Attn: Mark Jones & Cember Hardison
New Mexico Environment Department

May 22, 2020

Dear Mr. Jones and Ms. Hardison,

Thank you for the opportunity to discuss the options available for best mitigating haze-causing pollutants from sources in the oil and gas sector in New Mexico. We appreciate your work to develop a strong regional haze state implementation plan (SIP). While this letter is focused on emission reducing options for engines in the oil and gas sector, as we've identified elsewhere, other facilities in this and other sectors also contribute to regional haze, such as the San Juan Generating Station, and we maintain an interest in seeing the New Mexico haze SIP control pollution from those sources as well.

In response to your request for more information regarding selective catalytic reduction (SCR) for lean burn engines, we have attached an expert report prepared by Victoria Stamper and Megan Williams. As the report describes in detail, SCR is a feasible and cost-effective pollution control option. However, rather than require SCR, we urge NMED to require operators to replace gas-fueled engines with electric motors wherever feasible. To that end, the agency must establish clear and specific criteria for determining "infeasibility." Electrification is ultimately the best option for reducing or eliminating emissions of NO_x (and all other air pollutants from gas-fired engines), thereby better reducing visibility and public health harming emissions while helping New Mexico achieve its climate goals. Electrification can also be highly cost-effective. State and federal regulations establish the authority for NMED to require electrification of gas engines or replacement or set near-zero NO_x emissions limits, as detailed below. Where electrification is not feasible, SCR provides a feasible and cost-effective alternative.

I. Benefits of Electrification

Gas-fired engines used in oil and gas development contribute significantly to NO_x and other air pollution in New Mexico. Electric engines, by contrast, eliminate NO_x and other pollutants, decrease noise levels, and are easier to maintain. Compared to gas-fired engines, electric engines also result in fewer upset events at wells – events that can release large quantities of pollutants, including volatile organic compounds ("VOCs") and methane, a powerful greenhouse gas with 86 times the 20-year global warming potential of CO_2.[1] Mandatory electrification would significantly reduce methane emissions and waste, ozone, and haze, leading to improved air quality and thus improved visibility and health throughout New Mexico. It would also help New Mexico achieve its climate and energy goals, including but not limited to those articulated in Governor Michelle Lujan Grisham's January 2019 Executive Order

[1] *See* Vicki Stamper & Megan Williams, Nat'l Parks Conservation Ass'n, *Oil & Gas Sector Reasonable Progress Four-Factor Analysis of Controls For Five Source Categories* 57 (2020) [hereinafter Stamper & Williams, *Oil and Gas Four-Factor Analysis of Controls*].

2019-003, "Executive Order on Addressing Climate Change and Energy Waste Prevention."[2] Mandatory electrification would also complement and reinforce NMED's (and EMNRD's) ongoing efforts to reduce ozone and methane emissions through the Ozone Attainment Initiative (OAI) and Methane rulemakings, respectively.

Electrification can also be highly cost-effective. In 2001, the California Air Resources Board (CARB) found that electrification of units between 50 and 500 hp can control NOx pollution at a cost of about $900 to $1,100 per ton of NOx reduced.[3] CARB further concluded that for units between 500 and 1,000 hp the installed costs of electrification and internal combustion engines are about the same, and that below 500 hp the installed costs of electrification are lower than the installed costs of comparable internal combustion engines.[4] Given the significant advances in technology during the past 20 years, electrification is likely even more cost effective today.

II. Legal Authority for Electrification

Under state and federal law, NMED has the authority to mandate the electrification of engines used in oil and gas development, and/or to set NO_x emissions limitations near zero to favor electrification. Requiring SCR is also well within the scope of the state's regulatory authority. However, in order to create a SIP that will best meet state and federal clean air objectives, electrification should be required.

A. State Law

Broadly, New Mexico's Air Quality Control Act, Chapter 74, Article 2, NMSA 1978 ("Air Quality Control Act") requires the New Mexico Environmental Improvement Board (Board) to "prevent or abate air pollution."[5] The Board shall "adopt, promulgate, publish, amend and repeal rules and standards consistent with the Air Quality Control Act to attain and maintain national ambient air quality standards and prevent or abate air pollution," and "adopt a plan for the regulation, control, prevention or abatement of air pollution, recognizing the differences, needs, requirements and conditions within the geographic area of the environmental improvement board's jurisdiction . . ."[6]

Further, the Environmental Improvement Board may take action inclusive of "rules to protect visibility in mandatory class I areas to prevent significant deterioration of air quality and to achieve national ambient air quality standards in nonattainment areas . . . "[7] A rule requiring electrification of oil and gas engines would further NMED's duty to prevent or abate air pollution, including via adoption, promulgation, publication, or amendment of rules and adoption of a plan for the regulation, control,

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[2] Executive Order 2019-003, "Executive Order on Addressing Climate Change and Energy Waste Prevention," (January 29, 2019), *Available at* https://www.governor.state.nm.us/wp-content/uploads/2019/01/EO_2019-003.pdf

[3] *Id.* at 41-42. CARB's conservative cost estimate, which is in 1999 dollars, assumed only 2,000 hours of operation each year and a 10-year, rather than a 30-year, life of the equipment. *Id.* at 42; *See generally Id.* at 41-46.

[4] Cal. Air Res. Bd., *Determination of Reasonably Available Control Technology and Best Available Retrofit Control Technology for Stationary Spark-Ignited Internal Combustion Engines*, at V-5 (2001), https://ww3.arb.ca.gov/ractbarc/rb-iceall.pdf.

[5] Air Quality Control Act, 74-2-5 (A) NMSA 1978 (emphasis added).

[6] Air Quality Control Act, 74-2-5 (B)(1) and (B)(2) NMSA 1978.

[7] Air Quality Control Act, 74-2-5 (C)(1) and (C)(2) NMSA 1978.

prevention or abatement of air pollution. Mandating electrification would also further NMED's duty to adopt rules to protect visibility in mandatory Class I areas to prevent significant deterioration of air quality.

Electrification would also account for the "character and degree of injury to or interference with health, welfare, visibility, and property" caused by engines and "the public interest, including the social and economic value of the sources *and subjects* of air contaminants."[8] (*Emphasis added*). Electrification of gas-fired RICE engines would eliminate 100% of NOx and other emissions.

These emissions degrade air resources in and around class 1 airsheds, which negatively impacts the health of nearby communities, and undercuts the economic benefits of the national parks and wilderness areas which comprise these airsheds. For example, NOx emissions from increased energy activity in the Permian Basin have led to noted degradation of visibility for park visitors, and repeated instances of 24-hour non-attainment of ozone near Carlsbad Caverns National Park, and deposition of NOx in the area's fragile ecosystem threatens its unique flora and fauna. Damage to the park's resources would greatly harm the area's economy; a 2019 National Park Service report shows that 466,000 visitors to Carlsbad Caverns National Park in 2018 spent $30.2 million in communities near the park. That spending supported 405 jobs in the local area and had a cumulative benefit to the local economy of $34 million.[9]

Given its technical feasibility and cost effectiveness, electrification also ensures that NMED considers measures through the lens of its duty to consider "technical practicability and economic reasonableness of reducing or eliminating air contaminants from the sources involved and previous experience with equipment and methods available to control the air contaminants involved."[10]

Finally, electrification of oil and gas drilling and other operations serves to fulfill cross-cutting initiatives by the state to address various air pollutant emissions. Electrification is mentioned as a pollution control technology for many methane emissions sources. The MAP Technical Report notes that due to the resulting elimination of criteria pollutants, HAPs, and methane, "In some situations, oil and gas operators determine that electrified compression is a viable and preferred technology in place of natural gas fired engines or turbines."(MAP Technical Report p. 99). Further discussion of recommendations for putting electrification into practice can be found in the following sections of the MAP Technical Report, to aid in establishing paths forward for achievement of air quality goals:

- Section 10.4, outlining utility co-op incentives to expand service territories in the pursuit of providing well sites with electricity;
- Section 10.8, recommends the establishment of interagency coordination to more efficiently and speedily develop electrical oilfield infrastructure in cooperation with utilities to manage distributed generation, increasing the ability of operators to cost effectively adopt electrification;
- Section 10.15, recommends that the state allow temporary gen set power on a site, in case of delays in getting line power to the site, mitigating methane as well as haze-causing pollutant emissions.

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[8] Air Quality Control Act, 74-2-5 (E)(1) and (E)(2) NMSA 1978.

[9] U.S. National Park Service (NPS), "Tourism to Carlsbad Caverns National Park Creates $34 Million in Economic Benefits" (May 24, 2019), *Available at* https://www.nps.gov/cave/learn/news/tourism-creates-34-million-in-economic-benefits.htm

[10] Air Quality Control Act, 74-2-5 (E)(3) NMSA 1978.

We thus emphasize the need for interagency coordination among waste and pollution regulators and electric utility regulators, including the Public Regulation Commission, to facilitate policies to most effectively enable electrification.

B. Federal Law

In developing the state's regional haze plan under the federal Clean Air Act, the state has discretion to set NOx emissions limitations that favor electrification. In developing a regional haze SIP, a state must include reasonable progress requirements based on consideration of four factors, including the energy and non-air quality environmental impacts of compliance.[11] The state must also develop a long-term strategy for regional haze that includes enforceable emissions limitations, and emissions reduction measures necessary to make reasonable progress.[12] As explained above, and discussed in further detail in the March 6, 2020 report on Reasonable Progress Controls for the Oil and Gas Sector, electrification of engines used in oil and gas development is a cost-effective pollution control strategy with an array of environmental, climate, and public health co-benefits. The cost effectiveness of this NOx pollution control strategy supports requiring electrification of oil and gas engines and establishing a corresponding very low (near-zero) NOx limit for this source category.

Setting low NO_x emissions limits and considering technology that reduces or eliminates emissions, such as electrification, for oil and gas engines is well within the scope of regional haze analysis and SIP development, and is consistent with the Clean Air Act, and regulatory requirements for reasonable progress outlined in 40 C.F.R. § 51.308(d)(1). Regional haze SIPs must contain "emissions limits, schedules of compliance, and other measures as may be necessary to make reasonable progress toward the national goal." 42 U.S.C. § 7491 (b)(2). In determining what emissions reductions measures are needed to make reasonable progress, states must consider four factors: the cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts of compliance, and remaining useful life of any potentially affected sources. 40 C.F.R. § 51.308(d)(1)(i)(A). Near-zero NO_x emissions limitations would be well within these parameters–and indeed would have positive energy and non-air quality environmental impacts.

Requiring the replacement of gas-fired engines with electric motors would serve as a reasonable progress measure applicable to a source type and would not constitute "redesigning the source" or otherwise fall outside the allowable scope of the state's regional haze planning authority. These engines assume a variety of applications, including gas compression, pumping, and power generation and the functionality of the source is undisturbed irrespective of whether it is subject to more or less stringent emission limitations. The difference is in the scale of pollution emitted or avoided as determined by the type of control strategy or technology employed to achieve an emission limit in order to help achieve a variety of benefits in the public interest, here motivated by requirements to achieve reasonable progress towards natural visibility conditions.

In looking at other regional haze requirements, the BART Guidelines allow states to "establish design, equipment, work practice or other operational standards when limitations on measurement technologies make emission standards infeasible." 40 C.F.R. Appendix Y to Part 51, Section I (E)(3). More broadly, Clean Air Act programs and analyses such as BACT, and PSD afford considerable flexibility

[11] *See* 40 C.F.R. § 51.308(d)(1)(i)(A), (f)(2)(i), (f)(3)(i).
[12] *See* 40 C.F.R. § 51.308 (f)(2)(i), (f)(3)(i).

to regulators in determining the range and type of pollution reduction practices or control strategies for states to consider as well. As the U.S. EPA Environmental Appeals Board has stated:

> "Permit issuers generally have broad discretion in conducting BACT determinations, but they are strongly discouraged from categorizing emissions control options as "impermissible redesign" without first taking the requisite "hard look" at the project. ***To skip this step might result in their "paving an automatic BACT off-ramp" that "frustrates congressional will" and may constitute a reversible abuse of discretion***. *In re N. Mich. Univ.*, 14 E.A.D. 283, 302 (EAB 2009); *accord La Paloma*, slip op. at 26, 16 E.A.D. ___. "[13] (Emphasis added).

Nothing in the Clean Air Act, applicable regulations or guidance, prohibits emissions limitations that reflect the reductions achievable through electrification. NMED should thus exercise its authority under state and federal law to require that oil and gas operators electrify oil and gas engines by either mandating electrification or establishing a NOx emission limit near 0 g/hp-hr. Doing so will expedite New Mexico's progress toward attaining natural visibility in national parks and other Class I areas, help the state in its Ozone Attainment Initiative and efforts to reduce methane emissions and waste, and help New Mexico achieve its climate goals, including but not limited to those outlined in Governor Lujan Grisham's Executive Order 2019-003.

III. SCR as a Feasible, Cost Effective Option Where Electrification is Infeasible

While replacement of gas-fired engines in oil and gas development with electric motors is our preferred pollution control measure, we recognize that there may be instances in which electrification is not feasible. If electrification is demonstrated to be infeasible in a given case, e.g., when there is no reasonable access or reasonable opportunity to create access to a power grid, we recommend that NMED require selective catalytic reduction (SCR), a cost-effective and practicable option as described in the attached Expert Report and the March 6, 2020 report on Reasonable Progress Controls for the Oil and Gas Sector. Some highlights from the Expert Report include:

- SCR has been an effective, feasible technology applied to lean burn engines for nearly four decades.
- Multiple emissions tests conducted in California for several lean burn engines with SCR showed 84% to 87% NO_x reductions, even after several years of operation.
- While space constraints can be a concern for SCR retrofits, there are several proven ways to address this issue. For example, SCR systems can be installed in place of existing exhaust mufflers on the roof of buildings.
- Given the relatively advanced age of most lean-burn engines for which NMED has requested reasonable progress analysis (with many manufactured before the Clean Air Act was enacted in 1970), NMED should also consider replacing these engines with new engines with

[13] *See, e.g., In Re: Arizona Public Service Company Ocotillo Power Plant,* 17 EAD 323, 336-37 (E.P.A. Sept. 1, 2016) *(citing In re N. Mich. Univ.,* 14 E.A.D. 283, 302 (EAB 2009*); In re La Paloma,* 16 EAD 267, 289 (EAB 2014)). ("Each such determination, like each BACT analysis itself, requires a case-by-case analysis and is highly fact- and circumstance-specific. *La Paloma,* slip op. at 26, 16 E.A.D. at ___ (citing CAA § 169(3), 42 U.S.C. § 7479(3)) (defining "BACT" as a "case-by-case" determination); GHG Guidance at 26.").

state-of-the-art low NO_x emission control technology, or, as advocated throughout this letter, replacing them with electric engines that would eliminate NO_x emissions (and other air pollutant emissions) altogether.

IV. Conclusion

Electrification is a feasible, cost-effective pollution control technology which NMED has the authority to require in its regional haze SIP. In addition to helping NMED achieve reasonable progress towards national visibility goals as required by the Clean Air Act, electrification has several co-benefits for climate, health, and ongoing regulatory and policy initiatives in New Mexico. Thus, we request that NMED require emission limitations as reasonable progress for gas-fueled engines reflective of replacement with electric-motors, with limitations reflective of SCR instead as an option when electrification is not feasible.

Thank you again for your continued engagement with the public during the regional haze SIP development process, even amidst the difficult conditions of the COVID-19 pandemic, and for your consideration of the recommendations and information in this letter and attached Expert Report. Please do not hesitate to contact us with any questions or concerns, or to discuss the attached SCR analysis or electrification further.

Sincerely,

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Review of Claims Made by New Mexico Oil and Gas Companies Regarding Applicability of Selective Catalytic Reduction (SCR) to Lean Burn Engines

May 21, 2020

By

Victoria Stamper and Megan Williams

We have reviewed most of the claims raised by New Mexico oil and gas companies regarding applicability of selective catalytic reduction (SCR) to lean burn engines and have conducted additional research beyond what was provided in our March 6, 2020 report. We are providing some additional information to address some of the issues raised in the New Mexico company submittals with respect to SCR on lean burn engines. Specifically, claims were raised that SCR has not been proven for lean burn engines or specifically for two-stroke engines.

As discussed in our March 6, 2020 report on Reasonable Progress Controls for the Oil and Gas Sector, SCR has been applied to lean burn engines since the 1980's. EPA's 1993 Alternative Control Techniques Document for RICE said they had found "23 SCR installations with lean-burn SI engines [] in the United States from information provided by catalyst vendors, in addition to over 40 overseas installations."[1]

EPA's 1993 Alternative Control Techniques (ACT) Document for RICE had emissions test information for 16 SCR applications at lean burn engines at 9 installations in California, including for Cooper-Bessemer engines.[2] Specifically, EPA provided performance data from a California vendor for an SCR application on a 660 hp Cooper-Bessemer Engine (Model GMV-6) that achieved 80% NOx control and data for two Cooper-Bessemer engines Model GMV-8 that also achieved 80% control of NOx.[3] Notably, the GMV-8 engines were using a load-following ammonia control, which is best suited for engines operated at variable load. In addition, EPA's 1993 ACT Document also provided emissions test data from California's Ventura County Air Pollution Control District for SCR used with lean burn RICE, including test data from 1987-1990 for two Cooper-Bessemer engines (Models GMV and GMV-8) and several Clark engines (Engine Models HRA-6 and HRA-32).[4] Note, some of the engines were no longer operating at the time of EPA's 1993 ACT Document due to being electrified as a result of Southern California Edison's incentive program.[5]

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[1] March 6, 2020 Report at 34; EPA 1993 Alternative Control Techniques Document for RICE.

[2] U.S. EPA, Alternative Control Techniques Document – NOx Emissions from Stationary Reciprocating Internal Combustion Engines, EPA -453/R-93-032, July 1993, *available at:* https://www3.epa.gov/airquality/ctg_act/199307_nox_epa453_r-93-032_internal_combustion_engines.pdf ("EPA 1993 ACT Document") at 5-61 to 5-62

[3] *Id.* at Table 5-8 at 5-62.

[4] *Id.*, Appendix A at A-16 (Table A-5).

[5] *Id.*

In September 2000, EPA issued an updated report on Stationary RICE controls.[6] Based on that EPA report, we said in our March 2020 report that "…while diesel engines are the most prevalent applications of SCR at RICE units, SCR has also been applied at lean-burn spark-ignition engines fired with natural gas, including at natural gas pipeline compressor stations."[7] The SCR installations at the time of EPA's 1993 and 2000 reports were mostly if not all from California. Several California air districts had adopted NOx limits for existing RICE that required SCR on lean burn engines particularly if low emissions combustion systems would not have allowed the unit to meet the applicable limits (or were not as cost effective as SCR), as was demonstrated in the cost reports relied on or cited in our report.[8]

In EPA's 2000 Update, it discusses one facility that operated SCR on a lean burn engine for 12 years (from 1984-1996). According to EPA, "[t]he SCR system met or exceeded the guaranteed level of NOx control (70 percent), allowing the facility to meet the applicable emission limit."[9] Indeed, emissions testing from 1993 of this lean-burn SCR retrofit as well as another lean-burn engine the company operated with SCR – eight to nine years after SCR installation – showed the SCR achieving between 84 to 87% NOx reduction.[10] This data certainly seems indicative of SCR working to significantly reduce NOx at lean-burn engines. The EPA 2000 Update identifies costs with operating the SCR, including the costs of continuous emissions monitoring systems (CEMs), cost of anhydrous ammonia, and cost of catalyst replacement.[11] The EPA 2000 Update also said that the facility found operation and maintenance required additional work not normally required for an engine.[12] These are cost issues with the control, but SCR is still a technically feasible control. Twelve years of operational data on a lean-burn engine with the engine continuing to meet high levels of NOx control even after several years of operation clearly show that SCR is a demonstrated technology for lean-burn engines. According to EPA, the company subsequently – twelve years after installation of SCR – replaced the engine with Low Emissions Combustion (LEC)-equipped engines.[13] Thus, there is no current emissions data for the engine reflective of SCR.

The EPA 2000 Update also refers to emissions test data from the Ventura County Air Pollution Control District (VCAPCD) for 7 lean burn engines with SCR, ranging in size from 291 bhp to 800 bhp.[14] The average percent NOx reduction from the test data was 84%.[15] Again, this data indicates that SCR is technically feasible for lean-burn engines. Instead, this data shows that SCR works to significantly reduce NOx from lean-burn engines. This test data was conducted from 1986 to 1993.[16] After 1993, EPA noted that the VCAPCD database did not include test data for lean-burn engines with SCR, but EPA also noted that several engines were replaced with electric motors and that a 1998 paper indicated that

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[6] *See* U.S. EPA, Stationary Reciprocating Internal Combustion Engines Updated Information on NOx Emissions and Control Techniques, EPA-457/R-00-001, September 2000, *available at:* https://nepis.epa.gov/Exe/ZyPDF.cgi/P100V343.PDF?Dockey=P100V343.PDF ("EPA 2000 Update").
[7] March 6, 2020 Report at 35; EPA 2000 Updated Information on NOx Emissions and Control Techniques at 4-13.
[8] March 6, 2020 Report at 36-40.
[9] EPA 2000 Update at 4-14.
[10] *Id.*
[11] *Id.*
[12] *Id.*
[13] *Id.*
[14] *Id.*
[15] *Id.*
[16] *Id.*

VCAPCD's more stringent NOx limits adopted in 1993 were intended to encourage electrification of engines.[17]

EPA's 2000 Update also cited to information from vendors of SCR systems, indicating that SCRs on lean-burn engines since 1993 have been designed to achieve 80-95% control and citing to a design outlet NOx emissions levels for three lean-burn engines at one natural gas pipeline compressor facility of less than 30 ppmv. Again, that information indicates that SCR continued to be applied to lean-burn engines, including those used at compressor stations.

Also, EPA's 2000 Update discussed test summary data for three 3,130 bhp 4-stroke lean-burn engines equipped with SCR systems that were believed to be urea-based.[18] These engines were at a liquid fuel pipeline pumping station and operated at variable loads and variable speeds, "depending on the quantity, pressure, and density of the fuel being pumped."[19] EPA stated, "[t]he SCR system utilizes a feedforward system based on engine load and speed and on exhaust temperature." According to EPA, the engines achieved their required NOx emission limit (15 ppmv or about 0.2 g/bhp-hr) during all testing with NOx emission ranging between 0.11 grams per brake horsepower per hour (g/bhp-hr) and 0.21 g/bhp-hr.[20]

EPA's 2000 Update also discussed a plot of CEM data over a 10 minute period from a heavy-duty diesel truck engine equipped with a feedforward urea SCR system. According to EPA:

> During this period, the engine varied from a speed of about 700 rotations per minute (rpm) at idle to about 2,300 rpm, with load varying concurrently from nearly 0 foot-pounds (ft-lbs) to about 800 ft-lbs. Inlet NOX concentrations varied closely with load, ranging from a less than 10 ppmv up to over 150 ppmv. Outlet NOX concentrations remained relatively stable, varying from nearly 0 ppmv up to about 20 ppmv.[21]

While this CEM data is from a diesel engine, this data shows how a feedforward urea system can address issues of variable NOx emissions due to variable loads and engines speeds – regardless of whether coming from a diesel-fired or gas-fired engine.

EPA further stated:

> Vendors of SCR systems indicate that the feedforward controls on modern systems provide for excellent NOX control in load-following applications. One representative indicated that the advance in technology has been driven by the interest of diesel engine manufacturers, working with catalyst vendors, in developing urea SCR for on-road vehicles. Such vehicles exhibit varying load by nature. [Fn omitted]. Another source also stressed that the PEMS feedforward system, with optional CEMS feedback system, has been advanced by a strong research and development effort. This vendor

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[17] *Id.* at 4-15.
[18] EPA 2000 Update at 4-15.
[19] *Id.*
[20] *Id.*
[21] *Id.*

has supplied such SCR systems for a variety of applications, including stationary IC engines, ship engines, railroad engines, and diesel truck engines. [Fn omitted].[22]

In a more recent example of SCR being applied to two-stroke lean-burn engines, such engines at a power generating facility in Utah were successfully retrofit with SCR systems. Specifically, a Power Engineering article from 2006 discusses the retrofit of SCR systems along with catalytic convertors at lean burn engines at a Springville Utilities power station in Utah.[23] These engines burned 90% natural gas and 10% diesel. The article discusses one of the main problems using a catalyst on a two-stroke engine is the poisoning of the catalyst by the engine lubricant and states that the catalyst selected (manufactured by Miratech Corporation) was "designed to be durable and overcomes this problem."[24] While these units are used to generate electricity, this is still a relevant example of SCR being applied to two-stroke lean-burn engines. It is not known what the age of the two-stroke lean-burn engines that were retrofitted with SCR at the Springville Utilities power station in Utah. It appears that the power station being referred to is the Whitehead Power Plant, which (according to the Springville City website) was built in 1985 and was powered by Enterprise R4-V16 engines and EMD 645 engines.[25]

As another more recent example, a demonstration project was conducted at the Orange County Sanitation District's Central Power Generating Station, which is fueled by 95% landfill digester gas and 5% natural gas.[26] A demonstration project done at one Cooper Bessemer LSBV-12-SGC (a 3,471 hp lean-burn engine that drives a 2.5 MW generator) found that 78-86% NOx reduction could be achieved.[27]

SCR was also installed at the Bio Energy Washington landfill-gas dual-fuel power plant at which there are 18 dual-fuel 350 kW engine generators fueled by landfill gas and diesel.[28] This is a power plant located at the Cedar Hills gas processing facility in Washington.[29] An interesting fact about this application is that each SCR plus oxidation catalyst system treats the exhaust from 6 engines. Thus, only three SCR systems were required for 18 engines,[30] an approach that could greatly reduce the capital cost of NOx reduction and also address space constraints for SCR installation.

While we realize that space constraints can be an issue for SCR retrofits, this is something that has been dealt with on numerous instances for SCR retrofits for numerous industrial facilities. A concern about lack of space for an SCR should not be a reason to discount an SCR as not technically feasible without consultations with vendors about options for SCR locations. For example, the Manufacturers of

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[22] *Id.* at 4-15 to 4-16.
[23] *See* "Emissions Control for Huge Two-Stroke Engines: It Can Work, Power Engineering, 2/3/06, available at https://www.power-eng.com/2006/02/03/emissions-control-for-huge-two-stroke-engines-it-can-work/#gref.
[24] *Id.*
[25] *See* https://www.springville.org/power/about/.
[26] *See* Institute of Clean Air Companies, NJ DEP/ICAC Technology Seminar, November 24, 2014, at Slide 26.
[27] *Id*. at Slide 31. *See also* Johnson Matthey Application fact sheet 1304 for Orange County Sanitation District, available at https://www.jmsec.com/references/application-fact-sheets/?L=0.
[28] *See* Institute of Clean Air Companies, NJ DEP/ICAC Technology Seminar, November 24, 2014, at Slide 24.
[29] *Id.* at 21.
[30] *Id.* at Slide 24.

Emission Controls Association (MECA) describes situations where SCR systems have been installed in place of the existing exhaust muffler on the roof of buildings housing a lean-burn engine.[31]

In terms of SCR applications on lean-burn engines in the EPA's RACT/BACT/LAER Clearinghouse, we found several examples. The table below lists those RBLC entries that we found, which was not necessarily an exhaustive search.

EPA RACT/BACT/LAER Clearinghouse Entries for Lean-burn Engines with SCR

RBLC ID Number	Company Name	Permit Date	Weblink
MI-0440	MICHIGAN STATE UNIVERSITY	5/22/2019	https://cfpub.epa.gov/rblc/index.cfm?action=PermitDetail.PollutantInfo&Facility_ID=28704&Process_ID=113037&Pollutant_ID=149&Per_Control_Equipment_Id=166066
CA-1240	GOLD COAST PACKING	3/17/2017	https://cfpub.epa.gov/rblc/index.cfm?action=PermitDetail.PollutantInfo&Facility_ID=28389&Process_ID=111763&Pollutant_ID=149&Per_Control_Equipment_Id=161706
KS-0030	MID-KANSAS ELECTRIC COMPANY, LLC - RUBART STATION	3/31/2016	https://cfpub.epa.gov/rblc/index.cfm?action=PermitDetail.ProcessInfo&facility_id=28279&PROCESS_ID=111490
KS-0035	TRADEWIND ENERGY, INC.	1/24/2014	https://cfpub.epa.gov/rblc/index.cfm?action=PermitDetail.ProcessInfo&facility_id=28362&PROCESS_ID=111715 and https://cfpub.epa.gov/rblc/index.cfm?action=PermitDetail.PollutantInfo&Facility_ID=28362&Process_ID=111715&Pollutant_ID=149&Per_Control_Equipment_Id=161501
TX-0692	SOUTH TEXAS ELECTRIC COOPERATIVE, INC.	12/20/2013	https://cfpub.epa.gov/rblc/index.cfm?action=PermitDetail.PollutantInfo&Facility_ID=27823&Process_ID=109804&Pollutant_ID=149&Per_Control_Equipment_Id=156478
TX-0663	ETC TEXAS PIPELINE, LTD.	5/25/2012	https://cfpub.epa.gov/rblc/index.cfm?action=PermitDetail.PollutantInfo&Facility_ID=27718&Process_ID=109572&Pollutant_ID=149&Per_Control_Equipment_Id=155758
PA-0303	NATL FUEL GAS SUPPLY CORP	2/2/2012	https://cfpub.epa.gov/rblc/index.cfm?action=PermitDetail.ProcessInfo&facility_id=28009&PROCESS_ID=110380
CA-0959	NEO CALIFORNIA POWER	4/9/2001	https://cfpub.epa.gov/rblc/index.cfm?action=PermitDetail.PollutantInfo&Facility_ID=25194&Process_ID=99462&Pollutant_ID=149&Per_Control_Equipment_Id=125492

In addition to these specific examples of SCR applications, a 2011 report from the state of Delaware highlights many examples of commercially available retrofit NOx controls for engines and turbines used in gas compressor prime mover service, including SCR.[32] Several of the SCR systems were specifically

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[31] Written Statement of the Manufacturers of Emission Controls Association on the San Joaquin Valley Unified Air Pollution Control District's Proposed Amendments to Rule 4702 (August 2, 2011), *available at:* http://www.meca.org/galleries/files/MECA_SJV_Rule_4702_testimony_080211.pdf.

[32] *See* Background Information Oil and Gas Sector Significant Sources of NOx Emissions, *available online at*: https://fossil.energy.gov/ng_regulation/sites/default/files/programs/gasregulation/authorizations/2011/applications/exhibits_11-161-LNG/36_DE_Nox.pdf.

advertised as being applicable to lean-burn natural gas fired engines utilized for gas compression (e.g., CleanAir Systems, Johnson Matthey, Miratech Corporation, Clean Air Power, etc.).[33] We highlighted some of these vendors in our March 2020 report, and pointed out how catalysts have been developed to operate over a wide range of temperatures.[34] Some of the information provided in the Delaware report included specific announcements for orders and installations at lean-burn natural gas compressor engines and / or at natural gas midstream sources (e.g., installations on large lean-burn natural gas compressor engines at gas storage sites in Texas and Mississippi).[35] The Delaware report discusses some of the SCR systems being formulated for operation at a wide range of temperatures, allowing for NOx control over a wide range of engine operation.[36] More generally, the Delaware Report dispels several technical issues specific to two-stroke lean-burn SCR retrofits, including the availability of: (1) modern controls and communication technologies to help overcome potential issues with remotely manned units; (2) catalysts that are effective over wide temperature ranges that are reflective of a wider range in engine operating loads (noting that SCR systems "have been installed on EGUs that start and stop on a daily basis, and change loads across a wider range while on line to balance electric generation to electric demand"); and (3) the ability to closely regulate fuel, air, and reagent flow to ensure proper SCR function over a broad range of operating condition.[37]

Targa's February 2020 Regional Haze Four-Factor Analysis Addendum stated the following in response to NMED's request for the "historical precedent that installation of SACR on two-stroke lean-burn (@SLB) engines can result in significant technical complications, require deration of engines, and unreliable operation post-retrofit:"

> Selective catalytic reduction technology has not been applied successfully to 2SLB engines. After researching SCR controls on 2SLB engines, the EPA document titled "Technical Issues Related to the Potential Use of Selective Catalytic Reduction (SCR) to Reduce NOx Emissions from Natural Gas-Fired Lean Burn Engines" is the only document found with information on the application of SCR's on 2SLB engines. This documentation shows that many units did not perform properly after SCR was installed. Targa was unable to find any historical installation of SCR on 2SLB engines in the RLBC tables. The only proven technology to control NOX for 2SLB engines is Clean Burn Technology. This is also the technology recommended by the engine control vendor to control NOX for the units at Targa's three gas plants.[38]

It must first be pointed out that the document that Targa referred to as an "EPA document" is a 1998 document prepared for the Gas Research Institute. Second, the document referred to is now twenty-two years old. We provided one example of SCR being successfully retrofit to lean-burn engines at the Springville Utilities Power Station in Utah. Further, the 2011 Delaware reported discussed above highlights several SCR vendors with a focus on lean-burn engines, including two-stroke lean-burn

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[33] *Id.* at PDF pp. 29-32.
[34] March 6, 2020 Report at 34. *See also* https://matthey.com/en/products-and-services/emission-control-technologies/mobile-emissionscontrol/selective-catalytic-reaction, https://www.miratechcorp.com/products/cbl/, and http://intermountainelectronics.com/uploads/media/Media_633929646982817973.pdf.
[35] *Id.* at PDF p. 31.
[36] *Id.* at PDF p. 30. (Johnson Matthey).
[37] *Id.* at PDF p. 35.
[38] February 2020 Regional Haze Four-Factor Analysis Addendum, Targa Midstream Services LLC, at pdf page 7.

engines. With respect to the RLBC not identifying any two-stroke engines using SCR, the RBLC entries that we found showing SCR being required on lean-burn engines generally do not specify whether the engines are two-stroke or four-stroke.

In summary, the information provided herein shows that SCR is considered a demonstrated technology that can be applied to lean-burn engines. The information presented above shows examples of SCR being applied to Cooper-Bessemer and Clark lean-burn engines. including two-stroke lean-burn engines. The reports cited above show application of SCR to natural gas-fired lean-burn engines used in the oil and gas industry starting in the 1980's to 1990's, and the RBLC data show SCR being required on lean-burn engines in more recent years including those used in the oil and gas industry. While application of SCR to lean-burn engines used in the oil and gas industry may not be commonplace, one cannot say it has not been required or implemented on lean-burn natural gas-fired engines used in the natural gas industry. Further, the fact that SCR has been retrofit and installed on lean-burn engines used in electricity production is still relevant information. Because most of those lean-burn engines operate as peaking or peak shaving power plants, the lean-burn engine load will vary greatly, more in line with how a compressor engine would operate. Thus, the use of SCR at natural gas-fired power generating lean-burn engines provides further support of the feasibility of SCR for lean-burn engines used in the oil and gas industry.

We understand that the age of the lean-burn engines for which NMED has requested reasonable progress analyses are quite old. Our review based on age of engines reported in permits for the New Mexico facilities shows that the age range of the lean-burn engines for which New Mexico has targeted for reasonable progress controls ranges from 39 years to as high as 72 years. Most of the engines were manufactured before the 1970 Clean Air Act was enacted. It appears that in most cases, the companies have not proposed any NOx controls for these older lean-burn engines in their reasonable progress analyses, claiming that SCR is not feasible and that Clean Burn (i.e., low emissions combustions) is too costly to retrofit. Given the age of these engines, consideration should be given to the control of replacing the engines with new engines with state-of-the-art low NOx emission control, or replacing the engines with electric engines powered off the grid which would reduce emissions of NOx (and all other pollutants from the engines) down to zero. As discussed in our March 6, 2020 Report, replacement of engines with electric motors can be quite cost effective.[39]

[39] March 6, 2020 Report at 41-46.