$337 per short ton)

Theory of Operation:

In a fabric filter, flue gas is passed through a tightly woven or felted fabric, causing PM in the flue gas to be collected on the fabric by sieving and other mechanisms. Fabric filters may be in the form of sheets, cartridges, or bags, with a number of the individual fabric filter units housed together in a group. Bags are most common type of fabric filter. The dust cake that forms on the filter from the collected PM can significantly increase collection efficiency. Fabric filters are frequently referred to as baghouses because the fabric is usually configured in cylindrical bags. Bags may be 6 to 9 m (20 to 30 ft) long and 12.7 to 30.5 centimeters (cm) (5 to 12 inches) in diameter. Groups of bags are placed in isolable compartments to allow cleaning of the bags or replacement of some of the bags without shutting down the entire fabric filter. (STAPPA/ALAPCO, 1996)

Operating conditions are important determinants of the choice of fabric. Some fabrics (e.g., polyolefins, nylons, acrylics, polyesters) are useful only at relatively low temperatures of 95 to 150•C (200 to 300•F). For high-temperature flue gas streams, more thermally stable fabrics such as fiberglass, Teflon®, or Nomex® must be used (STAPPA/ALAPCO, 1996).

Practical application of fabric filters requires the use of a large fabric area in order to avoid an unacceptable pressure drop across the fabric. Baghouse size for a particular unit is determined by the choice of air-to-cloth ratio, or the ratio of volumetric air flow to cloth area. The selection of air-to-cloth ratio depends on the particulate loading and characteristics, and the cleaning method used. A high particulate loading will require the use of a larger baghouse in order to avoid forming too heavy a dust cake, which would result in an excessive pressure drop As an example, a baghouse for a 250 megawatt (MW) utility boiler may have 5,000 separate bags with a total fabric area approaching 46,500 m^2 (500,000 square feet). (ICAC, 1999)

Determinants of baghouse performance include the fabric chosen, the cleaning frequency and methods, and the particulate characteristics. Fabrics can be chosen which will intercept a greater fraction of particulate, and some fabrics are coated with a membrane with very fine openings for enhanced removal of submicron particulate. Such fabrics tend to be more expensive. Cleaning intensity and frequency are important variables in determining removal efficiency. Because the dust cake can provide a significant fraction of the fine particulate removal capability of a fabric, cleaning which is too frequent or too intense will lower the removal efficiency. On the other hand, if removal is too infrequent or too ineffective, then the baghouse pressure drop will become too high. (ICAC, 1999)

Reverse-air cleaning is a popular fabric filter cleaning method that has been used extensively and improved over the years. It is a gentler but sometimes less effective clearing mechanism than mechanical shaking.

Most reverse-air fabric filters operate in a manner similar to shaker-cleaned fabric filters. Typically, the bags are open on the bottom, closed on top and the gas flows from the inside to the outside of the bags with dust being captured on the inside. However, some reverse-air designs collect dust on the outside of the bags. In either design, reverse-air cleaning is performed by forcing clean air through the filters in the opposite direction of the dusty gas flow. The change in direction of the gas flow causes the bag to flex and crack the filter cake. In internal cake collection, the bags are allowed to collapse to some extent during reverse-air cleaning. The bags are usually prevented from collapsing entirely by some kind of support, such as rings that are sewn into the bags. The support enables the dust cake to fall off the bags and into the hopper. Cake release is also aided by the reverse flow of the gas. Because felted fabrics retain dust more than woven fabrics and thus, are more difficult to clean, felts are usually not used in reverse-air systems. (EPA, 1998a)

There are several methods of reversing the flow through the filters. As with mechanical shaker-cleaned fabric filters, the most common approach is to have separate compartments within the fabric filter so that each compartment can be isolated and cleaned separately while the other compartments continue to treat the dusty gas. One method of providing the reverse flow air is by the use of a secondary fan or cleaned gas from the other compartments. Reverse-air cleaning alone is used only in cases where the dust releases easily from the fabric. In many instances, reverse-air is used in conjunction with shaking, pulsing or sonic horns. (EPA, 1998a)

Sonic horns are increasingly being used to enhance the collection efficiency of mechanical shaker and reverse-air fabric filters (AWMA, 1992). Sonic horns utilize compressed air to vibrate a metal diaphragm, producing a low frequency sound wave from the horn bell. The number of horns required is determined by fabric area and the number of baghouse compartments. Typically, 1 to 4 horns per compartment operating at 150 to 200 hertz are required. Compressed air to power the horns is supplied at 275 to 620 kiloPascals (kPa) (40 to 90 pounds per square inch gage (psig)). Sonic horns activate for approximately 10 to 30 seconds during each cleaning cycle (Carr, 1984) .

Sonic horn cleaning significantly reduces the residual dust load on the bags. This decreases the pressure drop across the filter fabric by 20 to 60%. It also lessens the mechanical stress on the bags, resulting in longer operational life (Carr, 1984). As stated previously, this can decrease the O&M cost by 1 to 3%, annually. Baghouse compartments are easily retrofitted with sonic horns. Sonic assistance is frequently used with fabric filters at coal-burning utilities (EPA, 1998a).

Reverse-jet is a cleaning method developed in the 1950's to provide better removal of residual dusts. In this method, the reverse air is piped to a ring around the bag with a narrow slot in it. The air flows through the slot, creating a high velocity air stream that flexes the bag at that point. The ring is mounted on a carriage, driven by a motor and cable system, that travels up and down the bag. This method provides excellent cleaning of residual dust. Due to its complexity, however, maintenance requirements are high. In addition, air impingement on the bags results in increased wear (Billings, 1970). The application of reverse-jet cleaning has been declining (EPA, 1998a).

Advantages:

Fabric filters in general provide high collection efficiencies on both coarse and fine (submicron) particulates. They are relatively insensitive to fluctuations in gas stream conditions. Efficiency and pressure drop are relatively unaffected by large changes in inlet dust loadings for continuously cleaned filters. Filter outlet air is very clean and may be recirculated within the plant in many cases (for energy conservation). Collected material is collected dry for subsequent processing or disposal. Corrosion and rusting of components are usually not problems. Operation is relatively simple. Unlike electrostatic precipitators, fabric filter systems do not require the use of high voltage, therefore, maintenance is simplified and flammable dust may be collected with proper care. The use of selected fibrous or granular filter aids (precoating) permits the high-efficiency collection of submicron smokes and gaseous contaminants. Filter collectors are available in a large number of configurations, resulting in a range of dimensions and inlet and outlet flange locations to suit installation requirements. (AWMA, 1992)

Disadvantages:

Temperatures much in excess of 290•C (550•F) require special refractory mineral or metallic fabrics, which can be expensive. Certain dusts may require fabric treatments to reduce dust seepage, or in other cases, assist in the removal of the collected dust. Concentrations of some dusts in the collector, approximately 50 g/m^3 (22 gr/ft^3), may represent a fire or explosion hazard if a spark or flame is accidentally admitted. Fabrics can burn if readily oxidizable dust is being collected. Fabric filters have relatively high maintenance requirements (e.g., periodic bag replacement). Fabric life may be shortened at elevated temperatures and in the presence of acid or alkaline particulate or gas constituents. They cannot be operated in moist environments; hygroscopic materials, condensation of moisture, or tarry adhesive components may cause crusty caking or plugging of the fabric or require special additives. Respiratory protection for maintenance personnel may be required when replacing fabric. Medium pressure drop is required, typically in the range of 100 to 250 mm of water column (4 to 10 inches of water column). (AWMA, 1992)

Other Considerations:

Fabric filters are useful for collecting particles with resistivities either too low or too high for collection with electrostatic precipitators. Fabric filters therefore may be good candidates for collecting fly ash from low-sulfur coals or fly ash containing high unburned carbon levels, which respectively have high and low resistivities, and thus are relatively difficult to collect with electrostatic precipitators. (STAPPA/ALAPCO, 1996)

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EPA-452/F-03-027

Air Pollution Control Technology Fact Sheet

Name of Technology: Dry Electrostatic Precipitator (ESP)- Wire-Pipe Type

Type of Technology: Control Device - Capture/Disposal

Applicable Pollutants:

Particulate Matter (PM), including particulate matter less than or equal to 10 micrometers (µm) in aerodynamic diameter (PM_{10}), particulate matter less than or equal to 2.5 µm in aerodynamic diameter ($PM_{2.5}$), and hazardous air pollutants (HAPs) that are in particulate form, such as most metals (mercury is the notable exception, as a significant portion of emissions are in the form of elemental vapor).

Achievable Emission Limits/Reductions:

Typical new equipment design efficiencies are between 99 and 99.9%. Older existing equipment have a range of actual operating efficiencies of 90 to 99.9%. While several factors determine ESP collection efficiency, ESP size is most important. Size determines treatment time; the longer a particle spends in the ESP, the greater its chance of being collected. Maximizing electric field strength will maximize ESP collection efficiency (STAPPA/ALAPCO, 1996). Collection efficiency is also affected by dust resistivity, gas temperature, chemical composition (of the dust and the gas), and particle size distribution.

Applicable Source Type: Point

Typical Industrial Applications:

Many older ESPs are of the wire-pipe design, consisting of a single tube placed on top of a smokestack (EPA, 1998). Dry pipe-type ESPs are occasionally used by the textile industry, pulp and paper facilities, the metallurgical industry, including coke ovens, hazardous waste incinerators, and sulfuric acid manufacturing plants, among others, though other ESP types are employed as well. Wet wire-pipe ESPs are used much more frequently than dry wire-pipe ESPs, which are used only in cases in which wet cleaning is undesirable, such as high temperature streams or wastewater restrictions (EPA, 1998; Flynn, 1999).

Emission Stream Characteristics:

a. **Air Flow:** Typical gas flow rates for dry wire-pipe ESPs are 0.5 to 50 standard cubic meters per second (sm^3/sec) (1,000 to 100,000 standard cubic feet per minute (scfm)) (Flynn, 1999).

b. **Temperature:** Dry wire-pipe ESPs can operate at very high temperatures, up to 700°C (1300°F) (AWMA, 1992). Operating gas temperature and chemical composition of the dust are key factors influencing dust resistivity and must be carefully considered in the design of an ESP.

c. **Pollutant Loading:** Typical inlet concentrations to a wire-pipe ESP are 1 to 10 g/m^3 (0.5 to 5 gr/scf). It is common to pretreat a waste stream, usually with a wet spray or scrubber, to bring the stream temperature and pollutant loading into a manageable range. Highly toxic flows with concentrations well below 1 g/m^3 (0.5 gr/scf) are also sometimes controlled with ESPs (Flynn, 1999).

d. Other Considerations: In general, dry ESPs operate most efficiently with dust resistivities between 5×10^3 and 2×10^{10} ohm-cm. In general, the most difficult particles to collect are those with aerodynamic diameters between 0.1 and 1.0 µm. Particles between 0.2 and 0.4 µm usually show the most penetration. This is most likely a result of the transition region between field and diffusion charging (EPA, 1998).

Emission Stream Pretreatment Requirements:

When much of the pollutant loading consists of relatively large particles, mechanical collectors, such as cyclones or spray coolers may be used to reduce the load on the ESP, especially at high inlet concentrations. Gas conditioning equipment to improve ESP performance by changing dust resistivity is occasionally used as part of the original design, but more frequently it is used to upgrade existing ESPs. The equipment injects an agent into the gas stream ahead of the ESP. Usually, the agent mixes with the particles and alters their resistivity to promote higher migration velocity, and thus higher collection efficiency. Conditioning agents that are used include SO_3, H_2SO_4, sodium compounds, ammonia, and water; the conditioning agent most used is SO_3 (AWMA, 1992).

Cost Information:

The following are cost ranges (expressed in 2002 dollars) for dry wire-pipe ESPs of conventional design under typical operating conditions, developed using EPA cost-estimating spreadsheets (EPA, 1996). Costs can be substantially higher than in the ranges shown for pollutants which require an unusually high level of control, or which require the ESP to be constructed of special materials such as stainless steel or titanium. In general, smaller units controlling a low concentration waste stream will not be as cost effective as a large unit cleaning a high pollutant load flow.

a. **Capital Cost:** \$42,000 to \$260,000 per sm^3/sec (\$20 to \$125 per scfm)

b. **O & M Cost:** \$8,500 to \$19,000 per sm^3/sec (\$4 to \$9 per scfm), annually

c. **Annualized Cost:** \$19,000 to \$55,000 per sm^3/sec (\$9 to \$26 per scfm), annually

d. **Cost Effectiveness:** \$47 to \$710 per metric ton (\$43 to \$640 per short ton)

Theory of Operation:

An ESP is a particulate control device that uses electrical forces to move particles entrained within an exhaust stream onto collection surfaces. The entrained particles are given an electrical charge when they pass through a corona, a region where gaseous ions flow. Electrodes in the center of the flow lane are maintained at high voltage and generate the electrical field that forces the particles to the collector walls. In dry ESPs, the collectors are knocked, or "rapped", by various mechanical means to dislodge the particulate, which slides downward into a hopper where they are collected. Recently, dry wire-pipe ESPs are being cleaned acoustically with sonic horns (Flynn, 1999). The horns, typically cast metal horn bells, are usually powered by compressed air, and acoustic vibration is introduced by a vibrating metal plate that periodically interrupts the airflow (AWMA, 1992). As with a rapping system, the collected particulate slides downward into the hopper. The hopper is evacuated periodically, as it becomes full. Dust is removed through a valve into a dust-handling system, such as a pneumatic conveyor, and is then disposed of in an appropriate manner.

In a wire-pipe ESP, also called a tubular ESP, the exhaust gas flows vertically through conductive tubes, generally with many tubes operating in parallel. The tubes may be formed as a circular, square, or hexagonal honeycomb. Square and hexagonal pipes can be packed closer together than cylindrical pipes, reducing wasted space. Pipes are generally 7 to 30 cm (3 to 12 inches (in.)) in diameter and 1 to 4 meters (3 to 12 feet) in length. The high voltage electrodes are long wires or rigid "masts" suspended from a frame in the upper part of the ESP that run through the axis of each tube. Rigid electrodes are generally supported by both an upper and lower frame. In modern designs, sharp points are added to the electrodes, either at the entrance to a tube or along the entire length in the form of stars, to provide additional ionization sites (EPA, 1998; Flynn, 1999).

The power supplies for the ESP convert the industrial AC voltage (220 to 480 volts) to pulsating DC voltage in the range of 20,000 to 100,000 volts as needed. The voltage applied to the electrodes causes the gas between the electrodes to break down electrically, an action known as a "corona." The electrodes are usually given a negative polarity because a negative corona supports a higher voltage than does a positive corona before sparking occurs. The ions generated in the corona follow electric field lines from the electrode to the collection surfaces. Therefore, each electrode-pipe combination establishes a charging zone through which the particles must pass. As larger particles (>10 µm diameter) absorb many times more ions than small particles (>1 µm diameter), the electrical forces are much stronger on the large particles (EPA, 1996).

Due to necessary clearances needed for nonelectrified internal components at the top of wire-plate ESPs, part of the gas is able to flow around the charging zones. This is called "sneakage" and places an upper limit on the collection efficiency. Wire-pipe ESPs provide no sneakage paths around the collecting region, but field nonuniformities may allow some particles to avoid charging for a considerable fraction of the tube length. Dry wire-pipe ESPs are, however, subject to reentrainment of the collected material after cleaning the collectors with a rapping or acoustic mechanism, though the closed nature of the pipes increases chances for recollection (AWMA, 1992).

Another major factor in the performance is the resistivity of the collected material. Because the particles form a continuous layer on the ESP pipes, all the ion current must pass through the layer to reach the ground. This current creates an electric field in the layer, and it can become large enough to cause local electrical breakdown. When this occurs, new ions of the wrong polarity are injected into the wire-pipe gap where they reduce the charge on the particles and may cause sparking. This breakdown condition is called "back corona." Back corona is prevalent when the resistivity of the layer is high, usually above 2×10^{11} ohm-cm. Above this level, the collection ability of the unit is reduced considerably because the sever back corona causes difficulties in charging the particles. Low resistivities will also cause problems. At resistivities below 10^8 ohm-cm, the particles are held on the collecting surface so loosely that general reentrainment, as well as that associated with collector cleaning, become much more severe. Hence, care must be taken in measuring or estimating resistivity because it is strongly affected by such variables as temperature, moisture, gas composition, particle composition, and surface characteristics (AWMA, 1992).

Advantages:

Dry wire-pipe ESPs and other ESPs in general, because they act only on the particulate to be removed, and only minimally hinder flue gas flow, have very low pressure drops (typically less than 13 millimeters (mm) (0.5 in.) water column). As a result, energy requirements and operating costs tend to be low. They are capable of very high efficiencies, even for very small particles. They can be designed for a wide range of gas temperatures, and can handle high temperatures, up to 700°C (1300°F). Dry collection and disposal allows for easier handling. Operating costs are relatively low. ESPs are capable of operating under high pressure (to 1,030 kPa (150 psi)) or vacuum conditions. Relatively large gas flow rates can be effectively handled, though are uncommon in wire-pipe ESPs (AWMA, 1992).

Disadvantages:

ESPs generally have high capital costs. Wire discharge electrodes (approximately 2.5 mm (0.01 in.) in diameter) are high-maintenance items. Corrosion can occur near the top of the wires because of air leakage and acid condensation. Also, long weighted wires tend to oscillate - the middle of the wire can approach the pipe, causing increased sparking and wear. Newer ESP designs are tending toward rigid electrodes, or "masts" which largely eliminate the drawbacks of using wire electrodes (Cooper and Alley, 1994; Flynn, 1999).

ESPs in general are not suited for use in processes which are highly variable because they are very sensitive to fluctuations in gas stream conditions (flow rates, temperatures, particulate and gas composition, and particulate loadings). ESPs are also difficult to install in sites which have limited space since ESPs must be relatively large to obtain the low gas velocities necessary for efficient PM collection (Cooper and Alley, 1994). Certain particulates are difficult to collect due to extremely high or low resistivity characteristics. There can be an explosion hazard when treating combustible gases and/or collecting combustible particulates. Relatively sophisticated maintenance personnel are required, as well as special precautions to safeguard personnel from the high voltage. Dry ESPs are not recommended for removing sticky or moist particles. Ozone is produced by the negatively charged electrode during gas ionization (AWMA, 1992).

Other Considerations:

Dusts with very high resistivities (greater than 10^{10} ohm-cm) are also not well-suited for collection in dry ESPs. These particles are not easily charged, and thus are not easily collected. High-resistivity particles also form ash layers with very high voltage gradients on the collecting electrodes. Electrical breakdowns in these ash layers lead to injection of positively charged ions into the space between the discharge and collecting electrodes (back corona), thus reducing the charge on particles in this space and lowering collection efficiency. Fly ash from the combustion of low-sulfur coal typically has a high resistivity, and thus is difficult to collect (ICAC, 1999).

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EPA-452/F-03-028

Air Pollution Control Technology Fact Sheet

Name of Technology: Dry Electrostatic Precipitator (ESP) - Wire-Plate Type

Type of Technology: Control Device - Capture/Disposal

Applicable Pollutants: Particulate Matter (PM), including particulate matter less than or equal to 10 micrometers (•m) in aerodynamic diameter (PM_{10}), particulate matter less than or equal to 2.5 •m in aerodynamic diameter ($PM_{2.5}$), and hazardous air pollutants (HAPs) that are in particulate form, such as most metals (mercury is the notable exception, as a significant portion of emissions are in the form of elemental vapor).

Achievable Emission Limits/Reductions:

Typical new equipment design efficiencies are between 99 and 99.9%. Older existing equipment have a range of actual operating efficiencies of 90 to 99.9%. While several factors determine ESP collection efficiency, ESP size is most important. Size determines treatment time; the longer a particle spends in the ESP, the greater its chance of being collected. Maximizing electric field strength will maximize ESP collection efficiency (STAPPA/ALAPCO, 1996). Collection efficiency is also affected by dust resistivity, gas temperature, chemical composition (of the dust and the gas), and particle size distribution. Cumulative collection efficiencies of PM, PM_{10}, and $PM_{2.5}$ for actual operating ESPs in various types of applications are presented in Table 1.

Table 1. Cumulative PM, PM_{10}, and $PM_{2.5}$ Collection Efficiencies for Dry ESPs (EPA, 1998; EPA, 1997)

Application	Collection Efficiency (%)		
	Total PM (EPA, 1997)	PM_{10} (EPA, 1998)	$PM_{2.5}$ (EPA, 1998)
Coal-Fired Boilers			
Dry bottom (bituminous)	99.2	97.7	96.0
Spreader stoker (bituminous)	99.2	99.4	97.7
Primary Copper Production			
Multiple hearth roaster	99.0	99.0	99.1
Reverbatory smelter	99.0	97.1	97.4
Iron and Steel Production			
Open hearth furnace	99.2	99.2	99.2

Applicable Source Type: Point

Typical Industrial Applications:

Approximately 80% of all ESPs in the U.S. are used in the electric utility industry. ESPs are also used in pulp and paper (7%), cement and other minerals (3%), and nonferrous metals industries (1%) (EPA, 1998). Common applications of dry wire-plate ESPs are presented in Table 2.

Table 2. Typical Industrial Applications of Dry Wire-Plate ESPs (EPA, 1998)

Application	Source Category Code (SCC)	Are Other ESP Types Also Typically Used for this Application?
Utility Boilers (Coal, Oil)	1-01-002...004	No
Industrial Boilers (Coal, Oil, Wood, Liquid Waste)	1-02-001...005 1-02-009,-013	No
Commercial/Institutional Boilers (Coal, Oil, Wood)	1-03-001...005 1-03-009	No
Chemical Manufacture	Site specific	Yes
Non-Ferrous Metals Processing (Primary and Secondary):		
Copper	3-03-005 3-04-002	Yes
Lead	3-03-010 3-04-004	Yes
Zinc	3-03-030 3-04-008	Yes
Aluminum	3-03-000...002 3-04-001	Yes
Other metals production	3-03-011...014 3-04-005...006 3-04-010...022	Yes
Ferrous Metals Processing:		
Ferroalloy Production	3-03-006...007	No
Iron and Steel Production	3-03-008...009	Yes
Gray Iron Foundries	3-04-003	No
Steel Foundries	3-04-007,-009	Yes
Petroleum Refineries and Related Industries	3-06-001...999	No
Mineral Products:		
Cement Manufacturing	3-05-006...007	No
Stone Quarrying and Processing	3-05-020	Yes
Other	3-05-003...999	Yes
Wood, Pulp, and Paper	3-07-001	Yes
Incineration (Municipal Waste)	5-01-001	Yes

Emission Stream Characteristics:

a. **Air Flow:** Typical gas flow rates for wire-plate ESPs are 100 to 500 standard cubic meters per second (sm^3/sec) (200,000 to 1,000,000 standard cubic feet per minute (scfm)). Most smaller plate-type ESPs (50 sm^3/sec to 100 sm^3/sec, or 100,000 to 200,000 scfm) use flat plates instead of wires for the high-voltage electrodes (AWMA, 1992).

b. **Temperature:** Wire-plate ESPs can operate at very high temperatures, up to 700•C (1300•F) (AWMA, 1992). Operating gas temperature and chemical composition of the dust are key factors influencing dust resistivity and must be carefully considered in the design of an ESP.

c. **Pollutant Loading:** Typical inlet concentrations to a wire-plate ESP are 2 to 110 g/m^3 (1 to 50 grains per cubic foot (gr/ft^3)). It is common to pretreat a waste stream, usually with a mechanical collector or cyclone, to bring the pollutant loading into this range. Highly toxic flows with concentrations below 1 g/m^3 (0.5 gr/ft^3) are also sometimes controlled with ESPs (Bradburn, 1999; Boyer, 1999; Brown, 1999).

d. **Other Considerations:** In general, dry ESPs operate most efficiently with dust resistivities between 5×10^3 and 2×10^{10} ohm-cm. In general, the most difficult particles to collect are those with aerodynamic diameters between 0.1 and 1.0 • m. Particles between 0.2 and 0.4 • m usually show the most penetration. This is most likely a result of the transition region between field and diffusion charging (EPA, 1998).

Emission Stream Pretreatment Requirements:

When much of the pollutant loading consists of relatively large particles, mechanical collectors such as cyclones or spray coolers may be used to reduce the load on the ESP, especially at high inlet concentrations. Gas conditioning equipment to improve ESP performance by changing dust resistivity is occasionally used as part of the original design, but more frequently it is used to upgrade existing ESPs. The equipment injects an agent into the gas stream ahead of the ESP. Usually, the agent mixes with the particles and alters their resistivity to promote higher migration velocity, and thus higher collection efficiency. Conditioning agents that are used include SO_3, H_2SO_4, sodium compounds, ammonia, and water; the conditioning agent most used is SO_3 (AWMA, 1992).

Cost Information:

The following are cost ranges (expressed in 2002 dollars) for wire-plate ESPs of conventional design under typical operating conditions, developed using EPA cost-estimating spreadsheets (EPA, 1996). Costs can be substantially higher than in the ranges shown for pollutants which require an unusually high level of control, or which require the ESP to be constructed of special materials such as stainless steel or titanium. In general, smaller units controlling a low concentration waste stream will not be as cost effective as a large unit cleaning a high pollutant load flow.

a. **Capital Cost:** \$21,000 to \$70,000 per sm^3/sec (\$10 to \$33 per scfm)

b. **O & M Cost:** \$6,400 to \$74,000 per sm^3/sec (\$3 to \$35 per scfm), annually

c. **Annualized Cost:** \$9,100 to \$81,000 per sm^3/sec (\$4 to \$38 per scfm), annually

d. **Cost Effectiveness:** \$38 to \$260 per metric ton (\$35 to \$236 per short ton)

Theory of Operation:

An ESP is a particulate control device that uses electrical forces to move particles entrained within an exhaust stream onto collector plates. The entrained particles are given an electrical charge when they pass through a corona, a region where gaseous ions flow. Electrodes in the center of the flow lane are maintained at high voltage and generate the electrical field that forces the particles to the collector walls. In dry ESPs, the collectors are knocked, or "rapped", by various mechanical means to dislodge the particulate, which slides downward into a hopper where they are collected. The hopper is evacuated periodically, as it becomes full. Dust is removed through a valve into a dust-handling system, such as a pneumatic conveyor, and is then disposed of in an appropriate manner.

In the wire-plate ESP, the exhaust gas flows horizontally and parallel to vertical plates of sheet metal. Plate spacing is typically between 19 to 38 cm (9 in. and 18 in.) (AWMA, 1992). The high voltage electrodes are long wires that are weighted and hang between the plates. Some later designs use rigid electrodes (hollow pipes approximately 25 mm to 40 mm in diameter) in place of wire (Cooper and Alley, 1994). Within each flow path, gas flow must pass each wire in sequence as it flows through the unit. The flow areas between the plates are called ducts. Duct heights are typically 6 to 14 m (20 to 45 feet) (EPA, 1998).

The power supplies for the ESP convert the industrial AC voltage (220 to 480 volts) to pulsating DC voltage in the range of 20,000 to 100,000 volts as needed. The voltage applied to the electrodes causes the gas between the electrodes to break down electrically, an action known as a "corona." The electrodes are usually given a negative polarity because a negative corona supports a higher voltage than does a positive corona before sparking occurs. The ions generated in the corona follow electric field lines from the wires to the collecting plates. Therefore, each wire establishes a charging zone through which the particles must pass. As larger particles (>10 • m diameter) absorb many times more ions than small particles (>1 • m diameter), the electrical forces are much stronger on the large particles (EPA, 1996).

Certain types of losses affect control efficiency. The rapping that dislodges the accumulated layer also project some of the particles (typically 12% for coal fly ash) back into the gas stream. These reentrained particles are then processed again by later sections, but the particles reentrained in the last section of the ESP have no chance to be recaptured and so escape the unit. Due to necessary clearances needed for nonelectrified internal components at the top of the ESP, part of the gas may flow around the charging zones. This is called "sneakage" and places an upper limit on the collection efficiency. Anti-sneakage baffles are placed to force the sneakage flow to mix with the main gas stream for collection in later sections (EPA, 1998).

Another major factor in the performance is the resistivity of the collected material. Because the particles form a continuous layer on the ESP plates, all the ion current must pass through the layer to reach the ground plates. This current creates an electric field in the layer, and it can become large enough to cause local electrical breakdown. When this occurs, new ions of the wrong polarity are injected into the wire-plate gap where they reduce the charge on the particles and may cause sparking. This breakdown condition is called "back corona." Back corona is prevalent when the resistivity of the layer is high, usually above 2×10^{11} ohm-cm. Above this level, the collection ability of the unit is reduced considerably because the sever back corona causes difficulties in charging the particles. Low resistivities will also cause problems. At resistivities below 10^8 ohm-cm, the particles are held on the plates so loosely that rapping and nonrapping reentrainment become much more severe. Hence, care must be taken in measuring or estimating resistivity because it is strongly affected by such variables as temperature, moisture, gas composition, particle composition, and surface characteristics (AWMA, 1992).

Precipitator size is related to many design parameters. One of the main parameters is the specific collection area (SCA), which is defined as the ratio of the surface area of the collection electrodes to the gas flow. Higher collection areas lead to better removal efficiencies. Collection areas normally are in the range of 40 to 160 m^2 per sm^3/second of gas flow (200-800 ft^2/1000 scfm), with typical values of 80 (400) (AWMA, 1992).

Advantages:

Dry wire-plate ESPs and other ESPs in general, because they act only on the particulate to be removed, and only minimally hinder flue gas flow, have very low pressure drops (typically less than 13 mm (0.5 in.) water column). As a result, energy requirements and operating costs tend to be low. They are capable of very high efficiencies, even for very small particles. They can be designed for a wide range of gas temperatures, and can handle high temperatures, up to 700•C (1300•F). Dry collection and disposal allows for easier handling. Operating costs are relatively low. ESPs are capable of operating under high pressure (to 1,030 kPa (150 psi)) or vacuum conditions. Relatively large gas flow rates can be effectively handled. (AWMA, 1992)

Disadvantages:

ESPs generally have high capital costs. The wire discharge electrodes (approximately 2.5 mm (0.01 in.) in diameter) are high-maintenance items. Corrosion can occur near the top of the wires because of air leakage and acid condensation. Also, long weighted wires tend to oscillate - the middle of the wire can approach the plate, causing increased sparking and wear. Newer ESP designs are tending toward rigid electrodes (Cooper and Alley, 1994).

ESPs in general are not suited for use in processes which are highly variable because they are very sensitive to fluctuations in gas stream conditions (flow rates, temperatures, particulate and gas composition, and particulate loadings). ESPs are also difficult to install in sites which have limited space since ESPs must be relatively large to obtain the low gas velocities necessary for efficient PM collection (Cooper and Alley, 1994). Certain particulates are difficult to collect due to extremely high or low resistivity characteristics. There can be an explosion hazard when treating combustible gases and/or collecting combustible particulates. Relatively sophisticated maintenance personnel are required, as well as special precautions to safeguard personnel from the high voltage. Dry ESPs are not recommended for removing sticky or moist particles. Ozone is produced by the negatively charged electrode during gas ionization (AWMA, 1992).

Other Considerations:

Dusts with very high resistivities (greater than 10^{10} ohm-cm) are also not well-suited for collection in dry ESPs. These particles are not easily charged, and thus are not easily collected. High-resistivity particles also form ash layers with very high voltage gradients on the collecting electrodes. Electrical breakdowns in these ash layers lead to injection of positively charged ions into the space between the discharge and collecting electrodes (back corona), thus reducing the charge on particles in this space and lowering collection efficiency. Fly ash from the combustion of low-sulfur coal typically has a high resistivity, and thus is difficult to collect (ICAC, 1999).

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EPA-452/F-03-029

Air Pollution Control Technology
Fact Sheet

Name of Technology: Wet Electrostatic Precipitator (ESP)- Wire-Pipe Type

Type of Technology: Control Device - Capture/Disposal

Applicable Pollutants: Particulate Matter (PM), including particulate matter less than or equal to 10 micrometers (μm) in aerodynamic diameter (PM_{10}), particulate matter less than or equal to 2.5 μm in aerodynamic diameter ($PM_{2.5}$), and hazardous air pollutants (HAPs) that are in particulate form, such as most metals (mercury is the notable exception, as a significant portion of emissions are in the form of elemental vapor). Wet ESPs are often used to control acid mists and can provide incidental control of volatile organic compounds.

Achievable Emission Limits/Reductions:

Typical new equipment design efficiencies are between 99 and 99.9%. Older existing equipment have a range of actual operating efficiencies of 90 to 99.9%. While several factors determine ESP collection efficiency, ESP size is most important. Size determines treatment time; the longer a particle spends in the ESP, the greater its chance of being collected. Maximizing electric field strength will maximize ESP collection efficiency (STAPPA/ALAPCO, 1996). Collection efficiency is also affected to some extent by dust resistivity, gas temperature, chemical composition (of the dust and the gas), and particle size distribution.

Applicable Source Type: Point

Typical Industrial Applications:

Wet ESPs are used in situations for which dry ESPs are not suited, such as when the material to be collected is wet, sticky, flammable, explosive, or has a high resistivity. Also, as higher collection efficiencies have become more desirable, wet ESP applications have been increasing. Many older ESPs are of the wire-pipe design, consisting of a single tube placed on top of a smokestack (EPA, 1998). Wet pipe-type ESPs are commonly used by the textile industry, pulp and paper facilities, the metalurgical industry, including coke ovens, hazardous waste incinerators, and sulfuric acid manufacturing plants, among others, though other ESP types are employed as well (EPA, 1998; Flynn, 1999).

Emission Stream Characteristics:

a. **Air Flow:** Typical gas flow rates for wet wire-pipe ESPs are 0.5 to 50 standard cubic meters per second (sm^3/sec) (1,000 to 100,000 standard cubic feet per minute (scfm)) (Flynn, 1999).

b. **Temperature:** Wet wire-pipe ESPs are limited to operating at temperatures lower than approximately 80 to 90•C (170 to 190•F) (EPA, 1998; Flynn, 1999).

c. **Pollutant Loading:** Typical inlet concentrations to a wire-pipe ESP are 1 to 10 grams per cubic meter (g/m^3) (0.5 to 5 gr/ft^3). It is common to pretreat a waste stream, usually with a wet spray or scrubber, to bring the stream temperature and pollutant loading into a manageable range. Highly toxic flows with concentrations well below 1 g/m^3 (0.5 gr/ft^3) are also sometimes controlled with ESPs (Flynn, 1999).

d. **Other Considerations:** Dust resistivity is not a factor for wet ESPs, because of the high humidity atmosphere which lowers the resistivity of most materials. Particle size is much less of a factor for wet ESPs, compared to dry ESPs. Much smaller particles can be efficiently collected by wet ESPs due to the lack of resistivity concerns and the reduced reentrainment (Flynn, 1999).

Emission Stream Pretreatment Requirements:

When the pollutant loading is exceptionally high or consists of relatively large particles (> 2 μm), venturi scrubbers or spray chambers may be used to reduce the load on the ESP. Much larger particles (> 10 μm), are controlled with mechanical collectors such as cyclones. Gas conditioning equipment to reduce both inlet concentration and gas temperature is occasionally used as part of the original design of a wet ESPs (AWMA, 1992; Flynn, 1999).

Cost Information:

The following are cost ranges (expressed in 2002 dollars) for wire-pipe ESPs of conventional design under typical operating conditions, developed using EPA cost-estimating spreadsheets for dry wire-plate ESPs with adjustments made to reflect wet wire-pipe ESPs (EPA, 1996). Costs can be substantially higher than in the ranges shown for pollutants which require an unusually high level of control, or which require the ESP to be constructed of special materials such as titanium. Capital and operating costs are generally higher due to noncorrosive materials requirements, increased water usage, and treatment and disposal of wet effluent. In most cases, smaller units controlling a low concentration waste stream will not be as cost effective as a large unit cleaning a high pollutant load flow (EPA, 1998).

a. **Capital Cost:** \$85,000 to \$424,000 per sm^3/sec (\$40 to \$200 per scfm)

b. **O & M Cost:** \$12,000 to \$21,000 per sm^3/sec (\$6 to \$10 per scfm), annually

c. **Annualized Cost:** \$25,000 to \$97,000 per sm^3/s (\$12 to \$46 per scfm), annually

d. **Cost Effectiveness:** \$73 to \$720 per metric ton (\$65 to \$660 per ton)

Theory of Operation:

An ESP is a particulate control device that uses electrical forces to move particles entrained within an exhaust stream onto collection surfaces. The entrained particles are given an electrical charge when they pass through a corona, a region where gaseous ions flow. Electrodes in the center of the flow lane are maintained at high voltage and generate the electrical field that forces the particles to the collector walls. In wet ESPs, the collectors are either intermittently or continuously washed by a spray of liquid, usually water. The collection hoppers used by dry ESPs are replaced with a drainage system. The wet effluent is collected, and often treated on-site (EPA, 1998).

In a wire-pipe ESP, also called a tubular ESP, the exhaust gas flows vertically through conductive tubes, generally with many tubes operating in parallel. The tubes may be formed as a circular, square, or hexagonal honeycomb. Square and hexagonal pipes can be packed closer together than cylindrical pipes, reducing wasted space. Pipes are generally 7 to 30 cm (3 to 12 inches (in.)) in diameter and 1 to 4 m (3 to 12 feet) in length. The high voltage electrodes are long wires or rigid “masts” suspended from a frame in the upper part of the ESP that run through the axis of each tube. Rigid electrodes are generally supported by both an upper and lower frame. In modern designs, sharp points are added to the electrodes, either at the entrance to a tube or along the entire length in the form of stars, to provide additional ionization sites (EPA, 1998; Flynn, 1999).

The power supplies for the ESP convert the industrial AC voltage (220 to 480 volts) to pulsating DC voltage in the range of 20,000 to 100,000 volts as needed. The voltage applied to the electrodes causes the gas between the electrodes to break down electrically, an action known as a "corona." The electrodes are usually given a negative polarity because a negative corona supports a higher voltage than does a positive corona before sparking occurs. The ions generated in the corona follow electric field lines from the electrode to the collecting pipe. Therefore, each electrode-pipe combination establishes a charging zone through which the particles must pass. As larger particles (>10 μm diameter) absorb many times more ions than small particles (>1 μm diameter), the electrical forces are much stronger on the large particles (EPA, 1996).

Due to necessary clearances needed for nonelectrified internal components at the top of wire-plate ESPs, part of the gas is able to flow around the charging zones. This is called "sneakage" and places an upper limit on the collection efficiency. Wire-pipe ESPs provide no sneakage paths around the collecting region, but field nonuniformities may allow some particles to avoid charging for a considerable fraction of the tube length (AWMA, 1992).

Wet ESPs require a source of wash water to be injected or sprayed near the top of the collector pipes either continuously or at timed intervals. This wash system replaces the rapping mechanism usually used by dry ESPs. The water flows with the collected particles into a sump from which the fluid is pumped or drained. A portion of the fluid may be recycled to reduce the total amount of water required. The remainder is pumped into a settling pond or passed through a dewatering stage, with subsequent disposal of the sludge (AWMA, 1992).

Unlike dry ESPs, resistivity of the collected material is generally not a major factor in performance. Because of the high humidity in a wet ESP, the resistivity of particles is lowered, eliminating the "back corona" condition. The frequent washing of the pipes also limits particle buildup on the collectors (EPA, 1998).

Advantages:

Wet wire-pipe ESPs and other ESPs in general, because they act only on the particulate to be removed, and only minimally hinder flue gas flow, have very low pressure drops (typically less than 13 millimeters (mm) (0.5 in.) water column). As a result, energy requirements and operating costs tend to be low. They are capable of very high efficiencies, even for very small particles. Operating costs are relatively low. ESPs are capable of operating under high pressure (to 1,030 kPa (150 psi)) or vacuum conditions, and relatively large gas flow rates can be effectively handled (AWMA, 1992).

Wet ESPs can collect sticky particles and mists, as well as highly resistive or explosive dusts. The continuous or intermittent washing with a liquid eliminates the reentrainment of particles due to rapping which dry ESPs are subject to. The humid atmosphere that results from the washing in a wet ESP enables them to collect high resistivity particles, absorb gases or cause pollutants to condense, and cools and conditions the gas stream. Liquid particles or aerosols present in the gas stream are collected along with particles and provide another means of rinsing the collection electrodes (EPA, 1998). Wet wire-pipe ESPs have the additional advantages of reducing "sneakage" by passing the entire gas stream through the collection field, and the ability to be tightly sealed to prevent leaks of materia, especially valuable or hazardous materials (AWMA, 1992).

Disadvantages:

ESPs generally have high capital costs. Wire discharge electrodes (approximately 2.5 mm (0.01 in.) in diameter) are high-maintenance items. Corrosion can occur near the top of the wires because of air leakage and acid condensation. Also, long weighted wires tend to oscillate - the middle of the wire can approach the pipe, causing increased sparking and wear. Newer ESP designs are tending toward rigid electrodes, or “masts” which largely eliminate the drawbacks of using wire electrodes (Cooper and Alley, 1994; Flynn, 1999).

ESPs in general are not suited for use in processes which are highly variable because they are very sensitive to fluctuations in gas stream conditions (flow rates, temperatures, particulate and gas composition, and particulate loadings). ESPs are also difficult to install in sites which have limited space since ESPs must be relatively large to obtain the low gas velocities necessary for efficient PM collection (Cooper and Alley, 1994). Relatively sophisticated maintenance personnel are required, as well as special precautions to safeguard personnel from the high voltage. Ozone is produced by the negatively charged electrode during gas ionization (AWMA, 1992). Wet ESPs add the complexity of a wash system, and the fact that the resulting slurry must be handled more carefully than a dry product, and in many cases requires treatment, especially if the dust can be sold or recycled. Wet ESPs are limited to operating at stream temperatures under approximately 80 to 90•C (170 to 190•F), and generally must be constructed of noncorrosive materials (EPA, 1998; Flynn, 1999).

Other Considerations:

For wet ESPs, consideration must be given to handling wastewaters. For simple systems with innocuous dusts, water with particles collected by the ESP may be discharged from the ESP system to a solids-removing clarifier (either dedicated to the ESP or part of the plant wastewater treatment system) and then to final disposal. More complicated systems may require skimming and sludge removal, clarification in dedicated wequipment, pH adjustment, and/or treatment to remove dissolved solids. Spray water from an ESP preconditioner may be treated separately from the water used to wash the ESP collecting pipes so that the cleaner of the two treated water streams may be returned to the ESP. Recirculation of treated water to the ESP may approach 100 percent (AWMA, 1992).

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EPA-452/F-03-005

Air Pollution Control Technology Fact Sheet

Name of Technology: Cyclones

This type of technology is a part of the group of air pollution controls collectively referred to as "precleaners," because they are oftentimes used to reduce the inlet loading of particulate matter (PM) to downstream collection devices by removing larger, abrasive particles. Cyclones are also referred to as cyclone collectors, cyclone separators, centrifugal separators, and inertial separators. In applications where many small cyclones are operating in parallel, the entire system is called a multiple tube cyclone, multicyclone, or multiclone.

Type of Technology: Removal of PM by centrifugal and inertial forces, induced by forcing particulate-laden gas to change direction.

Applicable Pollutants:

Cyclones are used to control PM, and primarily PM greater than 10 micrometers (μm) in aerodynamic diameter. However, there are high efficiency cyclones designed to be effective for PM less than or equal to 10 μm and less than or equal to 2.5 μm in aerodynamic diameter (PM_{10} and $PM_{2.5}$). Although cyclones may be used to collect particles larger than 200 μm, gravity settling chambers or simple momentum separators are usually satisfactory and less subject to abrasion (Wark, 1981; Perry, 1984).

Achievable Emission Limits/Reductions:

The collection efficiency of cyclones varies as a function of particle size and cyclone design. Cyclone efficiency generally <u>increases</u> with (1) particle size and/or density, (2) inlet duct velocity, (3) cyclone body length, (4) number of gas revolutions in the cyclone, (5) ratio of cyclone body diameter to gas exit diameter, (6) dust loading, and (7) smoothness of the cyclone inner wall. Cyclone efficiency will <u>decrease</u> with increases in (1) gas viscosity, (2) body diameter, (3) gas exit diameter, (4) gas inlet duct area, and (5) gas density. A common factor contributing to decreased control efficiencies in cyclones is leakage of air into the dust outlet (EPA, 1998).

Control efficiency ranges for single cyclones are often based on three classifications of cyclone, i.e., conventional, high-efficiency, and high-throughput. The control efficiency range for conventional single cyclones is estimated to be 70 to 90 percent for PM, 30 to 90 percent for PM_{10}, and 0 to 40 percent for $PM_{2.5}$.

High efficiency single cyclones are designed to achieve higher control of smaller particles than conventional cyclones. According to Cooper (1994), high efficiency single cyclones can remove 5 μm particles at up to 90 percent efficiency, with higher efficiencies achievable for larger particles. The control efficiency ranges for high efficiency single cyclones are 80 to 99 percent for PM, 60 to 95 percent for PM_{10}, and 20 to 70 percent for $PM_{2.5}$. Higher efficiency cyclones come with higher pressure drops, which require higher energy costs to move the waste gas through the cyclone. Cyclone design is generally driven by a specified pressure-drop limitation, rather than by meeting a specified control efficiency (Andriola, 1999; Perry, 1994).

According to Vatavuk (1990), high throughput cyclones are only guaranteed to remove particles greater than 20 μm, although collection of smaller particles does occur to some extent. The control efficiency ranges for high-throughput cyclones are 80 to 99 percent for PM, 10 to 40 percent for PM_{10}, and 0 to 10 percent for $PM_{2.5}$.

Multicyclones are reported to achieve from 80 to 95 percent collection efficiency for 5 μm particles (EPA, 1998).

Applicable Source Type: Point

Typical Industrial Applications:

Cyclones are designed for many applications. Cyclones themselves are generally not adequate to meet stringent air pollution regulations, but they serve an important purpose as precleaners for more expensive final control devices such as fabric filters or electrostatic precipitators (ESPs). In addition to use for pollution control work, cyclones are used in many process applications, for example, they are used for recovering and recycling food products and process materials such as catalysts (Cooper, 1994).

Cyclones are used extensively after spray drying operations in the food and chemical industries, and after crushing, grinding and calcining operations in the mineral and chemical industries to collect salable or useful material. In the ferrous and nonferrous metallurgical industries, cyclones are often used as a first stage in the control of PM emissions from sinter plants, roasters, kilns, and furnaces. PM from the fluid-cracking process are removed by cyclones to facilitate catalyst recycling. Fossil-fuel and wood-waste fired industrial and commercial fuel combustion units commonly use multiple cyclones (generally upstream of a wet scrubber, ESP, or fabric filter) which collect fine PM (< 2.5 μm) with greater efficiency than a single cyclone. In some cases, collected fly ash is reinjected into the combustion unit to improve PM control efficiency (AWMA, 1992; Avallone, 1996; STAPPA/ALAPCO, 1996; EPA, 1998).

Emission Stream Characteristics:

a. **Air Flow:** Typical gas flow rates for a single cyclone unit are 0.5 to 12 standard cubic meters per second (sm^3/sec) (1,060 to 25,400 standard cubic feet per minute (scfm)). Flows at the high end of this range and higher (up to approximately 50 sm^3/sec or 106,000 scfm) use multiple cyclones in parallel (Cooper, 1994). There are single cyclone units employed for specialized applications which have flow rates of up to approximately 30 sm^3/sec (63,500 scfm) and as low as 0.0005 sm^3/sec (1.1 scfm) (Wark, 1981; Andriola, 1999).

b. **Temperature:** Inlet gas temperatures are only limited by the materials of construction of the cyclone, and have been operated at temperatures as high as 540°C (1000°F) (Wark, 1981; Perry, 1994).

c. **Pollutant Loading:** Waste gas pollutant loadings typically range from 2.3 to 230 grams per standard cubic meter (g/sm^3) (1.0 to 100 grains per standard cubic foot (gr/scf)) (Wark, 1981). For specialized applications, loadings can be as high as 16,000 g/sm^3 (7,000 gr/scf), and as low as l g/sm^3 (0.44 gr/scf) (Avallone, 1996; Andriola, 1999).

d. **Other Considerations:** Cyclones perform more efficiently with higher pollutant loadings, provided that the device does not become choked. Higher pollutant loadings are generally associated with higher flow designs (Andriola, 1999).

Emission Stream Pretreatment Requirements:

No pretreatment is necessary for cyclones.

Cost Information:

The following are cost ranges (expressed in 2002 dollars) for a single conventional cyclone under typical operating conditions, developed using an EPA cost-estimating spreadsheet (EPA, 1996), and referenced to the volumetric flow rate of the waste stream treated. Flow rates higher than approximately 10 sm^3/sec (21,200 scfm) usually employ multiple cyclones operating in parallel. For purposes of calculating the example cost effectiveness, flow rates are assumed to be between 0.5 and 50 sm^3/sec (1,060 and 106,000 scfm), the PM inlet loading is assumed to be approximately 2.3 and 230 g/sm^3 (1.0 to 100 gr/scf) and the control efficiency is assumed to be 90 percent. The costs do not include costs for disposal or transport of collected material. Capital costs can be higher than in the ranges shown for applications which require expensive materials. As a rule, smaller units controlling a waste stream with a low PM concentration will be more expensive (per unit volumetric flow rate and per quantity of pollutant controlled) than a large unit controlling a waste stream with a high PM concentration.

a. **Capital Cost:** $4,600 to $7,400 per sm^3/sec ($2.20 to $3.50 per scfm)

b. **O & M Cost:** $1,500 to $18,000 per sm^3/sec ($0.70 to $8.50 per scfm), annually

c. **Annualized Cost:** $2,800 to $29,000 per sm^3/sec ($1.30 to $13.50 per scfm), annually

d. **Cost Effectiveness:** $0.47 to $440 per metric ton ($0.43 to $400 per short ton), annualized cost per ton per year of pollutant controlled

Flow rates higher than approximately 10 sm^3/sec (21,200 scfm), and up to approximately 50 sm^3/sec (106,000 scfm), usually employ multiple cyclones operating in parallel. Assuming the same range of pollutant loading and an efficiency of 90 percent, the following cost ranges (expressed in third quarter 1995 dollars) were developed for multiple cyclones, using an EPA cost-estimating spreadsheet (EPA, 1996), and referenced to the volumetric flow rate of the waste stream treated.

Theory of Operation:

Cyclones use inertia to remove particles from the gas stream. The cyclone imparts centrifugal force on the gas stream, usually within a conical shaped chamber. Cyclones operate by creating a double vortex inside the cyclone body. The incoming gas is forced into circular motion down the cyclone near the inner surface of the cyclone tube. At the bottom of the cyclone, the gas turns and spirals up through the center of the tube and out of the top of the cyclone (AWMA, 1992).

Particles in the gas stream are forced toward the cyclone walls by the centrifugal force of the spinning gas but are opposed by the fluid drag force of the gas traveling through and out of the cyclone. For large particles, inertial momentum overcomes the fluid drag force so that the particles reach the cyclone walls and are collected. For small particles, the fluid drag force overwhelms the inertial momentum and causes these particles to leave the cyclone with the exiting gas. Gravity also causes the larger particles that reach the cyclone walls to travel down into a bottom hopper. While they rely on the same separation mechanism as momentum separators, cyclones are more effective because they have a more complex gas flow pattern (AWMA, 1992).

Cyclones are generally classified into four types, depending on how the gas stream is introduced into the device and how the collected dust is discharged. The four types include tangential inlet, axial discharge; axial inlet, axial discharge; tangential inlet, peripheral discharge; and axial inlet, peripheral discharge. The first two types are the most common (AWMA, 1992).

Pressure drop is an important parameter because it relates directly to operating costs and control efficiency. Higher control efficiencies for a given cyclone can be obtained by higher inlet velocities, but this also increases the pressure drop. In general, 18.3 meters per second (60 feet per second) is considered the best operating velocity. Common ranges of pressure drops for cyclones are 0.5 to 1 kilopascals (kPa) (2 to 4 in. H_2O) for low-efficiency units (high throughput), 1 to 1.5 kPa (4 to 6 in. H_2O) for medium-efficiency units (conventional), and 2 to 2.5 kPa (8 to 10 in. H_2O) for high-efficiency units (AWMA, 1992).

When high-efficiency (which requires small cyclone diameter) and large throughput are both desired, a number of cyclones can be operated in parallel. In a multiple tube cyclone, the housing contains a large number of tubes that have a common gas inlet and outlet in the chamber. The gas enters the tubes through axial inlet vanes which impart a circular motion (AWMA, 1992). Another high-efficiency unit, the wet cyclonic separator, uses a combination of centrifugal force and water spray to enhance control efficiency.

Advantages:

Advantages of cyclones include (AWMA, 1992; Cooper, 1994; and EPA, 1998):

1. Low capital cost;
2. No moving parts, therefore, few maintenance requirements and low operating costs;
3. Relatively low pressure drop (2 to 6 inches water column), compared to amount of PM removed;
4. Temperature and pressure limitations are only dependent on the materials of construction;
5. Dry collection and disposal; and
6. Relatively small space requirements.

Disadvantages:

Disadvantages of cyclones include (AWMA, 1992; Cooper, 1994; and EPA, 1998):

1. Relatively low PM collection efficiencies, particularly for PM less than 10 μm in size;
2. Unable to handle sticky or tacky materials; and
3. High efficiency units may experience high pressure drops.

Other Considerations:

Using multiple cyclones, either in parallel or in series, to treat a large volume of gas results in higher efficiencies, but at the cost of a significant increase in pressure drop. Higher pressure drops translate to higher energy usage and operating costs. Several designs should be considered to achieve the optimum combination of collection efficiency and pressure drop (Cooper, 1994).

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Section 13

Determination of State & Federal Air Quality Regulations

This section lists each state and federal air quality regulation that may apply to your facility and/or equipment that are stationary sources of regulated air pollutants.

Not all state and federal air quality regulations are included in this list. Go to the Code of Federal Regulations (CFR) or to the Air Quality Bureau's regulation page to see the full set of air quality regulations.

Required Information for Specific Equipment:
For regulations that apply to specific source types, in the 'Justification' column **provide any information needed to determine if the regulation does or does not apply**. **For example**, to determine if emissions standards at 40 CFR 60, Subpart IIII apply to your three identical stationary engines, we need to know the construction date as defined in that regulation; the manufacturer date; the date of reconstruction or modification, if any; if they are or are not fire pump engines; if they are or are not emergency engines as defined in that regulation; their site ratings; and the cylinder displacement.

Required Information for Regulations that Apply to the Entire Facility:
See instructions in the 'Justification' column for the information that is needed to determine if an 'Entire Facility' type of regulation applies (e.g. 20.2.70 or 20.2.73 NMAC).

Regulatory Citations for Regulations That Do Not, but Could Apply:
If there is a state or federal air quality regulation that does not apply, but you have a piece of equipment in a source category for which a regulation has been promulgated, you must **provide the low level regulatory citation showing why your piece of equipment is not subject to or exempt from the regulation. For example** if you have a stationary internal combustion engine that is not subject to 40 CFR 63, Subpart ZZZZ because it is an existing 2 stroke lean burn stationary RICE with a site rating of more than 500 brake HP located at a major source of HAP emissions, your citation would be 40 CFR 63.6590(b)(3)(i). **We don't want a discussion of every non-applicable regulation, but if it is possible a regulation could apply, explain why it does not. For example,** if your facility is a power plant, you do not need to include a citation to show that 40 CFR 60, Subpart OOO does not apply to your non-existent rock crusher.

Regulatory Citations for Emission Standards:
For each unit that is subject to an emission standard in a source specific regulation, such as 40 CFR 60, Subpart OOO or 40 CFR 63, Subpart HH, include the low level regulatory citation of that emission standard. Emission standards can be numerical emission limits, work practice standards, or other requirements such as maintenance. **Here are examples:** a glycol dehydrator is subject to the general standards at 63.764C(1)(i) through (iii); an engine is subject to 63.6601, Tables 2a and 2b; a crusher is subject to 60.672(b), Table 3 and all transfer points are subject to 60.672(e)(1)

Federally Enforceable Conditions:
All federal regulations are federally enforceable. All Air Quality Bureau State regulations are federally enforceable except for the following: affirmative defense portions at 20.2.7.6.B, 20.2.7.110(B)(15), 20.2.7.11 through 20.2.7.113, 20.2.7.115, and 20.2.7.116; 20.2.37; 20.2.42; 20.2.43; 20.2.62; 20.2.63; 20.2.86; 20.2.89; and 20.2.90 NMAC. Federally enforceable means that EPA can enforce the regulation as well as the Air Quality Bureau and federally enforceable regulations can count toward determining a facility's potential to emit (PTE) for the Title V, PSD, and nonattainment permit regulations.

INCLUDE ANY OTHER INFORMATION NEEDED TO COMPLETE AN APPLICABILITY DETERMINATION OR THAT IS RELEVENT TO YOUR FACILITY'S NOTICE OF INTENT OR PERMIT.

EPA Applicability Determination Index for 40 CFR 60, 61, 63, etc: http://cfpub.epa.gov/adi/

There are no changes to prior representations. **Table13–2** demonstrates compliance with each applicable State Regulations. **Table 13–3** demonstrates compliance with each applicable Federal Regulations.

Table13–2 Applicable State Regulations

STATE REGU-LATIONS CITATION	Title	Applies to Entire Facility	Applies to Unit No(s).	Federally Enforce-able	Does Not Apply	JUSTIFICATION: Identify the applicability criteria, numbering each (i.e. 1. Post 7/23/84, 2. 75 m^3, 3. VOL)
20.2.3 NMAC	Ambient Air Quality Standards NMAAQS	X	All	Yes		20.2.3 NMAC is a SIP approved regulation that limits the maximum allowable concentration of Total Suspended Particulates, Sulfur Compounds, Carbon Monoxide and Nitrogen Dioxide.
20.2.7 NMAC	Excess Emissions	X	All	Yes		All Title V major sources are subject to Air Quality Control Regulations, as defined in 20.2.7 NMAC, and are thus subject to the requirements of this regulation. Also listed as applicable in NSR Permit PSD 3449-M4.
20.2.33 NMAC	Gas Burning Equipment - Nitrogen Dioxide		DB-1, DB-2	Yes		Hobbs duct burners are new gas burning equipment with a heat input greater than 1,000,000 MMBtu/yr per unit. Hobbs fuel gas heaters are new gas burning equipment with a heat input less than 1,000,000 MMBtu/yr, therefore this part does not apply to these equipment. Note: "New gas burning equipment" means gas burning equipment, the construction or modification of which is commenced after February 17, 1972.
20.2.34 NMAC	Oil Burning Equipment: NO_2	N/A	N/A	Yes	X	Not applicable. This facility has no oil burning equipment having a heat input of greater than 1,000,000 MMBtu/yr per unit.
20.2.35 NMAC	Natural Gas Processing Plant – Sulfur	N/A	N/A	N/A	X	Not applicable. Hobbs is not a Natural Gas Processing Plant; therefore, it is not subject to the requirements of 20.2.35 NMAC.
20.2.37 NMAC	Petroleum Processing Facilities	N/A	N/A	No	X	Not applicable. Hobbs is not a Petroleum Processing Facility; therefore, it is not subject to the requirements of 20.2.37 NMAC.
20.2.38 NMAC	Hydrocarbon Storage Facilities	N/A	N/A	No	X	Not applicable. Hobbs does not have hydrocarbon storage tanks with a capacity of 20,000 gallons or greater, nor does it contain a "tank battery" or "Storage facility".
20.2.39 NMAC	Sulfur Recovery Plant - Sulfur	N/A	N/A	No	X	Not applicable. Hobbs is not a Sulfur Recovery Plant.
20.2.61.109 NMAC	Smoke & Visible Emissions		HOBB-1, HOBB-2, DB-1, DB-2, FH-1, FH-2, FH-3, G-1 and FP-1	No		Hobbs CTGs, HRSG duct burners, fuel gas heaters, standby generator and diesel fire pump will not cause visible emissions to equal or exceed an opacity of 20%.
20.2.70 NMAC	Operating Permits	X	All	Yes		Hobbs operates under Operating Permit No. P244-M4. The facility is a major source for NOx, CO, PM_{10}/$PM_{2.5}$ and CO_2e.
20.2.71 NMAC	Operating Permit Fees	X	All	Yes		Hobbs is subject to 20.2.70 NMAC and is therefore subject to 20.2.71 NMAC.
20.2.72 NMAC	Construction Permits	X	All	Yes		Hobbs is subject to 20.2.72 NMAC and NSR Permit number: PSD 3449-M3.
20.2.73 NMAC	NOI & Emissions Inventory Requirements	X	All	Yes		**Emissions Inventory Reporting:** 20.2.73.300 NMAC applies. All Title V major sources meet the applicability requirements of 20.2.73.300 NMAC.

STATE REGU-LATIONS **CITATION**	**Title**	**Applies to Entire Facility**	**Applies to Unit No(s).**	**Federally Enforce-able**	**Does Not Apply**	**JUSTIFICATION:** **Identify the applicability criteria, numbering each (i.e. 1. Post 7/23/84, 2. 75 m^3, 3. VOL)**
20.2.74 NMAC	Permits – PSD	X	All	Yes		Hobbs is a PSD major source as defined by: (1) Any stationary source listed in 20.2.74.501 NMAC Table 1 (i.e., fossil fuel-fired steam electric facilities greater than 250 MMBtu) which emits, or has the potential to emit, emissions equal to or greater than 100 tons per year of any regulated pollutant.
20.2.75 NMAC	Construction Permit Fees	X	All	Yes		This facility is subject to 20.2.72 NMAC and is in turn subject to 20.2.75 NMAC. N/A if subject to 20.2.71 NMAC.
20.2.77 NMAC	New Source Performance		HOBB-1, HOBB-2, G-1	Yes		Hobbs is a stationary source subject to the requirements of 40 CFR Part 60, as amended through September 23, 2013.
20.2.78 NMAC	Emission Standards for HAPS	X	N/A	Yes		Under normal operating conditions the site is not subject to 40 CFR Part 61. Refer to Table 13-2 40 CFR Part 61 Subpart M for further discussion.
20.2.79 NMAC	Permits – Nonattainment Areas	N/A	N/A	Yes	X	Not applicable. Hobbs is located in Lea County, an attainment area for all regulated pollutants.
20.2.80 NMAC	Stack Heights	N/A	N/A	Yes	X	Not cited as applicable in NSR Permit PSD 3449-M3.
20.2.82 NMAC	MACT Standards for source categories of HAPS		G-1, FP-1	Yes		Hobbs is a minor source of hazardous air pollutants. The standby generator and fire water pump are subject to 40 CFR 63 Subpart ZZZZ.

Table 13–3 Applicable Federal Regulations

FEDERAL REGU-LATIONS **CITATION**	**Title**	Applies to **Entire Facility**	Applies to **Unit No(s).**	**Federally Enforce-able**	**Does Not Apply**	**JUSTIFICATION:**
40 CFR 50	NAAQS	X	N/A	Yes		Defined as applicable at 20.2.70.7.E.11. Any national ambient air quality standard. Not directly applicable to individual emission sources.
NSPS 40 CFR 60, Subpart A	General Provisions		HOBB-1, HOBB-2, DB-1, DB-2, G-1	Yes		Hobbs CTGs and HRSG duct burners are subject to 40 CFR 60 Subpart KKKK. Hobbs standby generator is subject to 40 CFR 60 Subpart IIII; therefore, these units are also subject to 40 CFR 60 Subpart A - General Provisions.
NSPS 40 CFR 60.40a Subpart Da	Subpart Da, Performance Standards for **Electric Utility Steam Generating Units**	N/A	N/A	Yes	X	Not applicable. Emissions from the HRSG duct burners are subject to 40 CFR 60 Subpart KKKK and therefore are exempt from the requirements of Subpart Da.
NSPS 40 CFR 60.40b Subpart Db	**Electric Utility Steam Generating Units**	N/A	N/A	Yes	X	Not applicable. Emissions from the HRSG duct burners are subject to 40 CFR 60 Subpart KKKK and therefore are exempt from the requirements of Subpart Db.

FEDERAL REGU-LATIONS CITATION	Title	Applies to Entire Facility	Applies to Unit No(s).	Federally Enforce-able	Does Not Apply	JUSTIFICATION:
NSPS 40 CFR 60, Subpart Ka	Standards of Performance for **Storage Vessels for Petroleum Liquids** for which Construction, Reconstruction, or Modification Commenced After May 18, 1978, and **Prior** to July 23, 1984	N/A	N/A	Yes	X	Not applicable. Hobbs has no petroleum liquid storage vessels subject to this regulation.
NSPS 40 CFR 60, Subpart Kb	Standards of Performance for **Volatile Organic Liquid Storage Vessels** (Including Petroleum Liquid Storage Vessels) for Which Construction, Reconstruction, or Modification Commenced **After** July 23, 1984	N/A	N/A	Yes	X	Not applicable. Hobbs does not have storage vessels with a capacity greater than or equal to 75 cubic meters that is used to store volatile organic liquids (VOL) for which construction, reconstruction, or modification is commenced after July 23, 1984.
NSPS 40 CFR 60.330 Subpart GG	**Stationary Gas Turbines**	N/A	N/A	Yes	X	Units HOBB-1 and HOBB-2 have a heat input equal to 1,697 MMBtu/hour (nominal), which is greater than the 10 MMBtu/hour threshold. These units were manufactured on 2007 which is after the October 3, 1977 applicability date.
NSPS 40 CFR 60, Subpart KKK	Leaks of VOC from **Onshore Gas Plants**	N/A	N/A	Yes	X	Not applicable. Hobbs is not an Onshore Gas Plant.
NSPS 40 CFR 60 Subpart LLL	Standards of Performance for **Onshore Natural Gas Processing:** SO_2 Emissions	N/A	N/A	Yes	X	Not applicable. Hobbs is not an Onshore Natural Gas Processing plant.
NSPS 40 CFR 60, Subpart IIII	Standards of Performance for Stationary Compression Ignition Internal Combustion Engines		G-1	Yes		Hobbs Diesel Standby Generator was manufactured after July 1, 2006 and is not a fire pump engine. Therefore, this unit is subject to the provisions of NSPS IIII, (§60.4200(a)(2)(i)). Hobbs Diesel Fire Water Pump, was manufactured and constructed in 2011, before all applicable trigger dates in the rule; therefore, it is not subject to NSPS IIII.
NSPS 40 CFR Part 60 Subpart JJJJ	Standards of Performance for Stationary Spark Ignition Internal Combustion Engines	N/A	N/A	Yes	X	Not applicable. Hobbs is not equipped with any stationary spark ignition internal combustion engine.

FEDERAL REGU-LATIONS CITATION	Title	Applies to Entire Facility	Applies to Unit No(s).	Federally Enforce-able	Does Not Apply	JUSTIFICATION:
NSPS 40 CFR 60, Subpart KKKK	Stationary Combustion Turbines		HOBB-1, HOBB-2, DB-1, DB-2	Yes		HOBB-1 and HOBB-2 are stationary combustion turbines with a heat input at peak load greater than 10 MMBtu/hr (HHV) and commenced construction after February 18, 2005. Therefore, the units are subject to the provisions of NSPS KKKK. The HRSG duct burners are also subject to the provisions of NSPS KKKK.
NSPS 40 CFR 60 Subpart OOOO	Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution	N/A	N/A	Yes	X	Not applicable. Hobbs is not a Crude Oil and Natural Gas Production, Transmission and Distribution facility.
NSPS 40 CFR 60 Subpart TTTT	Standards of Performance for Greenhouse Gas Emissions for Electric Generating Units	N/A	N/A	Yes	X	Not applicable. Modification date predates NSPS applicability date.
NSPS 40 CFR 60 Subpart UUUU	Emissions Guidelines for Greenhouse Gas Emissions and Compliance Times for Electric Utility Generating Units	N/A	N/A	Yes	X	Not applicable. Hobbs is not an Electric Utility Generating Unit.
NESHAP 40 CFR 61 Subpart A	General Provisions	X Potentially	Asbestos Demolition	Yes		Potentially Hobbs could be subject to 40 CFR 61 Subpart M. Refer to discussion below.
NESHAP 40 CFR 61 Subpart E	National Emission Standards for **Mercury**	N/A	N/A	Yes	X	Not applicable. This facility does not process mercury.
NESHAP 40 CFR 61 Subpart M	National Emission Standards for Asbestos	X Potentially	Asbestos Demolition	Yes		Not applicable during routine operation conditions. In the case of asbestos demolition, NESHAP M will apply.
NESHAP 40 CFR 61 Subpart V	National Emission Standards for Equipment Leaks (Fugitive Emission Sources)	N/A	N/A	Yes	X	Not applicable. Hobbs does not operate any sources in volatile hazardous air pollutant (VHAP) service.
MACT 40 CFR 63, Subpart A	General Provisions		G-1 FP-1 T-9	Yes		The Hobbs Diesel Standby Generator and Diesel Fire Water Pump are subject to MACT Subpart ZZZZ, and the gasoline storage tank is subject to MACT Subpart CCCCCC, therefore these sources must comply with the requirements of MACT Subpart A.

FEDERAL REGU-LATIONS CITATION	Title	Applies to Entire Facility	Applies to Unit No(s).	Federally Enforce-able	Does Not Apply	JUSTIFICATION:
MACT 40 CFR 63.760 Subpart HH	Oil and Natural Gas Production Facilities	N/A	N/A	Yes	X	Not applicable. Hobbs is not an Oil and Natural Gas Production facility.
MACT 40 CFR 63 Subpart HHH	Natural Gas Transmission and Storage Facilities	N/A	N/A	Yes	X	Not applicable. Hobbs is not a natural gas transmission and storage facility.
MACT 40 CFR 63 Subpart ZZZZ	Stationary Reciprocating Internal Combustion Engines (RICE MACT)	N/A	G-1 FP-1	Yes		Hobbs Diesel Standby Generator (G-1) is a new (emergency) stationary RICE at an area source of HAPs. Per §63.6590(c)(1), G-1 meets the requirements of MACT ZZZZ by meeting the requirements of NSPS IIII. Hobbs Diesel Fire Water Pump (FP-1) is an existing emergency RICE at an area source of HAPs and must comply with the requirements of MACT ZZZZ as of May 3, 2013.
MACT 40 CFR 63 Subpart DDDDD	National Emission Standards for Hazardous Air Pollutants for Major Industrial, Commercial, and Institutional Boilers & Process Heaters	N/A	N/A	Yes	X	Not applicable. No major boilers and/or process heaters are located at Hobbs.
MACT 40 CFR 63 Subpart UUUUU	National Emission Standards for Hazardous Air Pollutants Coal & Oil Fire Electric Utility Steam Generating Unit	N/A	N/A	Yes	X	Not applicable. Hobbs is not a coal and oil fire electric utility steam generating unit.
MACT 40 CFR 63 Subpart CCCCCC	Gasoline Dispensing Facilities	N/A	T-9	Yes		The affected source is located at an area source of HAPs. The proposed gasoline storage tank (T-9) will have a monthly throughput of less than 10,000 gallons of gasoline, and therefore, T-9 must comply with the requirements in §63.11116, which include: (1) minimize gasoline spills; (2) clean up spills as expeditiously as practicable; (3) cover all open gasoline containers and all gasoline storage tank fill-pipes with a gasketed seal when not in use; and (4) minimize gasoline sent to open waste collection systems.
NESHAP 40 CFR 64	**Compliance Assurance Monitoring**	N/A	N/A	Yes	X	Hobbs CTGs/HRSG exhaust stacks are equipped with a CEMS that satisfy the CAM exemption requirements (§64.2(b)(1)(vi)).
NESHAP 40 CFR 68	**Chemical Accident Prevention**	N/A	N/A	Yes	X	Not applicable. Hobbs does not manufacture, process, use, store, or otherwise handle regulated substances in excess of the quantities specified in 10 CFR 68.
Title IV – Acid Rain 40 CFR 72	**Acid Rain**		HOBB-1, HOBB-2	Yes		Hobbs CTGs are subject to the requirements of the Acid Rain Program.

FEDERAL REGU-LATIONS CITATION	**Title**	Applies to **Entire Facility**	Applies to **Unit No(s).**	**Federally Enforce-able**	**Does Not Apply**	**JUSTIFICATION:**
Title IV – Acid Rain 40 CFR 73	**Sulfur Dioxide** Allowance Emissions		HOBB-1, HOBB-2	Yes		Hobbs must obtain SO_2 calendar year allowances.
Title IV – Acid Rain 40 CFR 75	Continues Emission Monitoring (CEM)		HOBB-1, HOBB-2	Yes		Hobbs CTG/HRSG exhaust stack is equipped with a CEMS for NOx, CO and O_2.
Title IV – Acid Rain 40 CFR 76	**Acid Rain** Nitrogen Oxides **Emission Reduction Program**		N/A	Yes	X	Hobbs is not subject to the acid rain nitrogen oxides emission reduction program.
Title VI – 40 CFR 82	Protection of Stratospheric Ozone	X	N/A	Yes		Hobbs equipment includes appliances containing CFCs and is therefore subject to the requirements of 40 CFR 82. Hobbs uses only certified technicians for the maintenance, service, repair and disposal of these appliances and maintains the appropriate records.

Section 14

Operational Plan to Mitigate Emissions

(Submitting under 20.2.70, 20.2.72, 20.2.74 NMAC)

☐ **Title V Sources** (20.2.70 NMAC)**:** By checking this box and certifying this application the permittee certifies that it has developed an **Operational Plan to Mitigate Emissions During Startups, Shutdowns, and Emergencies** defining the measures to be taken to mitigate source emissions during startups, shutdowns, and emergencies as required by 20.2.70.300.D.5(f) and (g) NMAC. This plan shall be kept on site to be made available to the Department upon request. This plan should not be submitted with this application.

☒ **NSR** (20.2.72 NMAC)**, PSD** (20.2.74 NMAC) **& Nonattainment** (20.2.79 NMAC) **Sources:** By checking this box and certifying this application the permittee certifies that it has developed an **Operational Plan to Mitigate Source Emissions During Malfunction, Startup, or Shutdown** defining the measures to be taken to mitigate source emissions during malfunction, startup, or shutdown as required by 20.2.72.203.A.5 NMAC. This plan shall be kept on site to be made available to the Department upon request. This plan should not be submitted with this application.

☒ **Title V** (20.2.70 NMAC)**, NSR** (20.2.72 NMAC)**, PSD** (20.2.74 NMAC) **& Nonattainment** (20.2.79 NMAC) **Sources:** By checking this box and certifying this application the permittee certifies that it has established and implemented a Plan to Minimize Emissions During Routine or Predictable Startup, Shutdown, and Scheduled Maintenance through work practice standards and good air pollution control practices as required by 20.2.7.14.A and B NMAC. This plan shall be kept on site or at the nearest field office to be made available to the Department upon request. This plan should not be submitted with this application.

Startup and shutdown procedures are either based on manufacturer's recommendations and/or based on HGS' operating experience. These procedures are designed to proactively address the potential for malfunction to the greatest extent possible. These procedures dictate a sequence of operations that are designed to minimize emissions from the facility during events that result in shutdown and subsequent startup.

HGS equipment incorporates various safety devices and features that aid in the prevention of excess emissions in the event of an operational emergency. If an operational emergency does occur and excess emissions occur, Hobbs will submit the required Excess Emissions Report as per 20.2.7 NMAC. Corrective action to eliminate the excess emissions and prevent recurrence in the future will be undertaken as quickly as safety allows.

Section 15

Alternative Operating Scenarios

(Submitting under 20.2.70, 20.2.72, 20.2.74 NMAC)

Alternative Operating Scenarios: Provide all information required by the department to define alternative operating scenarios. This includes process, material and product changes; facility emissions information; air pollution control equipment requirements; any applicable requirements; monitoring, recordkeeping, and reporting requirements; and compliance certification requirements. Please ensure applicable Tables in this application are clearly marked to show alternative operating scenario.

Construction Scenarios: When a permit is modified authorizing new construction to an existing facility, NMED includes a condition to clearly address which permit condition(s) (from the previous permit and the new permit) govern during the interval between the date of issuance of the modification permit and the completion of construction of the modification(s). There are many possible variables that need to be addressed such as: Is simultaneous operation of the old and new units permitted and, if so for example, for how long and under what restraints? In general, these types of requirements will be addressed in Section A100 of the permit, but additional requirements may be added elsewhere. Look in A100 of our NSR and/or TV permit template for sample language dealing with these requirements. Find these permit templates at: https://www.env.nm.gov/aqb/permit/aqb_pol.html. Compliance with standards must be maintained during construction, which should not usually be a problem unless simultaneous operation of old and new equipment is requested.

In this section, under the bolded title "Construction Scenarios", specify any information necessary to write these conditions, such as: conservative-realistic estimated time for completion of construction of the various units, whether simultaneous operation of old and new units is being requested (and, if so, modeled), whether the old units will be removed or decommissioned, any PSD ramifications, any temporary limits requested during phased construction, whether any increase in emissions is being requested as SSM emissions or will instead be handled as a separate Construction Scenario (with corresponding emission limits and conditions, etc.

Not applicable, HGS does not have an alternative operating scenario.

Section 16

Air Dispersion Modeling

1) Minor Source Construction (20.2.72 NMAC) and Prevention of Significant Deterioration (PSD) (20.2.74 NMAC) ambient impact analysis (modeling): Provide an ambient impact analysis as required at 20.2.72.203.A(4) and/or 20.2.74.303 NMAC and as outlined in the Air Quality Bureau's Dispersion Modeling Guidelines found on the Planning Section's modeling website. If air dispersion modeling has been waived for one or more pollutants, attach the AQB Modeling Section modeling waiver approval documentation.
2) SSM Modeling: Applicants must conduct dispersion modeling for the total short term emissions during routine or predictable startup, shutdown, or maintenance (SSM) using realistic worst case scenarios following guidance from the Air Quality Bureau's dispersion modeling section. Refer to "Guidance for Submittal of Startup, Shutdown, Maintenance Emissions in Permit Applications (http://www.env.nm.gov/aqb/permit/app_form.html) for more detailed instructions on SSM emissions modeling requirements.
3) Title V (20.2.70 NMAC) ambient impact analysis: Title V applications must specify the construction permit and/or Title V Permit number(s) for which air quality dispersion modeling was last approved. Facilities that have only a Title V permit, such as landfills and air curtain incinerators, are subject to the same modeling required for preconstruction permits required by 20.2.72 and 20.2.74 NMAC.

What is the purpose of this application?	Enter an X for each purpose that applies
New PSD major source or PSD major modification (20.2.74 NMAC). See #1 above.	X
New Minor Source or significant permit revision under 20.2.72 NMAC (20.2.72.219.D NMAC). See #1 above. **Note:** Neither modeling nor a modeling waiver is required for VOC emissions.	
Reporting existing pollutants that were not previously reported.	
Reporting existing pollutants where the ambient impact is being addressed for the first time.	
Title V application (new, renewal, significant, or minor modification. 20.2.70 NMAC). See #3 above.	
Relocation (20.2.72.202.B.4 or 72.202.D.3.c NMAC)	
Minor Source Technical Permit Revision 20.2.72.219.B.1.d.vi NMAC for like-kind unit replacements.	
Other: i.e. SSM modeling. See #2 above.	
This application does not require modeling since this is a No Permit Required (NPR) application.	
This application does not require modeling since this is a Notice of Intent (NOI) application (20.2.73 NMAC).	
This application does not require modeling according to 20.2.70.7.E(11), 20.2.72.203.A(4), 20.2.74.303, 20.2.79.109.D NMAC and in accordance with the Air Quality Bureau's Modeling Guidelines.	

Check each box that applies:

☐ See attached, approved modeling **waiver for all** pollutants from the facility.
☒ See attached, approved modeling **waiver for some** pollutants from the facility.
☐ Attached in Universal Application Form 4 (UA4) is a **modeling report for all** pollutants from the facility.
☒ Attached in UA4 is a **modeling report for some** pollutants from the facility.
☐ No modeling is required.

Universal Application 4

Air Dispersion Modeling Report

Refer to and complete Section 16 of the Universal Application form (UA3) to assist your determination as to whether modeling is required. If, after filling out Section 16, you are still unsure if modeling is required, e-mail the completed Section 16 to the AQB Modeling Manager for assistance in making this determination. If modeling is required, a modeling protocol would be submitted and approved prior to an application submittal. The protocol should be emailed to the modeling manager. A protocol is recommended but optional for minor sources and is required for new PSD sources or PSD major modifications. Fill out and submit this portion of the Universal Application form (UA4), the "Air Dispersion Modeling Report", only if air dispersion modeling is required for this application submittal. This serves as your modeling report submittal and should contain all the information needed to describe the modeling. No other modeling report or modeling protocol should be submitted with this permit application.

16-A: Identification

1	Name of facility: **Hobbs Generating Station**
2	Name of company: **Lea Power Partners, LLC**
3	Current Permit number: **PSD 3449-M4**
4	Name of applicant's modeler: **Martin R. Schluep, Alliant Environmental, LLC**
5	Phone number of modeler: **(505) 205-4819**
6	E-mail of modeler: **mschluep@alliantenv.com**

16-B: Brief

1	Why is the modeling being done? **Other (describe below)** **This turbine upgrade project constitutes a major modification under PSD rules.**
2	Describe the permit changes relevant to the modeling. **Mitsubishi Hitachi Power System Americas (MHPSA) proposes to upgrade the two existing combustion turbines to the F4+ compressor upgrade at the Hobbs Generating Station (HGS). The upgrade consists of replacing the Inlet Guide Vanes (IGVs) and first six stages of the compressor, resulting in increased air flow. The expected impact of the upgrade on performance is an increase of 5% in output, no change in heat rate, and a 6.7% increase in turbine exhaust flow. As a result, permitted annual NO_2 and SO_2 emissions as well as hourly and annual TSP/PM_{10}/$PM_{2.5}$ emissions will increase.**
3	What geodetic datum was used in the modeling? **NAD83**
4	How long will the facility be at this location? **Indefinitely**

5	Is the facility a major source with respect to Prevention of Significant Deterioration (PSD)?	Yes **X**	No
6	Identify the Air Quality Control Region (AQCR) in which the facility is located. **155**		
7	List the PSD baseline dates for this region (minor or major, as appropriate). **Minor:** **SO_2: 7/28/1978** **PM_{10}: 2/20/1979** **$PM_{2.5}$: 11/13/2013** **Major:** **NO_2: 2/8/1988**		
8	Provide the name and distance to Class I areas within 50 km of the facility (300 km for PSD permits). **Three Class I areas within 300 km:** - **The Carlsbad Caverns National Park (CCNP) is the closest at 117 km from the HGS,** - **The Guadalupe Mountains National Park (GMNP) at 170 km, and** - **The Salt Creek Wilderness Area (SCWA) at 140 km from the HGS.**		
9	Is the facility located in a non-attainment area? If so, describe. **No**		
10	Describe any special modeling requirements, such as streamline permit requirements. **N/A**		

16-C: Modeling History of Facility

1	Describe the modeling history of the facility, including the air permit numbers, the pollutants modeled, the National Ambient Air Quality Standards (NAAQS), New Mexico AAQS (NMAAQS), and PSD increments modeled. (Do not include modeling waivers).			
	Pollutant	Latest permit and modification number that modeled the pollutant facility-wide.	Date of Permit	Comments
	CO	PSD-3449-M2	2014	
	NO_2	PSD-3449-M2	2014	
	SO_2	PSD-3449-M2	2014	
	H_2S	N/A	N/A	
	PM2.5	PSD-3449-M2	2014	
	PM10	PSD-3449-M2	2014	
	TSP	PSD-3449-M2	2014	
	Lead	N/A	N/A	
	Ozone (PSD only)	N/A	N/A	
	NM Toxic Air Pollutants (20.2.72.402 NMAC)	N/A	N/A	

16-D: Modeling performed for this application

1	For each pollutant, indicate the modeling performed and submitted with this application. Choose the most complicated modeling applicable for that pollutant, i.e., culpability analysis assumes ROI and cumulative analysis were also performed.					
	Pollutant	ROI	Cumulative analysis	Culpability analysis	Waiver approved	Pollutant not emitted or not changed.
	CO				**X**	**X**

	NO_2 (1-hr)				**X**	**X**
	NO_2 (annual)			**X**		
	SO_2 (1-,3-,24-hr)					**X**
	SO_2 (annual)			**X**		
	H_2S					**X**
	PM2.5			**X**		
	PM10			**X**		
	TSP			**X**		
	Lead					**X**
	Ozone					**X**
	State air toxic(s) (20.2.72.402 NMAC)					**X (NH_3 no change)**

16-E: New Mexico toxic air pollutants modeling

1	List any New Mexico toxic air pollutants (NMTAPs) from Tables A and B in 20.2.72.502 NMAC that are modeled for this application. **N/A**
	List any NMTAPs that are emitted but not modeled because stack height correction factor. Add additional rows to the table below, if required.

	Pollutant	Emission Rate (pounds/hour)	Emission Rate Screening Level (pounds/hour)	Stack Height (meters)	Correction Factor	Emission Rate/ Correction Factor

16-F: Modeling options

1	What model(s) were used for the modeling? Why? **The EPA approved AERMOD model was used per the NMED Air Quality Bureau Air Dispersion Modeling Guideline (Revised August 8, 2017) and as listed in the previously submitted Modeling Protocol to NMED. The facility-wide air dispersion modeling was performed using BEE-line Software's latest version of BEEST for Windows AERMOD model (Version 11.12).**
2	What model options were used and why were they considered appropriate to the application? **The AERMOD model was executed using the regulatory default options (stack-tip downwash, buoyancy induced dispersion, final plume rise), default wind speed profile categories, default potential temperature gradients, no pollutant decay, and no flagpole option.**

	The selection of the appropriate dispersion coefficients used in the modeling analysis were based on the classification method defined by Auer (1978). This method considers the dispersion coefficients to be rural or urban depending on the land use within three kilometers (km) of the facility if greater than 50% meets certain land use or zoning classifications. Based on the site location (see area map), the rural dispersion was selected. **The Elevated Terrain mode was used and receptor elevations were calculated within the model based on elevations obtained from 7.5 minute United States Geological Survey (USGS) National Elevation Data (NED) files for the applicable region.** **Source Group models were set up as suggested by NMED's modeling guidance as follows:** • **Source alone group – all sources at the facility used to compare with significant Impact Levels (SILs) for the pollutant and averaging period being modeled. This group determined if the facility is above significance levels at the location and time for total project emissions increases only.** **Affected sources: HOBBS-1 + DB-1 and HOBBS-2 + DB-2 (turbines and duct burners)** **An initial site specific and site and project-only source model for short term and long term averaging periods for each pollutant with proposed emissions increases was initially performed. All modeled impacts from project emissions increases for each pollutant were below the SILs and PSD Class I Increment SILs. Therefore, no further modeling analysis was required.** **Modeled Sources:** **The turbine and duct burner stacks were modeled as point sources using stack specific parameters (height, diameter, exhaust temperature and velocity).**

16-G: Surrounding source modeling

1	If the surrounding source inventory provided by the Air Quality Bureau was believed to be inaccurate, describe how the sources modeled differ from the inventory provided. If changes to the surrounding source inventory were made, use the unmerged list of sources to describe the changes. **N/A**	
2	Date of surrounding source retrieval. **N/A**	
	AQB Source ID	Description of Corrections

16-H: Building and structure downwash

1	How many buildings are present at the facility?	**16 buildings, including tanks**	
2	How many above ground storage tanks are present at the facility?	**5 above ground storage tanks**	
3	Was building downwash modeled for all buildings?	Yes **X**	No
4	If not, explain why.		

5	Building comments

16-I: Receptors and modeled property boundary

1	"Restricted Area" is an area to which public entry is effectively precluded. Effective barriers include continuous fencing, continuous walls, or other continuous barriers approved by the Department, such as rugged physical terrain with a steep grade that would require special equipment to traverse. If a large property is completely enclosed by fencing, a restricted area within the property may be identified with signage only. Public roads cannot be part of a Restricted Area. A Restricted Area is required in order to exclude receptors from the facility property. If the facility does not have a Restricted Area, then receptors shall be placed within the property boundaries of the facility. Describe the fence or other physical barrier at the facility that defines the restricted area. **A fence surrounds the property boundary.**		
2	Receptors must be placed along publicly accessible roads in the restricted area. Are there public roads passing through the restricted area?	Yes	No **X**
3	Are restricted area boundary coordinates included in the modeling files?	Yes	No **X**
4	Describe the receptor grids and their spacing. • **Receptors along the fenceline were placed every 50 meters and 50 meters outward.** • **A rectangular fine grid receptor array was placed at 100- by 100-meter spacing from the fenceline outward to 1000 meters in all directions.** • **A medium receptor grid was placed at 250- by 250-meter spacing from the fine grid to areas beyond 2500 meters from the facility.** • **A coarse receptor was placed at 500- by 500-meter spacing from the medium grid to areas beyond 5,000 meters from the facility.** • **A coarse receptor was placed at 1000- by 1000-meter spacing from the medium grid to areas beyond 10,000 meters from the facility.**		
5	Describe receptor spacing along the fence line. **Fenceline receptors were placed along the facility boundary every 50-meters in linear fenceline distance.**		
6	Describe the PSD Class I area receptors. **One receptor each was placed at the near boundary of the Class I area (CCNP, GMNO, and SCWA).**		

16-J: Sensitive areas

1	Are there schools or hospitals or other sensitive areas near the facility? This information is optional (and purposely undefined), but may help determine issues related to public notice.	Yes	No **X**
2	If so, describe.		
3	The modeling review process may need to be accelerated if there is a public hearing. Are there likely to be public comments opposing the permit application?	Yes	No **X**

16-K: Modeling Scenarios

1	Identify, define, and describe all modeling scenarios. Examples of modeling scenarios include using different production rates, times of day, times of year, simultaneous or alternate operation of old and new equipment during transition periods, etc. Alternative operating scenarios should correspond to all parts of the Universal Application and should be fully described in Section 15 of the Universal Application (UA3). **Two scenarios were modeled for the SILs the Class I PSD Increment SIL analyses:** **1. Short term for all 24-hour averaging periods for TSP/PM10/PM2.5** 2. **Long Term for all annual averaging periods (NO_2, SO_2 and TSP/PM_{10}/$PM_{2.5}$)**		
2	Which scenario produces the highest concentrations? Why? **All scenarios have low impacts and are below the SILs.**		
3	Were emission factor sets used to limit emission rates or hours of operation? (This question pertains to the "SEASON", "MONTH", "HROFDY" and related factor sets, not to the factors used for calculating the maximum emission rate.)	Yes	No **X**
4	If so, describe factors for each group of sources. List the sources in each group before the factor table for that group. (Modify or duplicate table as necessary. It's ok to put the table below section 16-K if it makes formatting easier.) Sources: **N/A**		

5

Hour of Day	Factor	Hour of Day	Factor								
1		13									
2		14									
3		15									
4		16									
5		17									
6		18									
7		19									
8		20									
9		21									
10		22									
11		23									
12		24									

If hourly, variable emission rates were used that were not described above, describe them here:

6	Were different emission rates used for short-term and annual modeling?	Yes **X**	No
7	If yes, describe. **TSP/PM_{10}/$PM_{2.5}$ hourly emission rates are based on rolling 24-hour average, calculation based on emission factor determined from compliance test data. Annual TSP/PM_{10}/$PM_{2.5}$ emissions are based on daily rolling 365-day total.**		

16-L: NO_2 Modeling

1	Which types of NO_2 modeling were used? Check all that apply.	
		100% NO_X to NO_2 conversion
		ARM
		PVMRM
		OLM
	X	ARM2
		Other:
2	Describe the NO_2 modeling. **The Tier 2 Ambient Ratio Method 2 (ARM2) Technique was applied using default minimum and maximum ratios. The highest impact (high first high) from the three years of meteorological data was used to compare against the SILs**	
3	In-stack NO_2/NO_X ratio(s) used in modeling. **Default 0.5 minimum and 0.9 maximum values.**	
4	Equilibrium NO_2/NO_X ratio(s) used in modeling. **N/A**	
5	Describe/justify the use of the ratios chosen. **The default allowable (no justification required) ratios were chosen.**	
6	Describe the design value used for each averaging period modeled. **Annual: High first high**	

16-M: Particulate Matter Modeling

1	Select the pollutants for which plume depletion modeling was used.			
		PM2.5		
		PM10		
		TSP		
	X	None		
2	Describe the particle size distributions used. **N/A** Include the source of information.			
3	Was secondary PM modeled for PM2.5? Only required for PSD major modifications that are significant for NOx and/or SOx. Optional for minor sources, but allows use of high eighth high.		Yes	No **X**
	This application is a major PSD modification only for TSP/PM_{10}/$PM_{2.5}$ and CO_2e			

16-N: Setback Distances and Source Classification

1	Portable sources or sources that need flexibility in their site configuration requires that setback distances be determined between the emission sources and the restricted area boundary (e.g. fence line) for both the initial location and future locations. Describe the setback distances for the initial location. **N/A**
2	Describe the requested, modeled, setback distances for future locations, if this permit is for a portable stationary source.

	Include a haul road in the relocation modeling. **N/A**		
3	The unit numbers in the Tables 2-A, 2-B, 2-C, 2-E, 2-F, and 2-I should match the ones in the modeling files. Do these match?	Yes **X**	No
4	Provide a cross-reference table between unit numbers if they do not match. It's ok to place the table below section 16-N for easier formatting.		
5	The emission rates in the Tables 2-E and 2-F should match the ones in the modeling files. Do these match?	Yes **X**	No
6	If not, explain why.		
7	Have the minor NSR exempt sources or Title V Insignificant Activities" (Table 2-B) sources been modeled?	Yes	No **X**
8	Which units consume increment for which pollutants? **None, all modeled proposed emissions increases were below their specific SILs.**		
9	PSD increment description for sources. (for unusual cases, i.e., baseline unit expanded emissions after baseline date). **N/A, no unusual case for this application.**		
10	Are all the actual installation dates included in Table 2A of the application form, as required? This is necessary to verify the accuracy of PSD increment modeling.	Yes **X**	No
11	If not please explain how increment consumption status is determined for the missing installation dates.		

16-O: Flare Modeling

1	For each flare or flaring scenario, complete the following: **N/A, no flare at this site**			
	Flare ID (and scenario)	Average Molecular Weight	Gross Heat Release (cal/s)	Effective Flare Diameter (m)

16-P: Volume and Related Sources

1	Were the dimensions of volume sources different from standard dimensions in the Air Quality Bureau (AQB) Modeling Guidelines? **N/A, no volume sources included in model**	Yes	No
2	If the dimensions of volume sources are different from standard dimensions in the AQB Modeling Guidelines, describe how the dimensions were determined.		
3	Describe the determination of sigma-Y and sigma-Z for fugitive sources.		
4	Describe how the volume sources are related to unit numbers. Or say they are the same.		
5	Describe any open pits. **N/A**		
6	Describe emission units included in each open pit. **N/A**		

16-Q: Background Concentrations

1	Identify and justify the background concentrations used. **N/A, all emissions increases were modeled below their specific SILs**		
2	Were background concentrations refined to monthly or hourly values? **N/A**	Yes	No

16-R: Meteorological Data

1	Identify and justify the meteorological data set(s) used. **The three-year (2013-2015) meteorological data set, HOBBS_Artesia-NWS_Midland-ua, as provided by NMED on the modeling website, was used, as discussed in the submitted and approved modeling protocol. This data set best represents the meteorological data for the site location.**
2	Discuss how missing data were handled, how stability class was determined, and how the data were processed, if the Bureau did not provide the data. **N/A, used NMED's met data set.**

16-S: Terrain

1	Was complex terrain used in the modeling? If no, describe why. **Yes, complex terrain was used.**
2	What was the source of the terrain data? **USGS NED data file (provided on disc)**

16-T: Modeling Files

1	Describe the modeling files:		
	File name (or folder and file name)	Pollutant(s)	Purpose (ROI/SIA, cumulative, culpability analysis, other)
	LPP_LT_SIL	**TSP/PM_{10}/$PM_{2.5}$, NO_2, SO_2 (Long Term, annual averaging periods)**	**Significant Impact Analysis**
	LPP_ST_SIL	**TSP/PM_{10}/$PM_{2.5}$, NO_2, SO_2 (Short Term, 24-hr averaging periods)**	**Significant Impact Analysis**
	LPP_LT_SIL_PSD	**TSP/PM_{10}/$PM_{2.5}$, NO_2, SO_2 (Long Term, annual averaging periods)**	**Class I PSD Increment Significant Impact Analysis**
	LPP_LT_SIL_PSD	**TSP/PM_{10}/$PM_{2.5}$, NO_2, SO_2 (Short Term, 24-hr averaging periods)**	**Class I PSD Increment Significant Impact Analysis**

16-U: PSD New or Major Modification Applications

1	A new PSD major source or a major modification to an existing PSD major source requires additional analysis. Was preconstruction monitoring done (see 20.2.74.306 NMAC and PSD Preapplication Guidance on the AQB website)? **A Preconstruction monitoring waiver was approved by NMED.**	Yes	No **X**
2	If not, did AQB approve an exemption from preconstruction monitoring?	Yes **X**	No
3	Describe how preconstruction monitoring has been addressed or attach the approved preconstruction monitoring or monitoring exemption. **See attached and approved preconstruction monitoring waiver.**		

4

Describe the additional impacts analysis required at 20.2.74.304 NMAC.

VISIBILITY IMPAIRMENT ANALYSIS

Visibility impairment may occur as a result of the scattering and absorption of light by particles and gases in the atmosphere. To assess the potential impact on Class I and Class II areas, industrial facilities are required to complete a visibility impairment analysis for their proposed sources.

Three Class I areas—the Carlsbad Caverns National Park (CCNP), Guadalupe Mountains National Park (GMNP) and Salt Creek Wilderness Area (SCWA) are located within 300 kilometers of the Hobbs Generating Station. Correspondence with the National Park Service (NPS) and with the U.S. Fish and Wildlife Service (USFWS), during initial construction permitting process (October 2006), concur that a Class I Impact Analysis was not required due to the distance to these areas.

The nearest Class I area to the HGS is the Carlsbad Caverns National Park located in Eddy County, NM, 117 km southwest of Hobbs. Since this Class I area is located at a distance greater than 100 km from the site, it may be assumed that the HGS has negligible impact at this distance. However, to assure that there are no impacts at "nearby" Class I areas, and based on pre-application meeting discussions with NMED, it is proposed to perform a Class I impacts analysis within 300km of the site. The Q/D test for Class I areas up to 300km was performed to assure that there will not be any issues with the Federal Land Managers mandate.

According to the "Federal Land Managers' Air Quality Related Values Work Group (FLAG) *Phase 1 Report—Revised (2010)*" (https://www.nature.nps.gov/air/Permits/flag/index.cfm) report, the initial screening criteria includes calculating a fixed Q/D factor for sources located greater than 50km from a Class I area; where "Q" is the total annual emission rate of the site's SO_2, NO_x, PM_{10}, and H_2SO_4 and "D" is the distance (in km) from the site to the Class I area. If Q/D is less than 10, the impacts on the Class I area are negligible.

Total proposed site-wide annual emission rates in tons per year (tpy):

SO_2: 21.5 lb/hr => 94 tpy

NO_x: 50.5 lb/hr => 221 tpy

PM_{10}: 36.3 lb/hr => 159 tpy

H_2SO_4: 34.0 lb/hr => 8 tpy

Total: 482 tpy

Total distance from the HGS to the nearest Class I area (Carlsbad Caverns National Park): 117km

Therefore Q/D = 482/117 = 4.1

	Since Q/D is less than 10, the impacts of the HGS on the Carlsbad Caverns or any other Class 1 Areas (greater distance from HGS) is negligible. **SOIL AND VEGETATION ANALYSES** **Sensitive soil and vegetation may be affected by the emission of certain air pollutants. The EPA developed the secondary NAAQS as a reference value for the protection from environmental damage that could be caused by certain air pollutants, including NO_x, particulate matter and sulfur dioxide (SO_2). It is considered that most soil types and vegetation will not be harmed by ground-level concentrations below the secondary NAAQS.** **As detailed in Section 6, NO_x short-term emission rates will not be increased above the currently permitted levels due to the proposed turbine upgrade. However, there will be an increase in annual emission rates. Air Dispersion Modeling results discussed in Form UA4 show that projected impact concentrations are below the significant Impact Level (SIL).** **WATER CONSUMPTION AND QUALITY ANALYSIS** **The proposed upgrade will not require an increase in the number of regular staff that operates and maintains the facility, nor will it require any additional industrial development. Therefore, the proposed project is not expected to have any effect on the water consumption or the quality of the water.**
5	If required, have ozone and secondary PM2.5 ambient impacts analyses been completed? **N/A, this application is a major modification for TSP/PM_{10}/$PM_{2.5}$ and CO_2e only.** **A facility is required to evaluate a MERP when an emissions analysis determines that emissions increases from a proposed project will exceed the PSD significance thresholds for ozone precursors (i.e., 40 tpy increases for either VOC and NO_X) and/or $PM_{2.5}$ (i.e., 10 tpy) and its precursors (i.e., 40 tpy increases for either SO_2 and NO_X). As stated in the approved Modeling Protocol, proposed VOC, NO_x, and SO_2 emissions increases do not trigger PSD review (tpy are below PSD SER). This was also discussed with NMED during the pre-application meeting.**

16-V: Modeling Results

1	If ambient standards are exceeded because of surrounding sources, a culpability analysis is required for the source to show that the contribution from this source is less than the significance levels for the specific pollutant. **No ambient standards are exceeded. The modeling results show that the project increases are below all SILs. Therefore, impacts from sources and associated emissions increases from this project and permit modification do not contribute to any exceedance of air quality standards or PSD increments.**
2	Identify the maximum concentrations from the modeling analysis.

Pollutant	Period	Facility Concentration (μg/m3)	Total Modeled Concentration (μg/m3)	Total Modeled Concentration (PPM)	Background Concentration	Cumulative Concentration	Standard (SIL)	Value of Standard	Units of Standard, Background, and Total	Percent of Standard
NO_2	**Annual**	**0.014**	**N/A**	**N/A**	**N/A**	**N/A**	**1.0**	**N/A**	**N/A**	**N/A**
SO_2	**Annual**	**0.008**	**N/A**	**N/A**	**N/A**	**N/A**	**1.0**	**N/A**	**N/A**	**N/A**
TSP/PM_{10}/$PM_{2.5}$	**Annual**	**0.016**	**N/A**	**N/A**	**N/A**	**N/A**	**0.2**	**N/A**	**N/A**	**N/A**
TSP/PM_{10}/$PM_{2.5}$	**24-hr**	**0.053**	**N/A**	**N/A**	**N/A**	**N/A**	**1.2**	**N/A**	**N/A**	**N/A**

16-W: Location of maximum concentrations

1	Identify the locations of the maximum concentrations.

Pollutant	Period	UTM East (m)	UTM North (m)	Elevation (ft)	Distance (m)	Radius of Impact (ROI) (m)
NO_2	**Annual**	**658,400**	**3,623,000**	**3,762**	**104 meters North of fenceline**	**0**
SO_2	**Annual**	**658,400**	**3,623,000**	**3,762**	**104 meters North of fenceline**	**0**
TSP/PM_{10}/$PM_{2.5}$	**Annual**	**658,400**	**3,623,000**	**3,762**	**104 meters North of fenceline**	**0**
TSP/PM_{10}/$PM_{2.5}$	**24-hr**	**658,600**	**3,623,000**	**3,760**	**104 meters North of fenceline**	**0**

16-X: Summary/conclusions

1	A statement that modeling requirements have been satisfied and that the permit can be issued. **This modeling analysis demonstrates that the proposed turbine upgrade project for the HGS as described in this report meets all N/NMAAQS and PSD increments.** **See Tables 16-X-1 through 16-X.6 for complete modeling results.**

Table 16-X.1 Project Emission Rate Increases

Units	Criteria Pollutant	Permitted Rates		Proposed Rates		Modeled Rates for SIL Comparison		Comments
		(lb/hr)[1]	(tpy)[2]	(lb/hr)	(tpy)	(lb/hr)	(tpy)	
Hobbs-1 + DB-1 and Hobbs-2 + DB-2	NO_2	193.2	181.0	193.2	190.1	**0.00**	**9.10**	Modeled 4.55 tpy increase for each unit to compare to annual SIL. No change in permitted and proposed lb/hr; therefore 1-hr NO2 was not modeled since previous model should compliance with NAAQS.
	SO_2	10.7	48.2	10.7	53.3	**0.00**	**5.10**	Modeled 2.55 tpy increase for each unit to compare to annual SIL. No change in permitted and proposed lb/hr; therefore 1-hr SO2 was not modeled since previous model should compliance with NAAQS.
	$TSP/PM_{10}/PM_{2.5}$	17.1	85.8	17.8	95.2	**0.70**	**9.40**	Modeled 0.7 lb/hr and 4.7 tpy increase for each unit to compare to 24-hr and annual SILs.
	CO	11.0	279.5	11.0	285.0	**0.00**	**5.50**	No hourly inccrease and previous model showed compliance with NAAQS. There is no annual NAAQS for CO.
	NH_3	32.1	281.3	32.1	281.3	**0.00**	**0.00**	No change, no annual or hourly increases proposed.

Notes:

[1] (lb/hr) each turbine + duct burner

[2] (tpy) combined both turbines + duct burners

Table 16-X.2 1Air Quality Impact Analysis (NM/NAAQS): Results

Units	Criteria Pollutant	Averaging Period	Significance Level (ug/m³)	NM/NAAQS (ug/m³)	GLC_{max} (ug/m³)	GLC_{max} from Project Impact < Significance Level? (ug/m³)
Hobbs-1 + DB-1 and Hobbs-2 + DB-2	NO_2	Annual	1.0	94	0.014	**Yes, no further analysis required**
	$PM_{2.5}$	24-hour	1.2	35	0.053	**Yes, no further analysis required**
	$PM_{2.5}$	Annual	0.2	12	0.016	**Yes, no further analysis required**
	PM_{10}	24-hour	5.0	150	0.053	**Yes, no further analysis required**
	PM_{10}	Annual	1.0	NA	0.016	**Yes, no further analysis required**
	TSP	24-hour	5.0	150	0.053	**Yes, no further analysis required**
	TSP	30-day	--	90	0.053	**Yes, no further analysis required**
	TSP	Annual	1.0	60	0.016	**Yes, no further analysis required**
	SO_2	Annual	1.0	52.4	0.008	**Yes, no further analysis required**

Note:

All modeled GLC_{max} concentrations for SIL comparison is highest met data year's high 1st high.

According to the New Mexico Air Quality Bureau Air Dispersion Modeling Guidelines (Revised Augist 8, 2017), Section 2.6.8 TSP Standards, there are no SILs for the 30-day or 7-day TSP averages. Assume that if a receptor is not significant for annual and 24-hour periods, then it's not significant for the other periods.

Table 16-X.3 PSD Class I Increment SIL Analysis: Carlsbad Cavern National Park

Units	Criteria Pollutant	Averaging Period	GLC_{max} (ug/m^3)	PSD Class I Increment (ug/m^3)	Below PSD Class I Increment?
Hobbs-1 + DB-1 and Hobbs-2 + DB-2	NO_2	Annual	0.00013	0.10	**Yes**
	$PM_{2.5}$	24-hour	0.00103	0.07	**Yes**
	$PM_{2.5}$	Annual	0.00015	0.06	**Yes**
	PM_{10}	24-hour	0.00103	0.30	**Yes**
	PM_{10}	Annual	0.00015	0.20	**Yes**
	SO_2	Annual	0.00008	0.10	**Yes**

Note:

All modeled GLC_{max} concentrations for SIL comparison is highest met data year's high 1st high.

PSD Class I Increment SIL per NMED Modeling Guidance.

Table 16-X.4 PSD Class I Increment SIL Analysis: Guadalupe Mountains National Park

Units	Criteria Pollutant	Averaging Period	GLC_{max} (ug/m^3)	PSD Class I Increment (ug/m^3)	Below PSD Class I Increment?
Hobbs-1 + DB-1 and Hobbs-2 + DB-2	NO_2	Annual	0.00002	0.10	**Yes**
	$PM_{2.5}$	24-hour	0.00015	0.07	**Yes**
	$PM_{2.5}$	Annual	0.00002	0.06	**Yes**
	PM_{10}	24-hour	0.00015	0.30	**Yes**
	PM_{10}	Annual	0.00002	0.20	**Yes**
	SO_2	Annual	0.00001	0.10	**Yes**

Note:

All modeled GLC_{max} concentrations for SIL comparison is highest met data year's high 1st high.

PSD Class I Increment SIL per NMED Modeling Guidance.

Table 16-X.5 PSD Class I Increment SIL Analysis: Salt Creek Wilderness Area

Units	Criteria Pollutant	Averaging Period	GLC_{max} (ug/m^3)	PSD Class I Increment (ug/m^3)	Below PSD Class I Increment?
Hobbs-1 + DB-1 and Hobbs-2 + DB-2	NO_2	Annual	0.00006	0.10	**Yes**
	$PM_{2.5}$	24-hour	0.00046	0.07	**Yes**
	$PM_{2.5}$	Annual	0.00007	0.06	**Yes**
	PM_{10}	24-hour	0.00046	0.30	**Yes**
	PM_{10}	Annual	0.00007	0.20	**Yes**
	SO_2	Annual	0.00004	0.10	**Yes**

Note:

All modeled GLC_{max} concentrations for SIL comparison is highest met data year's high 1st high.

PSD Class I Increment SIL per NMED Modeling Guidance.

Table 16-X.6 PSD Class I Area Receptors

Class I Area	UTM E	UTM N	Elevation (ft)
Calsbad Caverns National Park	552,681.84	3,560,193.04	4,358
Guadalupe Mountains National Park	512,050.37	3,534,315.62	8,002
Salt Creek Wilderness Area	554,357.10	3,718,810.57	3,540

New Mexico Environment Department Air Quality Bureau Modeling Section 525 Camino de Los Marquez - Suite 1 Santa Fe, NM 87505 Phone: (505) 476-4300 Fax: (505) 476-4375 www.env.nm.gov/aqb/		**For Department use only:** Approved by: Sufi Mustafa Date: 7/2/2018

Air Dispersion Modeling Waiver Request Form

This form must be completed and submitted with all air dispersion modeling waiver requests.

If an air permit application requires air dispersion modeling, in some cases the demonstration that ambient air quality standards and Prevention of Significant Deterioration (PSD) increments will not be violated can be satisfied with a discussion of previous modeling. The purpose of this form is to document and streamline requests to certify that previous modeling satisfies all or some of the current modeling requirements. The criteria for requesting and approving modeling waivers is found in the Air Quality Bureau Modeling Guidelines. Typically, only construction permit applications submitted per 20.2.72, 20.2.74, or 20.2.79 NMAC require air dispersion modeling. However, modeling is sometimes also required for a Title V permit application.

A waiver may be requested by e-mailing this completed form in MS Word format to the modeling manager, sufi.mustafa@state.nm.us.

This modeling waiver is not valid if the emission rates in the application are higher than those listed in the approved waiver request.

Section 1 and Table 1: Contact and facility information:

Contact name	Martin Schluep
E-mail Address:	mschluep@alliantenv.com
Phone	(505) 205-4819
Facility Name	Hobbs Generating Station
Air Quality Permit Number(s)	PSD3449-M4
Agency Interest Number (if known)	AIRS No. 35-025-0341

General Comments: (Add introductory remarks or comments here, including the purpose of and type of permit application.)

This application proposes a major modification to Permit No. PSD3449-M4 for Lea Power Partners, LLC (LPP) Hobbs Generating Station (HGS).

HGS is a natural gas fueled, nominal 604 MW gross output power plant with two advanced firing temperature, Mitsubishi 501F combustion turbine generators (CTGs), each provided with its own heat recovery steam generator (HRSG) including duct burners, a single condensing, reheat steam turbine generator (STG), and an air cooled condenser serving the STG. The plant generates electricity for sale to Southwestern Public Service Company, its successors or assigns. The facility is located approximately 8 miles west of Hobbs, New Mexico in Lea County.

LPP is currently in the process of developing an air permit application to authorize a proposed upgrade of the two combustion turbines to the F4+ compressor upgrade offered by Mitsubishi Hitachi Power System Americas (MHPSA). The upgrade consists of replacing the Inlet Guide Vanes (IGVs) and first six stages of the compressor, resulting in increased air flow. The expected impact of the upgrade on performance is an increase of 5% in output, no change in heat rate, and a 6.7% increase in turbine exhaust flow.

Stack exhaust nitrogen oxides (NO_x) emissions will continue to be controlled to 2 parts per million volume dry basis corrected to 15 percent oxygen (ppmvdc) on a 24-hour average basis, using selective catalytic reduction (SCR) with aqueous ammonia (NH_3). Stack exhaust carbon monoxide (CO) and volatile organic compounds (VOC) emissions will continue to be controlled to 2 ppmvdc on a 1-hour average basis and to 1 ppmvdc on a 24-hour average basis, respectively, by means of an oxidation catalyst. Stack exhaust sulfur dioxide (SO_2) emissions will continue to be controlled by exclusively firing pipeline quality natural gas. Although short term NO_x and CO concentrations from the turbine exhaust will remain constant, there will be an increase in actual mass emission rates of these pollutants due to the increased exhaust flow rate compared to historical past actual emission rates. Increases in particulate matter (PM_{10} and $PM_{2.5}$) and SO_2, are also expected due to the increased fuel consumption. However, the currently permitted short term emission rates (lb/hr) for NO_x and CO will not increase.

Section 2 – List All Regulated Pollutants from the Entire Facility - Required

In Table 2, below, list all regulated air pollutants emitted from your facility, except for New Mexico Toxic Air Pollutants, which are listed in Table 6 of this form. All pollutants emitted from the facility must be listed regardless if a modeling waiver is requested for that pollutant or if the pollutant emission rate is subject to the proposed permit changes.

Table 2: Air Pollutant summary table (Check all that apply. Include all pollutants emitted by the facility):

Pollutant	Pollutant is not emitted at the facility and modeling or waiver are not required.	Pollutant does not increase in emission rate at any emission unit (based on levels currently in the permit) and stack parameters are unchanged. Modeling or waiver are not required.	Stack parameters or stack location has changed.	Pollutant is new to the permit, but already emitted at the facility.	Pollutant is increased at any emission unit (based on levels currently in the permit).	A modeling waiver is being requested for this pollutant.	Modeling for this pollutant will be included in the permit application.
CO					X	X	
NO_2					X	X (1-hr NO_2 only)	X (annual only)
SO_2					X		X
TSP					X		X
PM10					X		X
PM2.5					X		X
H_2S							
Reduced S							
O_3 (PSD only)							
Pb							

Section 3: Facility wide pollutants, other than NMTAPs, with very low emission rates

The Air Quality Bureau has performed generic modeling to demonstrate that small sources, as listed in Appendix 2 of this form, do not need computer modeling. After comparing the facility's emission rates for various pollutants to Appendix 2, please list in Table 3 the pollutants that do not need to be modeled because of very low emission rates.

Section 3 Comments. (If you are not requesting a waiver for any pollutants based on their low emission rate, then note that here. You do not need to complete the rest of Section 3 or Table 3.)

Table 3 is not applicable. The modeling waiver request is for the 1-hr NO_2 and 1-hr and 8-hr CO standards since the permitted hourly emission rates NO_2 and CO will not increase.

Table 3: List of Pollutants with very low facility-wide emission rates

Pollutant	Requested Allowable Emission Rate From Facility (pounds/hour)	Release Type (select "all from stacks >20 ft" or "other")	Waiver Threshold (from appendix 2) (lb/hr)

Section 4: Pollutants that have previously been modeled at equal or higher emission rates

List the pollutants and averaging periods in Table 4 for which you are requesting a modeling waiver based on previous modeling for this facility. The previous modeling reports that apply to the pollutant must be submitted with the modeling waiver request. Request previous modeling reports from the Modeling Section of the Air Quality Bureau if you do not have them and believe they exist in the AQB modeling file archive or in the permit folder.

Section 4 Comments. (If you are not asking for a waiver based on previously modeled pollutants, note that here. You do not need to complete the rest of section 4 or table 4.)

The proposed project will not result in an increase in allowable CO and CO MSS hourly emission rate limits. Scaled results for CO impacts were previously accepted by NMED when the hourly limit was updated in 2016. Accordingly, it is requesting that air dispersion modeling for the 1-hr and 8-hr CO standards for this project be waived since no emissions increases are proposed.

Per 2016 Permitting Action:

Please allow impacts associated with CO MSS emissions to be scaled based on results obtained using the same averaging periods in the past (1-hour in 2014 and 8-hour in 2011). Refer to Attachment 2 for details.

	lb/hr (per unit)	**1-hr (μg/m³)**	**8-hr (μg/m³)**	
Scaled Value (1-hr)	2,060	332.08		[*1 unit running at 1-hr rate, actual proposed scenario*]
Scaled Value (8-hr)	2,060		346.43	[*2 units running at 1-hr rate, very conservative representation*]
Standard (SIL)		2000	500	

Table 4: List of previously modeled pollutants (facility-wide emission rates)

Pollutant	Averaging period	Proposed emission rate (pounds/hour)	Previously modeled emission rate (pounds/hour)	Proposed minus modeled emissions (lb/hr)	Modeled percent of standard or increment	Year modeled
NO2	1-hr	36.2 (HOBBS-1 and HOBBS-2 + DB-1 and DB-2)	36.2 (HOBBS-1 and HOBBS-2 + DB-1 and DB-2)	0	67.3%	2014
NO2	1-hr	386.34 (SSM HOBBS-1 and HOBBS-2)	386.34 (SSM HOBBS-1 and HOBBS-2)	0	67.3%	2014

Section 4, Table 5: Questions about previous modeling:

Question	Yes	No
Was AERMOD used to model the facility?	X	
Did previous modeling predict concentrations less than 95% of each air quality standard and PSD increment?	X	
Were all averaging periods modeled that apply to the pollutants listed above?	X	
Were all applicable startup/shutdown/maintenance scenarios modeled?	X	
Did modeling include all sources within 1000 meters of the facility fence line that now exist?	X	
Did modeling include background concentrations at least as high as current background concentrations?	X	
If a source is changing or being replaced, is the following equation true for all pollutants for which the waiver is requested? (Attach calculations if applicable.) EXISTING SOURCE — REPLACMENT SOURCE $\frac{[(g) \times (h1)] + [(v1)^2/2] + [(c) \times (T1)]}{q1} <= \frac{[(g) \times (h2)] + [(v2)^2/2] + [(c) \times (T2)]}{q2}$ Where g = gravitational constant = 32.2 ft/sec^2 h1 = existing stack height, feet v1 = exhaust velocity, existing source, feet per second c = specific heat of exhaust, 0.28 BTU/lb-degree F T1 = absolute temperature of exhaust, existing source = degree F + 460 q1 = emission rate, existing source, lbs/hour h2 = replacement stack height, feet	N/A	

v2 = exhaust velocity, replacement source, feet per second T2 = absolute temperature of exhaust, replacement source = degree F + 460 q2 = emission rate, replacement source, lbs/hour		

If you checked "no" for any of the questions, provide an explanation for why you think the previous modeling may still be used to demonstrate compliance with current ambient air quality standards.

Section 5: Modeling waiver using scaled emission rates and scaled concentrations

At times it may be possible to scale the results of modeling one pollutant and apply that to another pollutant. If the analysis for the waiver gets too complicated, then it becomes a modeling review rather than a modeling waiver, and applicable modeling fees will be charged for the modeling. Plume depletion, ozone chemical reaction modeling, post-processing, and unequal pollutant ratios from different sources are likely to invalidate scaling.

If you are not scaling previous results, note that here. You do not need to complete the rest of section 5.

Scaling previous results is not requested.

To demonstrate compliance with standards for a pollutant describe scenarios below that you wish the modeling section to consider for scaling results.

Section 6: New Mexico Toxic air pollutants – 20.2.72.400 NMAC

Modeling must be provided for any New Mexico Toxic Air Pollutant (NMTAP) with a facility-wide controlled emission rate in excess of the pound per hour emission levels specified in Tables A and B at **20.2.72.502 NMAC** - Toxic Air Pollutants and Emissions. An applicant may use a stack height correction factor based on the release height of the stack for the purpose of determining whether modeling is required. See Table C - Stack Height Correction Factor at 20.2.72.502 NMAC. Divide the emission rate for each release point of a NMTAP by the correction factor for that release height and add the total values together to determine the total adjusted pound per hour emission rate for that NMTAP. If the total adjusted pound per hour emission rate is lower than the emission rate screening level found in Tables A and B, then modeling is not required.

In Table 6, below, list the total facility-wide emission rates for each New Mexico Toxic Air Pollutant emitted by the facility. The table is pre-populated with common examples. Extra rows may be added for NMTAPS not listed or for NMTAPS emitted from multiple stack heights. NMTAPS not emitted at the facility may be deleted, left blank, or noted as 0 emission rate. Toxics previously modeled may be addressed in Section 5 of this waiver form. For convenience, we have listed the stack height correction factors in Appendix 1 of this form.

Section 6 Comments. (If you are not requesting a waiver for any NMTAPs then note that here. You do not need to complete the rest of section 6 or Table 6.)

Table 6: New Mexico Toxic Air Pollutants emitted at the facility

If requesting a waiver for any NMTAP, all NMTAPs from this facility must be listed in Table 3 regardless if a modeling waiver is requested for that pollutant or if the pollutant emission rate is subject to the proposed permit changes.

Pollutant	Requested Allowable Emission Rate (pounds/hour)	Release Height (Meters)	Correction Factor	Allowable Emission Rate Divided by Correction Factor	Emission Rate Screening Level (pounds/hour)
Ammonia	64.2	50.3	108	0.47	1.20
Asphalt (petroleum) fumes					0.333

Carbon black					0.233
Chromium metal					0.0333
Glutaraldehyde					0.0467
Nickel Metal					0.0667
Wood dust (certain hard woods as beech & oak)					0.0667
Wood dust (soft wood)					0.333
(add additional toxics if they are present)					

Section 7: Approval or Disapproval of Modeling Waiver

The AQB air dispersion modeler should list each pollutant for which the modeling waiver is approved, the reasons why, and any other relevant information. If not approved, this area may be used to document that decision.
The 1-hr NO2 emission rate remain the same as modeled in 2014. The CO short term emission rate was scaled in the past Modeling Waiver request. The CO short term emission rate remain the same in this request, therefore, the past Modeling Waiver is still effective.

Appendix 1: Stack Height Release Correction Factor (adapted from 20.2.72.502 NMAC)

Release Height in Meters	Correction Factor
0 to 9.9	1
10 to 19.9	5
20 to 29.9	19
30 to 39.9	41
40 to 49.9	71
50 to 59.9	108
60 to 69.9	152
70 to 79.9	202
80 to 89.9	255
90 to 99.9	317
100 to 109.9	378
110 to 119.9	451
120 to 129.9	533
130 to 139.9	617
140 to 149.9	690
150 to 159.9	781
160 to 169.9	837
170 to 179.9	902
180 to 189.9	1002
190 to 199.9	1066
200 or greater	1161

Appendix 2. Very small emission rate modeling waiver requirements

Modeling is waived if emissions of a pollutant for the entire facility (including haul roads) are below the amount:

Pollutant	If all emissions come from stacks 20 feet or greater in height and there are no horizontal stacks or raincaps (lb/hr)	If not all emissions come from stacks 20 feet or greater in height, or there are horizontal stacks, raincaps, volume, or area sources (lb/hr)
CO	50	2
H_2S (Pecos-Permian Basin)	0.1	0.02
H_2S (Not in Pecos-Permian Basin)	0.01	0.002
Lead	No waiver	No waiver
NO_2	2	0.025
PM2.5	0.3	0.015
PM10	1.0	0.05
TSP	5	0.25
SO_2	2	0.025
Reduced sulfur (Pecos-Permian Basin)	0.033	No waiver
Reduced sulfur (Not in Pecos-Permian Basin)	No waiver	No waiver

Lea Power Partners, LLC

Hobbs Generating Station
Pre-Construction Air Monitoring Waiver Request

Major Modification to PSD Permit 3449-M4

8 miles West of Hobbs, NM
Lea County, NM

May 30, 2018

Prepared for:

Lea Power Partners, LLC
98 N. Twombly Lane
Hobbs, NM 88242

LEA POWER PARTNERS

Prepared by:

Alliant Environmental, LLC
7804 Pan American Fwy. NE
Albuquerque, NM 87109

ALLIANT ENVIRONMENTAL, LLC

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Section **Page**

1.0 INTRODUCTION

1.1 Project Summary

Lea Power Partners, LLC (LPP) is kindly requesting a waiver from the New Mexico Environment Department (NMED) Air Quality Bureau (AQB) to perform pre-construction monitoring for PM_{10} and $PM_{2.5}$ prior to submittal of a major modification application to existing Prevention of Significant Deterioration (PSD) Permit No. 3449-M4 under New Mexico Administrative Code (NMAC) 20.2.74.

LPP is proposing to upgrade two combustion turbines to the F4+ compressor upgrade offered by Mitsubishi Hitachi Power System Americas (MHPSA). The upgrade consists of replacing the Inlet Guide Vanes (IGVs) and first six stages of the compressor, resulting in increased air flow. The expected impact of the upgrade on performance is an increase of 5% in output, no change in heat rate, and a 6.7% increase in turbine exhaust flow.

Hobbs, NM is located in Lea County, an area that is classified by the US EPA as in attainment with the National Ambient Air Quality Standards (NAAQS) for all regulated pollutants. The facility is included as one of the 28-named sources under PSD rules and is a major source as defined by the PSD rules under 40 CFR §52.21. The estimated annual emission rate increases and PSD applicability analysis for the proposed compressor upgrade project are summarized in Table 1-1 below:

Table 1-1: PSD Applicability Analysis Both Units Combined

Pollutant	**Past Actuals (tpy)**	**Proposed Project Annual w/o SSM (tpy)**	**Proposed Project Increase (tpy)**	**PSD SER (tpy)**	**PSD Review Required?**
NO_x	89.9	124.9	35.0	40	No
CO	9.5	76.0	66.5	100	No
VOC	3.9	13.1	9.2	40	No
SO_2	17.2	50.7	33.5	40	No
H_2SO_4 (mist)	2.6	7.77	5.1	7	No
TSP/PM_{10}	48.6	90.5	46.5	15	Yes
$PM_{2.5}$	48.6	90.5	46.5	10	Yes
CO_2e	1,604,421	1,985,998	381,577	75,000	Yes

The facility will be subject to PSD only for Total Suspended Particulates (TSP), particulate matter with an aerodynamic diameter of 10 and 2.5 microns (PM_{10}/$PM_{2.5}$), and greenhouse gases (GHG) as carbon dioxide equivalent (CO_2e) since the emissions increases from the project are significant only for TSP/PM_{10}/$PM_{2.5}$, CO_2e and no other pollutants. This means that no ozone or secondary $PM_{2.5}$ ambient impact analysis is required.

As stated in NMAC 20.2.74.306.A monitoring requirements:

"*Any application for a permit under this part shall contain an analysis of ambient air quality. Air quality data can be that measured by the applicant or that available from a government agency in the area affected by the major stationary source or major modification. The analysis shall contain the following:*

> ***(1)*** *for a major stationary source, each pollutant for which the potential to emit is equal to or greater than the significant emission rates as listed in Table 2 of this part (20.2.74.502 NMAC)"*

As shown in Table 1-1 above, preliminary estimated emissions calculations for both PM_{10} and $PM_{2.5}$ show that this project will be above the significant emission rates (SER) listed in NMAC 20.2.74.502 Table 2. Furthermore, NMAC 20.2.74.306.C states:

"Continuous air quality monitoring data shall be required for all pollutants for which a national ambient air quality standard exists. Such data shall be submitted to the department for at least the one (1) year period prior to receipt of the permit application. The department has the discretion to:

> ***(1)*** *determine that a complete and adequate analysis can be accomplished with monitoring data gathered over a period shorter than one year but not less than four months; or*
>
> ***(2)*** *determine that existing air quality monitoring data is representative of air quality in the affected area and accept such data in lieu of additional monitoring by the applicant."*

The following report presents justification for the NMED AQB to accept ambient monitoring data collected at the Hobbs Station (Monitor ID 5ZS) as "representative" for PM_{10} and $PM_{2.5}$ background data for the LPP power plant as defined in 20.2.74.306.C(2) NMAC. To determine "representativeness" of the Hobbs Monitoring Station ID 5ZS to the proposed LPP project, the following factors are analyzed:

- Surrounding topography, vegetation, and climate;
- Distance from the project site to the proposed monitor and population demographics; and
- Existing surrounding sources.

2.0 FACILITY DESCRIPTION

2.1 Facility Identification and Location

The LPP power plant is a 604 MW net output natural gas fired power plant located approximately 8 miles West of Hobbs, NM. From Hobbs travel 7 miles west on Carlsbad Highway and turn north just before mile marker 95. Travel north approximately 1.7 miles and turn west for 0.3 miles. After passing through an access gate, travel 0.5 miles to the LPP site location.

UTM Coordinates (UTM Zone 13) with NAD83 Datum and an Elevation of 3,767 feet above mean sea level:
UTME: 658,413
UTMN: 3,622,425

Latitude / Longitude:
Lat. 32^{o} 43' 47.1"
Long. -103^{o} 18' 34.6"

2.2 Brief Process Description

The LPP power plant operates two advanced firing temperature, Mitsubishi 501F combustion turbine generators (CTGs), each provided with its own heat recovery steam generator (HRSG) including duct burners, a single condensing, reheat steam turbine generator (STG), and an air-cooled condenser serving the STG. The plant generates electricity for sale to Southwestern Public Service Company, its successors or assigns.

The following sources are permitted to operate at the facility:

- Two (2) advanced gas-fired CTGs;
- Two (2) HRSG including duct burners;
- One (1) STG;
- One (1) air cooled condenser serving the STG;
- One (1) firewater pump diesel engine;
- One (1) standby generator diesel engine;
- Three (3) auxiliary cooling towers;
- Three (3) inlet chillers; and
- Three fuel gas heaters.

The proposed emissions increases are emitted through the two CTG stacks. There are no other emissions increases to any other Units or Emission Points proposed.

3.0 PRE-CONSTRUCTION MONITORING WAIVER REQUEST

3.1 LPP Power Plant Surrounding Topography, Vegetation, and Climate

The LPP power plant is located approximately 8 miles West of Hobbs, NM at an elevation of 3,767 feet above mean sea level. The terrain surrounding the power plant is relatively flat with small arroyos, semi-arid rangeland, oil and gas well pads, and a few crop circles. Vegetation is dominated by mesquite, mixed- and desert grassland. Soil cover is composed of caliche rubble and sand.

The climate at the LPP power plant is semi-arid with mild temperatures and low precipitation and humidity. The prevailing winds at the nearby Hobbs Meteorological Monitoring Station No. 722676 (same as Monitoring Station No. 5ZS) for year 2015 are from the south at an annual average wind speed of 3.1 to 5.1 miles per second (mps) (see Figure 3-1 below). Average winter temperature ranges are from the low 30 degrees Fahrenheit (^{o}F) to high 50^{o}F. Average summer temperature ranges are from low 60^{o}F to mid-high 90^{o}F. The average precipitation is about 18 inches. (https://www.usclimatedata.com/climate/hobbs/new-mexico/united-states/usnm0141).

3.2 Hobbs, New Mexico

The LPP power plant is located approximately 11 miles West of the Hobbs Monitoring Station ID 5ZS, which is located at 2320 N. Jefferson St., Hobbs, NM (Lat: 32.72666; Lon: -103.123; elevation: 3,634 feet above mean sea level). The area to the East of Hobbs and Monitoring Station 5ZS is mostly covered with vegetation and crop lands. The surrounding topography and the climate in Hobbs, NM and at Monitoring Station 5ZS is the same as described above in section 3.1. Attachment A shows the location of the LPP power plant and Monitoring Station 5ZS.

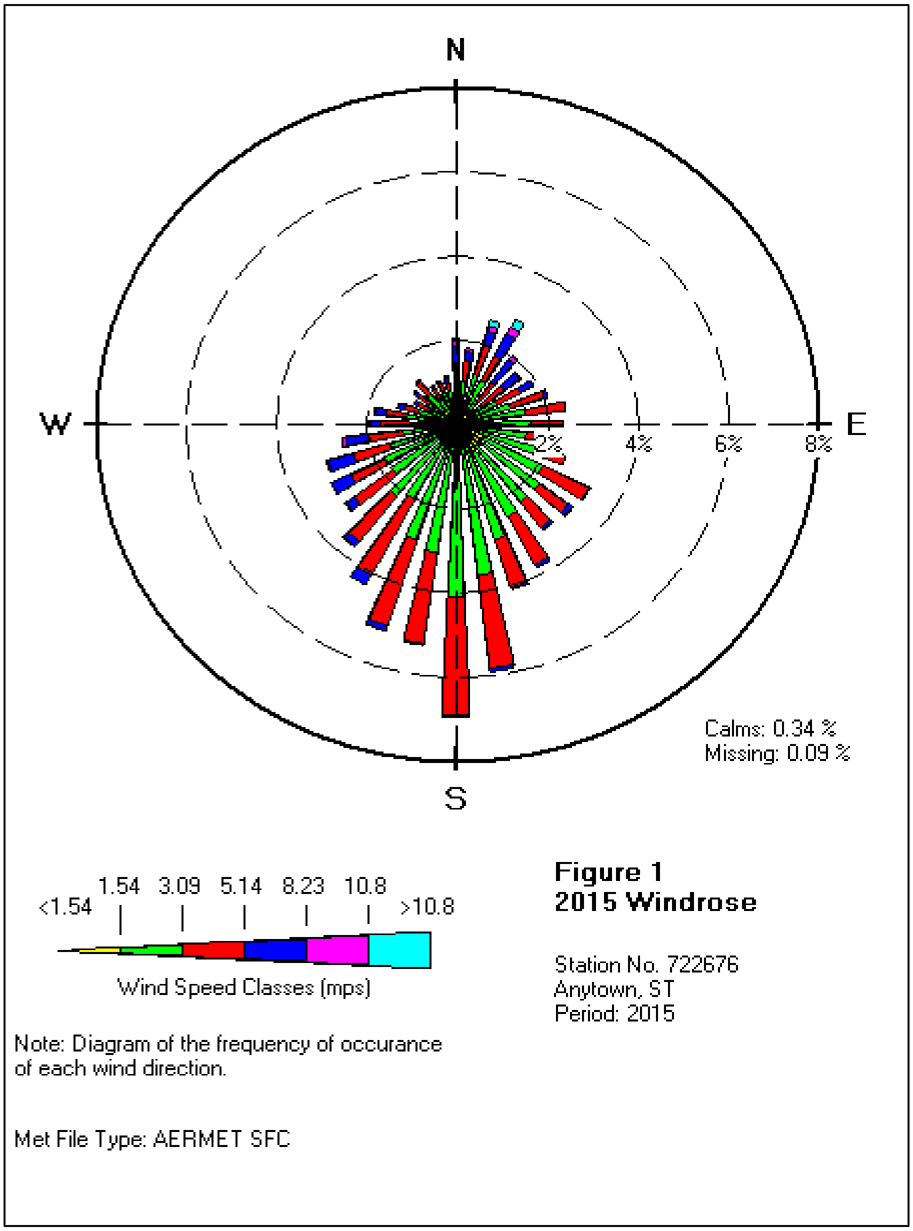

Figure 3-1: Hobbs Station No. 722676 2015 Windrose

3.3 Demographics

Both the city of Hobbs and the LPP power plant are located in Lea County, NM. According to the 2017 census, the population of Lea County is 68,759, (https://www.census.gov/quickfacts/fact/table/leacountynewmexico/PST045217) with the majority of the population living in Hobbs at 37,764. (https://www.census.gov/quickfacts/fact/table/hobbscitynewmexico/PST045216)

Since the majority of the population is centered around Hobbs and the nearby LPP power plant, the impacts of anthropogenic sources of airborne particulate matter, including PM_{10} and $PM_{2.5}$, in and around Hobbs are captured by Monitoring Station No. 5ZS and are representative of the LPP power plan's location.

3.4 Existing Surrounding Sources

Regulated sources of particulate matter emissions in Lea County and neighboring Eddy County consist mostly of oil and gas operations, potash mining and processing, and portable construction sources. A majority of the sources are located to the West of Hobbs and around the LPP power plant. Surrounding source data and background concentrations for PM_{10} and $PM_{2.5}$ (see Table 3-1 below) as applicable will be applied. The NMED AQB Air Dispersion Modeling Guidelines (Revised August 8, 2017) will be followed for the required air dispersion modeling portion of this project, which includes modeling the facility's PM_{10} and $PM_{2.5}$ including nearby sources and adding a background concentration to that. Note that the current NMED AQB Air Dispersion Modeling Guidelines recommend using background data for sources located in the Eastern part of New Mexico from Monitoring Station No. 5ZS.

Table 3-1: New Mexico/National Ambient Air Quality Standards

Criteria Pollutant	Averaging Period	NAAQS ug/m^3	NMAAQS ug/m^3	Proposed Background Concentrations	Proposed Monitoring Station/location/Data
$PM_{2.5}$	Annual	**12**	---	5.81	ID: 5ZS, 350250008 Hobbs-Jefferson: 2320 N. Jefferson St., Hobbs
	24-hour	**35**	---	27.77 (17.37*)	
PM_{10}	Annual	---	---	21.28	ID: 5ZS, 350250008 Hobbs-Jefferson: 2320 N. Jefferson St., Hobbs
	24-hour	150	**150**	101.50 (38.50**)	
TSP	7-day	---	**110**	---	---
	30-day	---	**90**	---	---
	Annual	---	**60**	21.28	ID: 5ZS, 350250008 Hobbs-Jefferson: 2320 N. Jefferson St., Hobbs
	24-hour	---	**150**	101.50 (38.50**)	

Notes:

TSP: There are no TSP monitors in New Mexico. TSP background concentrations are equal to PM_{10} concentrations for the same averaging period.

Alliant Environmental already requested and received surrounding source data from the NMED modeling section.

4.0 CONCLUSION

A waiver from the NMED AQB from performing pre-construction monitoring for PM_{10} and $PM_{2.5}$ is justified, because the data collected from Monitor Station ID 5ZS provides representative ambient air background data as required by regulation 20.2.74.306.A NMAC. This station is located 11 miles East from existing LPP power plant. To determine "representativeness" of the Hobbs Monitoring Station ID 5ZS to the LPP power plant, the following factors were analyzed:

- Surrounding topography, vegetation, and climate;
- Distance from the project site to the proposed monitor and population demographics; and
- Existing surrounding sources.

The LPP power plant is located only 11 miles West of the proposed Monitoring Station 5ZS. The terrain, vegetation and climate are virtually the same for both locations. This close proximity of the monitoring station to the LPP power plant would predict ambient concentrations due to large range transport of particulate matter to be identical.

Hobbs, NM is the largest city in Lea County with greater than 50% of the county's population. Anthropogenic sources of airborne particulate matter found in Hobbs resulting from human activity include:

- Vehicle traffic
- Combustion particulate matter from heating homes, boilers, etc.
- Agriculture and local businesses

The proposed project at the LPP power plant exceeds the SER of 15 tons per year (tpy) for PM_{10} and 10tpy for $PM_{2.5}$ for direct $PM_{2.5}$. Monitoring Station No. 5ZS, located in Hobbs, NM, provides background concentrations that are representative for use as background for the proposed permit modeling analysis. LPP kindly requests a waiver from performing pre-construction monitoring for PM_{10} and $PM_{2.5}$ and use "representative" monitoring data collected at the Hobbs Monitoring Station ID 5ZS.

Attachment A

Area Map Showing LPP Power Plant and Monitoring Station 5ZS

ALLIANT ENVIRONMENTAL, LLC

Area Map: LPP Power Plant And Monitor Station 5ZS

LPP Power Plant Hobbs, NM

Property Line: Fence Line: Flow: Acreage: 40	Drawn by: MRS	Date: 05/29/18	**LPP Power Plant** N 32° 43' 47.1" Latitude W -103° 18' 34.6" Longitude	Project No.: 085-002	File Name: **Area Map**	Figure: A-1
	Chk'd by:	Date:				

Section 17

Compliance Test History

(Submitting under 20.2.70, 20.2.72, 20.2.74 NMAC)

To show compliance with existing NSR permits conditions, you must submit a compliance test history. The table below provides an example.

Table 17–4 Compliance Test History Table

Unit No.	Permit No.	Permit Cond.	Test Description	Test Date
HOBB-1/DB-1	PSD 3449	A401A	Initial Compliance for PM/PM10/PM2.5	3/5/2015 - 3/6/2015
		A401C	RATA testing in accordance with EPA test methods for NOx and CO.	6/6/2018 9/21/2017 923/2016 9/23/2015 9/17/2014
		A401E	Annual ammonia compliance testing.	9/23/2015- 9/24/2015 9/17/2014
	PSD 3449	A401C	RATA testing in accordance with EPA test methods for NOx and CO.	6/6/2018 9/21/2017 923/2016 11/13/2013 11/7/2012 11/30/2011
		A401A	Annual stack testing for NOx and CO.	11/13/2013 11/7/2012 11/30/2011
		A401E	Annual ammonia compliance testing.	11/13/2013 11/7/2012 11/30/2011
HOBB-2/DB-2	PSD 3449	A401A	Initial Compliance for PM/PM10/PM2.5	3/11/2015 - 3/12/2015
		A401C	RATA testing in accordance with EPA test methods for NOx and CO.	6/6/2018 9/21/2017 923/2016 9/23/2015- 9/24/2015 9/16/2014
		A401E	Annual ammonia compliance testing.	9/25/2015- 9/27/2015 9/16/2014
	PSD 3449	A401C	RATA testing in accordance with EPA test methods for NOx and CO.	6/6/2018 9/21/2017

				923/2016 11/14/2013 11/8/2012 12/1/2011
		A401A	Annual stack testing for NOx and CO.	11/14/2013 11/8/2012 12/1/2011
		A401E	Annual ammonia compliance testing.	11/14/2013 11/8/2012 12/1/2011
HOBB1	PSD 3449	A401A	Initial Compliance for PM/PM10/PM2.5	9/29/2015- 10/1/2015
HOBB2	PSD 3449	A401A	Initial Compliance for PM/PM10/PM2.5	9/29/2015- 10/1/2015
G-1	PSD 3449	A111 B	Opacity test.	9/24/2015 9/17/2014
	PSD 3449	A111 B	Opacity test.	11/12/2013 11/6/2012 11/29/2011
FP-1	PSD 3449	A111 B	Opacity test.	9/24/2015 9/17/2014
	PSD 3449	A111 B	Opacity test.	11/12/2013 11/6/2012 11/29/2011

Section 20

Other Relevant Information

Other relevant information. Use this attachment to clarify any part in the application that you think needs explaining. Reference the section, table, column, and/or field. Include any additional text, tables, calculations or clarifying information.

Additionally, the applicant may propose specific permit language for AQB consideration. In the case of a revision to an existing permit, the applicant should provide the old language and the new language in track changes format to highlight the proposed changes. If proposing language for a new facility or language for a new unit, submit the proposed operating condition(s), along with the associated monitoring, recordkeeping, and reporting conditions. In either case, please limit the proposed language to the affected portion of the permit.

All relevant information has been incorporated in the appropriate application pages.

Section 22: Certification

Company Name: **Consolidated Asset Management Services (New Mexico), LLC**

I, **Roger Schnabel**, hereby certify that the information and data submitted in this application are true and as accurate as possible, to the best of my knowledge and professional expertise and experience.

Signed this 13th day of July, 2018, upon my oath or affirmation, before a notary of the State of

New Mexico.

[signature]
*Signature

13-July-2018
Date

Roger L. Schnabel
Printed Name

Plant Manager
Title

Scribed and sworn before me on this 13th day of July, 2018.

My authorization as a notary of the State of New Mexico expires on the

9th day of November, 2019.

Leslie Wills
Notary's Signature

7-13-18
Date

Leslie Wills
Notary's Printed Name

*For Title V applications, the signature must be of the Responsible Official as defined in 20.2.70.7.AE NMAC.

OFFICIAL SEAL
LESLIE WILLS
NOTARY PUBLIC-State of New Mexico
My Commission Expires Nov. 9, 2019