September 1, 2020

Ms. Kendal Stegmann
Air Quality Division
Oklahoma Department of Environmental Quality
P.O. Box 1677
Oklahoma City, OK 73101-1677

SUBJECT: Response to 4-Factor Analysis on Control Scenarios Request
Clean Air Act Regional Haze Program
Binger Gas Plant
Permit No. 2015-1174-TVR3 (M-1)
Mustang Gas Products, LLC

Dear Ms. Stegmann:

Altamira-US, LLC (Altamira) on behalf of Mustang Gas Products, LLC (Mustang) in response to the request from the Oklahoma Department of Environmental Quality (ODEQ) received on July 1, 2020 is submitting a four-factor analysis of all potential control measures for nitrogen oxide (NOx) on all fuel-burning equipment with a heat input of 50 Million British Thermal Units Per Hour (MMBTU/hr) or more located at the Binger Gas Plant (Facility). This response is being provided prior to the deadline of September 1, 2020 as specified in the request.

Regulatory Requirement

In the 1977 amendments to the Clean Air Act (CAA), Congress set a national goal to restore national parks and wilderness areas to natural conditions by remedying existing, anthropogenic visibility impairment and preventing future impairments. On July 1, 1999, the U.S. Environmental Protection Agency (EPA) published the final Regional Haze Rule (RHR). The objective of the RHR is to restore visibility to natural conditions in 156 specific areas across the United States, known as Class I areas. The Clean Air Act defines Class I areas as certain national parks (over 6,000 acres), wilderness areas (over 5,000 acres), national memorial parks (over 5,000 acres), and international parks that were in existence on August 7, 1977. In accordance with the RHR the ODEQ has set goals which provide for reasonable progress towards achieving natural visibility conditions at Oklahoma's Class 1 area, the Wichita Mountains Wilderness Area.

Introduction

The Facility consists of four (4) natural gas-fired four-stroke rich-burn (4SRB) engines with a heat input of 50 MMBTU/hr or more. Therefore, the engines are the only sources at the Facility which meet the applicable criteria of the four-factor analysis. As requested, this analysis provides achievable emission reductions, a timeframe for implementation, the remaining useful life of the equipment, all non-air-quality environmental impacts, and the cost of implementation for the reduction of NOx at the Facility.

Table 1. Equipment Summary

Emission Unit ID	Emission Unit	Manufacture Date	Horsepower
CM-2322	White Superior 12G825	1976	1,200
CM-2323	Waukesha L7042 GSI	1975	1,232
CM-2324	Waukesha L7042 GSI	2019	1,232
CM-2325	Waukesha L7042 GSI	1975	1,232

Potential NOx Controls for 4SRB Engines

A review of the RACT/BACT/LAER clearinghouse (RBLC) shows NOx reduction in 4SRB natural gas-fired engines can be accomplished by three general methods.

1. Operational control methods and good combustion practices.
2. Combustion control techniques such as reducing combustion temperatures and introducing catalysts to limit the formation of NOx.
3. The construction and operation of post combustion control technologies.

The following NOx controls for 4SRB engines were identified based on principles of control technologies and engineering experience for combustion units. The technical feasibility and anticipated performance of each control is provided below.

Good Combustion Practices

NOx emissions are caused by the oxidation of nitrogen during fuel combustion as a result of high temperatures and an insufficient air to fuel mixture within the cylinders. By following the Environmental Protection Agency's (EPA) "Good Working Practices" guidance document, good combustion practices can be achieved and maintained. Through means of experience, engineering controls, best management practices, and by operating the engines in accordance with manufacturer specifications, Mustang ensures the engines operate as intended with the lowest potential NOx emissions. Further, by means of routine inspections, regular maintenance, and conducting overhauls as needed the engines employ good combustion practices. As some of these conditions are required by specific conditions within the permit as well as federal regulations, no further assessment of these control practices are included in this report.

Clean Burn Technology

Clean burn technology (CBT) is a process of adjusting the fuel to air ratio mixture during combustion to obtain a desired effect. This is often done through the installation of an air fuel ratio controller (AFRC) which allows the operator to adjust the combustion mixture to a more desirable ratio. Engines with a higher air to fuel ratio operate with lower combustion temperatures and therefore lower NOx emissions. However, because rich burn engines are designed to operate close to a stoichiometric air to fuel ratio of 16:1, adding an AFRC can be problematic. Manufacturer performance curves have shown when air to fuel ratios exceed 18:1 the combustion temperature, horsepower, and NOx emissions of the engine begin to decrease. As the air ratio continues to increase in relation to the fuel, modifications such as turbochargers and pre-combustion chambers are required to promote stable combustion within the cylinders to aid in the ignition of the lean fuel mixture. The installations of such devices on the units CM-2322 and CM-2323 would be considered a modification under 40 CFR Part 60 for New Source Performance Standards (NSPS) opening the Facility up to additional testing requirements and further accrued cost. The most restricting issue with this type of control method for 4SRB engines is they cannot operate for extended periods of time with an air to fuel ratio higher than 20:1 without experiencing a loss of power. As these engines are permitted to operate 24/7 this presents a very large operational drawback. Due to the cost associated with retrofitting the engines, limited operational flexibility, and an increase in regulatory requirements, Mustang does not believe it is feasible to control the engines using an AFRC.

Selective Catalytic Reduction

A Selective Catalytic Reduction (SCR) is the process of injecting a nitrogen-based reagent, such as ammonia or urea, into the exhaust stream of an engine to control the emission of NOx. The injected reagent reacts selectively with the NOx to produce molecular nitrogen (N2) and water (H2O). An SCR system includes the catalyst, catalyst housing, reagent storage tank, reagent injector, reagent pump, pressure regulator, and an electronic control system. The electronic controls regulate the amount of reagent injected based on the engine load, speed, and temperature. However, when controlling a 4SRB engine with an SCR the effectiveness of the catalyst can decrease over time and potentially become ineffective. Often a portion of the ammonia is not completely consumed during the reaction and is expelled via the exhaust stream which is referred to as an ammonia slip. Unreacted ammonia in the exhaust will often form ammonium sulfates which can plug or corrode downstream equipment. If the resulting particulates become over abundant the catalyst can become encumbered and may require the application of a soot blower. Additionally, for an SCR system to function properly, the exhaust gas must be within an optimal temperature range of 450 and 850 °F. The temperature however can be altered by the type of catalyst used which if allowed to increase beyond the standard, NOx and ammonia will pass through the catalyst unreacted. As previously mentioned 4SRB engines are built to operate close to a stochiometric air-fuel ratio which causes the exhaust oxygen levels for rich-burn engines to be relatively low. For this reason, 4SRB engines are not typically controlled using an SCR as demonstrated in the attached RBLC table. In addition, AP-42 Section 3.2 does not list an SCR as an available control technology. Due to the number of issues with controlling a 4SRB engine with an SCR, Mustang does not believe this type of control is feasible.

Non-Selective Catalytic Reduction

A Non-Selective Catalytic Reduction (NSCR) is a control technique that uses residual hydrocarbons and carbon monoxide (CO) in engine exhaust as a reducing agent for NOx. In an NSCR system, hydrocarbons and CO are oxidized by oxygen and NOx. The excess hydrocarbons, CO and NOx pass over a catalyst typically made of platinum, rhodium, or palladium, that oxidizes the excess hydrocarbons and converts NOx to nitrogen (N2). This technique does not require additional reagents to be injected because the unburned hydrocarbons in the engine exhaust are used as the reductant. The applications of an NSCR is limited to engines with normal exhaust oxygen levels of 4% or less. This includes naturally aspirated 4SRB engines and some turbocharged 4SRB engines. In order to achieve effective NOx reduction, the engine may need to be run with a richer fuel adjustment than normal, resulting in an exhaust excess oxygen level closer to 1%. The exhaust oxygen levels for 4SRB engines are sufficiently low to support the reactions and therefore, this technology is routinely used to control NOx emissions from rich burn engines. Furthermore, AP-42 Section 3.2 does list a NSCR as a potential control of NOx emissions from 4SRB engines. For these reasons, it has been determined that this method of NOx control is feasible for the 4SRB engines at the Facility.

Time necessary to implement the measure

As the engines are located at a Title V Major Source the implementation of controls will establish additional regulatory requirements, particularly compliance assurance monitoring (CAM). Due to operational and permitting time restraints, Mustang estimates it will take approximately 2 years to budget, design, procure, authorize, and install the NSCR control equipment at the Facility.

Remaining Useful Life

The estimated useful life of the NSCR equipment is 20 years, based on default values from the EPA Air Pollution Control Cost Manual. However, the catalyst beds are estimated to require changing every 2 years based on operational hours and best engineering practices.

Energy and non-air quality environmental impacts of the measure

There are no anticipated unique or site-specific energy or non-air impacts imposed by continuing to use good combustion practices and fuel selection. The implementation of an NSCR on the 4SRB engine would result in requiring to periodically replace the catalyst, dispose of the catalyst, and will also require additional energy consumption.

Cost of implementing the measure

Based on prior knowledge of the equipment, Mustang has estimated the initial capital costs associated with purchasing the controls, installation, downtime, and compliance requirements. In addition, annual costs associated with incurred maintenance and operating requirements for the project have been incorporated. This cost estimate assumes that the NSCR will reduce NOx emissions to an outlet concentration of 3.00 g/hp-hr based on an engine test of a similar engine which is controlled by a NSCR. Cost effectiveness for each engine's control option is summarized in Table 2. To calculate the emission reductions, Mustang compared the 2019 Emission Inventory (EI) data to the maximum PTE emission rate of the equipment post-control. The Total Annual Cost was then divided by the Emission Reduction to come up with a Cost Effectiveness ($/ton) amount.

Table 2. Cost Analysis Summary

Control Equipment	Unit	Capital Cost ($)	Total Annual Cost ($)	Emission Reduction (TPY)	Cost Effectiveness ($/ton)
Non-Selective Catalytic Reduction	CM-2322	40,250	4,250	172.24	24.67
	CM-2323	16,250	4,250	177.10	24.00

Analysis Summary

Based on a comprehensive evaluation of available control technologies for 4SRB engines, Mustang has determined that an NSCR in conjunction with good combustion practices will be best suited to control engines CM-2322 and CM-2323 at the Facility. As these engines are currently already retrofitted with a single catalyst housing, the capital cost for these engines will be accrued through the purchase and installation of the elements along with the associated cost of maintaining compliance. However, due to the unforeseen nature of controlling these historically uncontrolled engines, a second catalyst and housing has been accounted for in the capitol cost for CM-2322. As required by permit No. 2015-1174-TVR3 (M-1), engines CM-2324 and CM-2325 are already operated with properly functioning NSCRs as well as with good combustion practices. A 90% control efficiency has already been demonstrated based on recent Portable Emissions Analyzer (PEA) testing in comparison to the uncontrolled manufactured specifications for these engines. Based on these findings, Mustang believes adding further controls to these engines would be uneconomical and unnecessary.

If you have any questions or need additional information, please contact me at (405) 748-9488.

Sincerely,
Mustang Gas Products, LLC

Sunni Stephenson
EHS Environmental Coordinator

cc: Mr. Steve Hoppe, Mustang Gas Products, LLC
Mr. Camren McMillan, Altamira-US, LLC

Enclosures:
Appendix 1. Cost Analysis Breakdown
Appendix 2. RBLC Tables

Cost Analysis Breakdown

NOX REDUCTION EMISSIONS SUMMARY
BINGER GAS PLANT
MUSTANG GAS PRODUCTS, LLC

Emissions Source	Emission Point Identification	2019 Emission Inventory NO_x		Controlled Emissions NO_x		Emission Reduction NOx	
		(lb/hr)	(T/yr)	(lb/hr)	(T/yr)	(lb/hr)	(T/yr)
White Superior 12G825 Compressor Engine (1,200 Hp)	CM-2322	47.26	207.00	7.94	34.76	39.32	172.24
Waukesha L7042GSI Compressor Engine (1,232 Hp)	CM-2323	48.58	212.79	8.15	35.69	40.43	177.10
	Totals	**109.74**	**480.58**	**17.89**	**78.36**	**79.76**	**349.35**

COST ANALYSIS BREAKDOWN
BINGER GAS PLANT
MUSTANG GAS PRODUCTS, LLC

Emissions Source	Emission Point Identification	Cost per Catalyst [1]	Cost per Housing	Installation Cost	Cost due to downtime	Cost due to CAM	Total Cost
White Superior 12G825 Compressor Engine (1,200 Hp)	CM-2322	$6,000	$18,000	$3,000	$1,500	$5,750	$40,250
Waukesha L7042GSI Compressor Engine (1,232 Hp)	CM-2323	$6,000	--	$3,000	$1,500	$5,750	$16,250

Emission Source	Emission Point Identification	Annual Cost to PEA Test	Annual Cost due to CAM	Total Annual Cost	Cost Effectiveness
White Superior 12G825 Compressor Engine (1,200 Hp)	CM-2322	$1,500	$2,750	$4,250	$24.67
Waukesha L7042GSI Compressor Engine (1,232 Hp)	CM-2323	$1,500	$2,750	$4,250	$24.00

1. It is conservatively assumed engine CM-2322 will require two catalysts to meet the proposed NOx reduction.

RBLC Tables

4SRB ENGINES					
RBLC ID	**Facility Name**	**Process Name**	**Throughput**	**Pollutant**	**Control Method**
KY-0110	Nucor Steel Branding	Tempering Furnace Rolls Emergency Generator	636 HP	NOx	Good Combustion and Operating Practices
MI-0440	Michigan State University	FGENGINES	16500 HP	NOx	Selective catalytic reduction
MI-0441	LBWL-Erickson Station	EUEMGNG1 -- A 1500 HP natural gas fueled emergency engine	1500 HP	NOx	Burn natural gas and be NSPS compliant
MI-0420	DTE Gas Company -- Milford Compressor Station	EUN_EM_GEN	225 H/YR	NOx	Low Nox design and goo combustion practices.
CA-1240	Gold Coast Packing	Internal Combustion Engine	881 bhp	NOx	SCR catalyst-Urea injection
LA-0292	Holbrook Compressor Station	Waukesha 16V-275GL Compressor Engine Nos. 1-12	5000 HP	NOx	Lean-burn combustion, burn natural gas, proper combustion techniques
TX-0755	Ramsey Gas Plant	Internal combustion Engines	2016149 MMBtu/yr	NOx	Ultra-Lean burn engines firing natural gas
LA-0287	Alexandria Compressor Station	Emergency Generator Reciprocating Engine	1175 HP	NOx	Good combustion practices, burn natural gas fuel
PA-0302	Clermont Compressor Station	Spark Ignited 4 Stroke Rich Burn Engine (7 units)	0	NOx	NSCR
KS-0035	Lacey Randal Generation Facility	Spark ignition four stroke lean burn reciprocating internal combustion engine (RICE) electric generating units	12526 BHP	NOx	Selective catalytic reduction (SCR) system and oxidation catalyst
TX-0692	Red Gate Power Plant	(12) reciprocating internal combustion engines	18 MW	NOx	Selective Catalytic Reduction (SCR)
MI-0412	Holland Board of Public Works - East 5th Street	Emergency Engine -- natural gas (EUNGENGINE)	1000 kW	NOx	Good combustion practices
TX-0680	Sonora Gas Plant	Recompression compressor engine	1380 HP	NOx	ultra-lean burn technology
IN-0167	Magnetation LLC	Emergency Generator	620 HP	NOx	Natural gas and good combustion practices
OK-0153	Rose Valley Plant	Emergency Generators 2,889-HP CAT G3520C IM	2,889 HP	NOx	Lean-burn combustion
OK-0148	Buffalo Creek Processing Plant	Large Internal combustion Engines	2370 HP	NOx	Ultra lean burn
OK-0148	Buffalo Creek Processing Plant	Large Internal combustion Engines	1775 HP	NOx	Ultra lean burn
PA-0303	NATL Fuel Gas Supply/Ellisburg Station	Emergency Generator Set, Rich Burn, 850 BHP	850 BHP	NOx	Miratech model IQ-24-10-ECI NSCR system
LA-0257	Sabine Pass LNG Terminal	Generator Engines (2)	2012 HP	NOx	Comply with 40 CFR 60 Subpart JJJJ
CA-1222	Kyocera America Inc.	ICE: Spark Ignition	2889 BHP	NOx	SCR with process control Nox monitor
CA-1192	Avenal Energy Project	Emergency IC Engine	550 KW	NOx	SCR, operation limit of 50 Hrs/yr
MI-0393	Ray Compressor Station	Five spark ignition internal combustion engines	32 MMBTU/H	NOx	low emission design and good combustion practices