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INCREASING GASOLINE OCTANE LEVELS TO REDUCE VEHICLE EMISSIONS:

A Review of Federal and State Authority

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EXECUTIVE SUMMARY

With concern growing over the transportation sector's contribution to climate change, many vehicle manufacturers are looking to deploy more efficient, high compression engines that have greater fuel economy and emit less carbon dioxide. To date, however, use of high compression engines has been hampered by the low octane rating of gasoline. This increases the potential for engine knock, wherein gasoline self-ignites and explodes, impairing vehicle performance and efficiency. Seeking to overcome this issue, vehicle manufacturers have called on the U.S. Environmental Protection Agency ("EPA") to adopt regulations to increase gasoline octane levels. While EPA officials have previously expressed support for regulation, it is unclear whether action will be taken by the Trump Administration. In the absence of federal action, states may wish to adopt their own regulations. This paper explores the legal basis for regulation at the federal and/or state levels.

EPA is the only federal agency authorized to regulate gasoline and other motor vehicle fuels. Regulatory authority is conferred on EPA by section 211 of the Clean Air Act. In that section, Congress expressed a clear preference for federal fuel regulation, curtailing state regulatory authority. Notably, the section pre-empts state regulation where EPA has regulated a fuel or found regulatory action to be unnecessary. There is, however, an exception for California which may adopt its own fuel regulations regardless of any action by EPA. Regulations adopted by California are not subject to review and/or approval by EPA. The regulations only apply in California and cannot be adopted by other states, in preference to federal regulations, as is permitted with respect to vehicle emission standards.

Under section 211(c) of the Clean Air Act, EPA may promulgate regulations with respect to the composition or characteristics of a fuel, including its octane rating. Regulation may occur through two pathways, namely:

(A) under section 211(c)(1)(A), EPA may regulate a fuel after:

- (I) finding that the fuel or its emission products contribute to air pollution that may reasonably be anticipated to endanger the public health or welfare; AND
- (II) considering medical and scientific evidence, including other technically or economically feasible means of achieving vehicle emissions standards, adopted under section 202 of the Clean Air Act; OR

(B) under section 211(c)(1)(B), EPA may regulate a fuel after:

(I) finding that emission products of the fuel will impair, to a significant degree, the performance of an emissions control device in or near general use; AND

(II) considering scientific and economic data, including a cost benefit analysis comparing emission control devices that require adoption of fuel regulations, with devices that do not.

A flow chart summarizing the process EPA must follow when adopting fuel regulations is included in Appendix 1 to this paper. As indicated there, the first question EPA must ask is whether the fuel to be regulated contributes to air pollution that endangers public health or welfare. This requirement is clearly met with respect to low octane gasoline, use of which necessitates the deployment of low compression engines, which emit significant carbon dioxide, a form of air pollution that contributes to climate change and thereby endangers public health. Nevertheless, prior to regulating gasoline octane levels, EPA must consider other means of achieving vehicle emissions standards. The legislative history and subsequent case law suggest that this requires EPA to consider whether regulation is "necessary or otherwise advisable" to achieve the standards.

EPA has established carbon dioxide emissions standards for model year 2012 through 2025 light-duty vehicles. Research by EPA and the Department of Transportation suggests that those standards can be achieved through improvements in engine design without any change in fuels. This has, however, been disputed by some vehicle manufacturers who claim that an increase in fuel octane levels is necessary to achieve the standards at low cost.

EPA could regulate low octane gasoline if evidence before it demonstrates that the emissions standards cannot be achieved without increasing octane levels or that such an increase would significantly lower the costs of achieving the standards. If EPA fails to act, state agencies may regulate octane provided EPA has not determined such regulation to be unnecessary. Even if EPA makes such a determination, however, regulations could be adopted by California.

CONTENTS

1. INTRODUCTION

The transportation sector is a major source of carbon dioxide and other greenhouse gases that contribute to climate change. According to the Environmental Protection Agency ("EPA"), the U.S. transportation sector emitted over 1.7 billion metric tons of carbon dioxide in 2014, equivalent to thirty one percent of national carbon dioxide emissions.[1] Approximately sixty percent of the transportation sector's emissions result from the use of light-duty vehicles ("LDVs"), primarily passenger cars, pick-up trucks, and sport utility vehicles, equipped with internal combustion engines powered by gasoline.[2] The combustion of gasoline in the engine produces carbon dioxide and other air pollutants that are emitted via the vehicle tailpipe.

Seeking to reduce carbon dioxide emissions from LDVs, EPA has adopted tailpipe emissions standards for model year ("MY") 2012 through 2025 vehicles, pursuant to section 202 of the Clean Air Act ("LDV Emissions Standards"). The standards become more stringent over time, requiring a forty-five percent reduction in average tailpipe emissions, from 295 grams per mile in MY2012 to 163 grams per mile in MY2025.[3] Seeking to achieve those reductions, vehicle manufacturers have made various engine design changes, leading to increased fuel economy.[4] There remains further scope for improvement, however.

One emissions reduction strategy that has yet to be fully explored involves increasing engine compression ratios. In high compression ratio engines, gasoline is subjected to greater pressure in the combustion chamber and therefore burns more completely, producing more power

[1] EPA, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990 – 2014 3-10 (2016), *available at* https://perma.cc/CPB2-V36Y (indicating that the transportation sector emitted 1,737.6 million metric tons of carbon dioxide in 2014). See also *Id*. at ES-5 – ES-7 (indicating that total carbon dioxide emissions in the U.S. in 2014 were 5,556.0 million metric tons).

[2] *Id*. at 3-18.

[3] See EPA, REGULATORY ANNOUNCEMENT: EPA AND NHTSA SET STANDARDS TO REDUCE GREENHOUSE GASES AND IMPROVE FUEL ECONOMY FOR MODEL YEARS 2017-2025 CARS AND LIGHT TRUCKS (2012), *available at* https://perma.cc/GH5F-55ZT; EPA, REGULATORY ANNOUNCEMENT: EPA AND NHTSA FINALIZE HISTORIC NATIONAL PROGRAM TO REDUCE GREENHOUSE GASES AND IMPROVE FUEL ECONOMY FOR CARS AND TRUCKS (2010), *available at* https://perma.cc/5X8Y-AN3Y.

[4] *See generally* EPA, PROPOSED DETERMINATION ON THE APPROPRIATENESS OF THE MODEL YEAR 2022-2025 LIGHT-DUTY VEHICLE GREENHOUSE GAS EMISSIONS STANDARDS UNDER THE MIDTERM EVALUATION (2016), *available at* https://perma.cc/R3TP-UWWR.

with fewer emissions. In view of these benefits, vehicle manufacturers have deployed high compression ratio engines in LDVs destined for the European market, but not yet in U.S. LDVs.[5] This is primarily due to concerns over the potential for high compression engines to experience knock – an abnormal combustion phenomenon wherein fuel self-ignites and explodes – unless used with specialized fuel with a high octane rating.[6] While widely available in Europe and other markets, such fuel is in limited supply in the U.S.

Seeking to realize the benefits of high compression engines, vehicle manufacturers have called for an increase in gasoline octane levels.[7] EPA officials have previously raised the possibility of regulating octane under the Clean Air Act.[8] It is, however, unclear whether regulatory action will be taken by the Trump Administration. If it is not, states may seek to adopt their own regulations. This paper explores the potential legal basis for federal and/or state regulatory action. The remainder of the paper is structured as follows: Section 2 provides background on gasoline octane and its relevance to engine design. Section 3 then discusses the possibility of federal regulation of octane under the Clean Air Act. The possibility of state regulation is discussed in Section 4. Section 5 concludes.

2. OCTANE: A PRIMER

A fuel's octane rating reflects its potential to self-ignite when compressed in a vehicle engine. During typical engine operation, the piston drops to the bottom of the combustion cylinder, which then fills with a mixture of fuel and air. The mixture is compressed by the rising piston and ignited by the spark plug. Sometimes, however, the compressed fuel-air mixture can self-ignite. This sets off an explosion, which forces the piston back down before it has reached the

[5] *See generally* Bo Zhang & S. Mani Sarathy, *Lifecycle Optimized Ethanol-Gasoline Blends for Turbocharged Engines*, 181 APPLIED ENERGY 38, 40 (2016)

[6] Fuel octane is typically measured using the research octane number (RON). See Raymond L. Speth et al., *Economic and Environmental Benefits of Higher-Octane Gasoline*, 48 ENVIRON. SCI. TECHNOL. 6561, 6561 – 6562 (2014).

[7] *See e.g.* Letter from Alliance of Automobile Manufacturers, to EPA (Oct. 6, 2011), *available at* https://perma.cc/AWZ4-J99Z (select "Attachment A: Alliance letter 10-6-2011").

[8] 42 U.S.C. 7401 et seq. See Richard Truett, *EPA Signals it will Start Looking at Mandating Higher Octane Gasoline*, AUTOMOTIVE NEWS (Aug. 23, 2016), https://perma.cc/29QH-FWQM.

top of its cycle, a phenomenon known as engine knock. This results in a loss of vehicle efficiency and can, in severe cases, lead to engine damage and/or reduced performance.

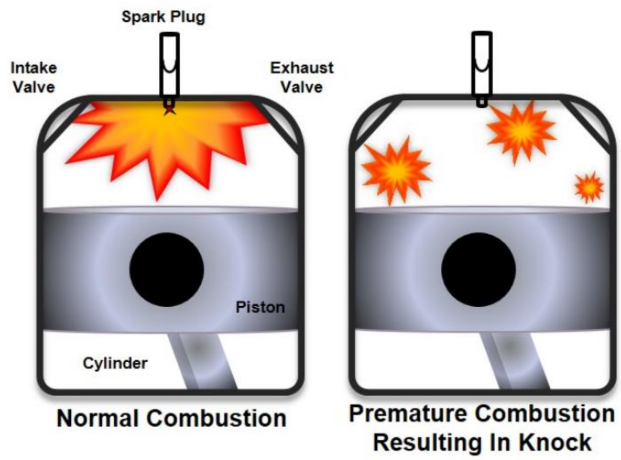

Figure 1: Normal and premature engine combustion[9]

A fuel's ability to withstand compression without self-igniting is reflected in its research octane number ("RON").[10] The higher a fuel's RON, the less likely it is to self-ignite when compressed by the piston. Straight-run gasoline (i.e., distilled directly from crude oil) has a fairly low RON, meaning that it is prone to self-ignition when compressed. Its RON can, however, be increased using various additives including:

- *tetraethyl lead*, which was used to increase gasoline octane levels throughout much of the 20th century but banned from January 1996 due to concerns over the health impacts of lead particles;[11]

[9] SADAF SOBHANI, ENERGY FUTURE COALITION, AIR POLLUTION FROM GASOLINE POWERED VEHICLES AND THE POTENTIAL BENEFITS OF ETHANOL BLENDING: A REVIEW OF PARTICULATE, NITROGEN OXIDE, AND VOLATILE ORGANIC COMPOUND POLLUTION 6 (2016), *available at* https://perma.cc/CL69-7ZMV

[10] A fuel's RON reflects its octane rating as measured in a test engine operating at fairly low speed (i.e., 600 revolutions per minute). Fuel octane ratings can also be measured using the motor octane number ("MON"), which tests the fuel under more stressful conditions, including higher engine speed (i.e., 900 revolutions per minute) and variable ignition. RON is generally considered a more accurate octane rating and is, therefore, used in this paper. *See* Speth et al., *supra* note 6, at 6562 (indicating that RON "is a better predictor of knock resistance in most modern engines"). See also TIM THEISS ET AL.,OAK RIDGE NATIONAL LABORATORY, SUMMARY OF HIGH-OCTANE, MID-LEVEL ETHANOL BLENDS STUDY 2 (2016), *available at* https://perma.cc/9Q6K-45X2 (noting that "[i]n the U.S., the octane number at the retail pump is given as the anti-knock index (AKI), the average of the RON and the motor octane number").

[11] *See generally*, RICHARD G. NEWELL & KRISTIAN ROGERS, RESOURCES FOR THE FUTURE, THE U.S. EXPERIENCE WITH THE PHASEDOWN OF LEAD IN GASOLINE (2003), *available at* https://perma.cc/RV7Y-SUT9.

- *ethers* such as methyl-tertiary-butyl-ether ("MTBE"), which was used in place of lead in the 1990s and early 2000s but has now been banned in several states due to its potential to contaminate water supplies;[12]
- *aromatics* such as benzene, which has recently been used as an alternative to lead and MTBE but is currently being phased out amid concerns over its air quality impacts;[13] and
- *alcohols* such as ethanol, which currently makes up approximately ten percent of regular gasoline and a larger percentage of premium blends.[14]

Most fuel retailers sell multiple grades of gasoline, each with a different octane rating. The vast majority of gasoline sold in the U.S., known as regular or E87,[15] has a low RON of 91.[16] Mid-grade gasoline (also known as E89) has an RON of 93 and premium gasoline (also known as E92) has an RON of 95 to 98.[17] These fuels are, however, significantly more expensive than regular gasoline.[18] Likely for this reason, they are not widely used; mid-grade and premium gasoline respectively accounted for just 6.9 and 10.3 percent of all gasoline sales in the U.S. in 2015.[19]

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[12] *See generally*, JAMES E. MCCARTHY & MARY TIEMANN, CONGRESSIONAL RESEARCH SERVICE, MTBE IN GASOLINE: CLEAN AIR AND DRINKING WATER ISSUES (2006), *available at* https://perma.cc/9H3J-L39B.

[13] *See generally*, ENVIRONMENTAL & ENERGY STUDY INSTITUTE, A BRIEF HISTORY OF OCTANE IN GASOLINE: FROM LEAD TO ETHANOL (2016), *available at* https://perma.cc/YL4E-BDPB.

[14] *See generally*, Zhang & Sarathy, *supra* note 5, at 38. EPA has approved the use of gasoline blends containing up to fifteen percent ethanol in MY2011 and newer LDVs. See EPA, *E15 Fuel Registration*, FUELS REGISTRATION, REPORTING, AND COMPLIANCE HELP, https://perma.cc/E98W-RCY7 (last visited Jan. 10, 2017). EPA has also approved the use of gasoline blends containing up to eighty-three percent ethanol in flex fuel vehicles. See EPA, *E85 Fuel*, RENEWABLE FUEL STANDARD PROGRAM, https://perma.cc/77NB-D65Q (last visited Jan. 10, 2017).

[15] The "E" number of gasoline reflects its octane rating, as measured using the anti-knock index (AKI). The AKI is calculated by averaging the RON and MON of the gasoline.

[16] Robert L. McCormick, National Renewable Energy Laboratory, High Octane Fuels: Benefits and Challenges, https://perma.cc/29RQ-R76E (Mar. 17, 2016).

[17] *Id*.

[18] U.S. Energy Information Administration, *Price Spread Between Regular and Premium Gasoline has Changed Over Time,* TODAY IN ENERGY, http://www.eia.gov/todayinenergy/detail.cfm?id=11131 (last updated May 6, 2013) (indicating that, as of January 2013, premium gasoline cost 30 cents per gallon more than regular gasoline).

[19] U.S. Energy Information Administration, *Refiner Motor Gasoline Sales Volumes*, PETROLEUM & OTHER LIQUIDS, http://www.eia.gov/dnav/pet/pet_cons_refmg_d_nus_VTR_mgalpd_a.htm (last updated Sep. 1, 2016).

2.1 Why Use High Octane Gasoline?

The key advantage of high octane gasoline is its reduced potential to self-ignite when compressed. It can, therefore, be used in high compression engines[20] that are more fuel efficient and emit less carbon dioxide than current models.[21] Most U.S. LDVs currently operate with engine compression ratios between 6:1 and 10:1.[22] This is significantly lower than the engine compression ratios used in LDVs in many other regions.[23] Most LDVs in Europe, for example, have an engine compression ratio of 11.5:1.[24] The use of such vehicles is made possible by the widespread availability of high octane fuels. Whereas the majority of gasoline sold in the U.S. has an RON of 91, in Europe, the RON of most gasoline exceeds 95.[25]

The low RON of U.S. gasoline has likely discouraged vehicle manufacturers from introducing high compression engines. A 2012 study by Ford Motor Company ("Ford Study") found:

> [T]o ensure acceptable operation and durability in all situations, auto manufacturers . . . design engines with CRs [(i.e., compression ratios)] that are compatible with the lowest octane-rated fuel available for the country where that vehicle will be operated. If vehicle manufacturers knew with certainty that the minimum octane rating of fuel would increase at a known future date and remain at these levels, it would be possible to provide future engines that are designed with high CRs.[26]

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[20] The "compression ratio" reflects the ratio of the maximum volume of the combustion cylinder (i.e., when the piston is at the bottom) to the minimum volume of the cylinder (i.e., when the piston is at the top). See SOBHANI, *supra* note 9, at 5.

[21] Theiss et al., supra note 10, at 2 (noting that "higher octane fuels will allow higher efficiency designs of" vehicle engines).

[22] J.E. Anderson et al., *High Octane Number Ethanol-Gasoline Blends: Quantifying the Potential Benefits in the United States*, 97 FUEL 585, 587 (2012).

[23] Zhang & Sarathy, *supra* note 5, at 40.

[24] *Id*.

[25] Anderson et al., *supra* note 22, at 591.

[26] *Id*. at 591. See also SOBHANI, *supra* note 9, at 5 (noting that "[a]utomakers design the extent of piston compression of their engines to be compatible with current fuel octane standards").

Fuel octane ratings would need to increase by approximately three to six RON to support a one point increase in engine compression ratios (e.g., from 10:1 to 11:1).[27]

A 2014 study by the Massachusetts Institute of Technology ("MIT Study") estimated that future LDVs, equipped with high compression engines and using a gasoline blend with a minimum RON of 98, would consume approximately two to five percent less fuel than existing vehicles.[28] Even greater fuel economy could be realized from using high octane gasoline in turbocharged engines. In these engines, a turbocharger is used to force more fuel and air into the combustion chamber, leading to higher thermal efficiency. This enables engine downsizing which, provided high octane gasoline is used, results in increased efficiency.[29] Research by the Department of Energy's Oak Ridge National Laboratory ("ORNL Study") indicates that increasing gasoline's RON to 101 would enable development of downsized engines which are up to ten percent more fuel efficient than current models and emit nine percent fewer greenhouse gases.[30]

Switching to high octane gasoline would also enable efficiency improvements in existing LDVs, which are equipped with electronic controls that adjust spark timing based on the octane content of gasoline. According to the Ford Study:

> Nearly all modern spark-ignited engines are equipped with knock sensors and adaptive spark control, allowing the engine to adjust to the octane rating of the fuel under actual operating conditions. Fuel with greater knock resistance allows earlier (more advanced) spark timing at high loads, which improves engine efficiency . . . The observed benefits depend on many factors of engine design, calibration, and operation . . . Improvements in fuel efficiency would be realized under high-load or high acceleration conditions observed in actual consumer driving.[31]

The ORNL Study estimates that some existing vehicles, equipped with turbocharged, direct injection engines, could see an increase in fuel economy of more than five percent.[32] For most

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[27] David S. Hirshfeld et al., *Refining Economics of U.S. Gasoline: Octane Ratings and Ethanol Content*, 48 ENVIRONMENTAL SCIENCE & TECHNOLOGY 11064, 11065 (2014). The range reflects differences in cylinder design and engine technology (e.g., direct injected or port fuel injected, turbocharged or naturally aspirated).
[28] Speth et al., *supra* note 6, at 6563 – 6564. This reflects the estimated decline in total fuel use (i.e., of gasoline and octane enhances).
[29] Downsized engines are prone to knock when used with low octane fuels. See *Id*.
[30] *Id*. at 5-6.
[31] Anderson et al., *supra* note 22, at 591.
[32] Theiss et al., *supra* note 10, at 9.

existing vehicles, however, the increase is likely to be smaller.[33] Nevertheless, given the large volume of fuel currently consumed by LDVs and the high level of emissions resulting therefrom, even a small improvement could have significant benefits.

2.2 Potential Drawbacks of Using High Octane Gasoline

The reduction in vehicle carbon dioxide emissions associated with switching to high octane gasoline may be partially offset by increased emissions from fuel production. The net effect will depend on the production process used and, in particular, the additive(s) blended with gasoline to increase its octane rating. As noted in section 2 above, restrictions have been imposed on the use of several additives, including lead, ethers, and aromatics. High octane gasoline is, therefore, often produced using reformates. Reformates are intermediary products of gasoline refining, produced from low-octane naptha feedstocks in catalytic reforming units, which use catalysts to reform (i.e., rearrange the molecules of) the naptha to form a higher-octane product. The reformation process is highly energy intensive and, as such, any increase in its use (e.g., to support high octane fuel production) may lead to higher refinery carbon dioxide emissions.

The extent of any increase in refinery emissions will depend on several factors, including the precise RON of the high octane fuel produced and demand for that fuel. The 2014 MIT Study considered a situation in which high octane fuel, with an RON of 98, is used by seventy-five percent of LDVs by 2040.[34] Those vehicles were assumed to be equipped with more efficient, high compression engines, leading to a reduction in fuel demand and production.[35] Total production of fuel was estimated to decline by approximately six percent compared to the reference case (i.e., in which high octane fuel and high compression engines are not introduced).[36] Nevertheless, refinery emissions were estimated to increase by eight percent due to greater use of catalytic reforming to produce high octane fuel.[37] This increase would, however, be more than offset by the reduction in

[33] The Ford Study estimates that, for most vehicles, "[t]he actual reduction in fuel consumption and [carbon dioxide] emissions would likely be less than a few percentage points." See Anderson et al., *supra* note 22, at 591.

[34] Speth et al., *supra* note 6, at 6562-6564.

[35] *Id*. at 6563.

[36] *Id*. at 6564.

[37] High octane fuel was estimated to make up eighty percent of production, compared to ten percent in the reference case. *Id*. at 6564 - 6565.

vehicle carbon dioxide emissions.[38] On a lifecycle (well-to-wheels) basis[39] net emissions would fall by nine to thirty-five megatons per year or up to five percent compared to the reference case.[40]

High octane fuel can be produced without reformates, using ethanol, which has a fairly high RON of 109.[41] Blending ethanol with gasoline has a non-linear effect on the RON of the finished blend; as more ethanol is added, the RON of the blend increases, but at a decreasing rate.[42] For this reason, mid-ethanol blends (i.e., containing twenty to thirty percent ethanol) are generally considered optimal from an emissions reduction perspective.[43] Research suggests that moving from mid- to high-ethanol blends is likely to result in only modest reductions in vehicle emissions. Those reductions may be offset by increased emissions from ethanol production.

A 2016 study estimated lifecycle (well-to-wheels) carbon dioxide emissions associated with the use of ten high octane fuel blends containing nine to thirty-eight percent ethanol.[44] For each blend, estimates were prepared assuming the use of corn-based ethanol, as well as sugarcane ethanol.[45] All of the sugarcane ethanol blends were found to have lower lifecycle emissions than regular gasoline.[46] The optimal blend, containing thirty-two percent sugarcane ethanol ("E32"),had lifecycle emissions seven to nine percent less than those of regular gasoline.[47] Blends containing more sugarcane ethanol were found to have higher lifecycle emissions than E32 as the increase in production emissions exceeded the reduction in vehicle emissions "due to limited combustion

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[38] *Id*. at 6562.
[39] The lifecycle analysis reflects total emissions associated with the extraction and transportation of crude oil, the refining of crude oil to produce high octane gasoline, and the use of high octane gasoline in vehicles.
[40] *Id*. at 6565.
[41] JAMES E. ANDERSON ET AL., OCTANE NUMBERS OF ETHANOL-GASOLINE BLENDS: MEASUREMENTS AND NOVEL ESTIMATION METHOD FROM MOLAR COMPOSITION 2 (2012), *available at* https://saemobilus.sae.org/content/2012-01-1274.
[42] *Id*. at 7 – 8.
[43] *See, for example*, THEISS ET AL., *supra* note 10.
[44] Each blend had an RON exceeding 97.3 (i.e., the RON of premium gasoline). The study also assessed lifecycle emissions from several lower RON blends. See Zhang & Sarathy, *supra* note 5, at 46.
[45] *Id*.
[46] *Id*. at 45.
[47] *Id*. at 46 (estimating lifecycle emissions from the use of 105 RON fuel, containing 32 percent sugarcane ethanol at 195 grams per kilometer, compared to 210 grams per kilometer for regular fuel containing eight percent sugarcane ethanol, and 214 grams per kilometer for regular fuel containing eight percent corn ethanol).

efficiency gain at high ethanol contents."[48] The high sugarcane ethanol blends did, however, have lower lifecycle emissions than regular gasoline.[49]

The 2016 study found that high octane fuel blends produced with corn-based ethanol typically have higher lifecycle carbon dioxide emissions than those containing sugarcane ethanol.[50] The study found that producing E32 with corn ethanol (i.e., rather than sugarcane) would result in lifecycle emissions equaling those of regular gasoline.[51] Lifecycle emissions from two other blends, containing thirty-six and thirty-eight percent corn ethanol, were found to be slightly higher than regular gasoline.[52] Notably however, mid-ethanol blends (i.e., containing up to twenty-two percent corn ethanol) had lifecycle emissions one to four percent lower than regular gasoline.[53] According to the ORNL Study, lifecycle emissions from blends containing twenty-five percent corn ethanol are eight to nine percent lower than those from regular gasoline.[54]

The above findings suggest that switching to high octane, mid-ethanol fuel blends would reduce carbon dioxide emissions. Vehicles using ethanol fuel blends may emit other air pollutants, most notably aldehyde, which contributes to smog formation.[55] Research suggests, however, that the increase in aldehyde emissions associated with switching from low- to mid-ethanol blends is l small and can be mitigated through changes in vehicle engine design.[56] Aldehyde emissions would not occur at all where vehicles use high octane fuel produced without ethanol (e.g., using reformates). In both cases, vehicle emissions of nitrogen oxide may increase due to the deployment

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[48] *Id*. at 45. (estimating lifecycle emissions from fuel containing 36 and 38 percent sugarcane ethanol at 196 grams per kilometer, compared to 195 grams per kilometer for fuel containing 32 percent sugarcane ethanol).

[49] *Id*. (estimating lifecycle emissions from fuel containing 36 and 38 percent sugarcane ethanol at 196 grams per kilometer, compared to 210 grams per kilometer for regular gasoline containing eight percent sugarcane ethanol, and 214 grams per kilometer for regular fuel containing eight percent corn ethanol).

[50] *Id*. at 46.

[51] *Id*.

[52] *Id*. (estimating lifecycle emissions from the use of high octane fuel containing 36 and 38 percent corn ethanol at 217 and 219 grams per kilometer, respectively).

[53] *Id*. (estimating lifecycle emissions from the use of high octane fuel containing 9, 12, 18, and 22 percent corn ethanol at 205, 207, 210, and 212 grams per kilometer, respectively).

[54] Thiess et al., *supra* note 10, at 11.

[55] *See generally* Mark Z. Jacobson, *Effects of Ethanol (E85) Versus Gasoline Vehicles on Cancer and Mortality in the United States*, 41 ENVIRON. SCI. TECHN. 4150 (2007).

[56] Roger Tanner et al., *Atmospheric Chemistry of Aldehydes: Enhanced Peroxyacetyl Nitrate Formation from Ethanol-Fueled Vehicular Emissions*, 22 ENVIRON. SCI. TECHNOL. 1026, 1027 (1988) (indicating that blends containing twenty percent ethanol are likely to produce only "marginal higher" aldehyde emissions).

of high compression engines, which combust fuel at higher temperatures.[57] Again, however, such emissions can be mitigated through engine design changes.[58] Manufacturers may have to make such changes to comply with nitrogen oxide emissions standards adopted by EPA under section 202 of the Clean Air Act.[59] Those standards will effectively prevent any increase in nitrogen oxide emissions from new vehicles. While the standards do not apply to existing vehicles, emissions therefrom are likely to be minimal. Following the switch to high octane gasoline, existing vehicles' engine compression ratios will remain unchanged, avoiding the temperature increases that cause higher emissions.

3. FEDERAL REGULATION OF GASOLINE OCTANE LEVELS

EPA is the only federal agency authorized to regulate gasoline and other motor vehicle fuels.[60] Section 211(c) of the Clean Air Act authorizes EPA to adopt regulations controlling or prohibiting a fuel if certain pre-requisites are met. The section provides, in relevant part:

> **Section 211. Regulation of Fuels**
>
> **(c) Offending Fuels and Fuel Additives; Control; Prohibition**
>
> **(1)** The Administrator may . . . by regulation, control or prohibit the manufacture, introduction into commerce, offering for sale, or sale of any fuel or fuel additive for use in a motor vehicle, motor vehicle engine, or nonroad engine or nonroad vehicle if, in the judgment of the Administrator, [(A)] any fuel or fuel additive or any emission product of such fuel or fuel additive causes, or contributes to air pollution or water pollution (including any degradation in the quality of groundwater) that may reasonably be anticipated to endanger the public health or welfare, or (B) emission products of such fuel or fuel additive will impair to a significant degree the performance of any emission control device or system which is in general use, or which the Administrator finds has been developed to a point where in a reasonable time it would be in general use were such regulation to be promulgated.

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[57] *See generally* B.M. Masum, *Effect of Ethanol-Gasoline Blend on NOX Emissions in SI Engine*, 24 RENEWABLE & SUSTAINABLE ENERGY REVIEWS 209 (2013). Some studies suggest that using high octane fuel produced with ethanol may reduce nitrogen oxide emissions as ethanol has a higher heat of vaporization than gasoline which translates to lower compressed gas temperatures. See SOBHANI, *supra* note 9, at 16 – 17.

[58] *See generally* Masum, *supra* note 57.

[59] Tier 2 Motor Vehicle Emissions Standards & Gasoline Sulfur Control Requirements, 65 Fed. Reg. 6,698 (Feb. 10, 2000) (establishing emissions standards with respect to nitrogen oxides and non-methane hydrocarbons, which apply to new LDVs beginning in MY 2004).

[60] The Federal Aviation Authority has authority over aircraft fuels in certain circumstances.

> **(2)(A)** No fuel, class of fuels, or fuel additive may be controlled or prohibited by the Administrator pursuant to clause (A) of paragraph (1) except after consideration of all relevant medical and scientific evidence available to him, including consideration of other technologically or economically feasible means of achieving emission standards under section [201] of this title.
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> **(B)** No fuel or fuel additive may be controlled or prohibited by the Administrator pursuant to clause (B) of paragraph (1) except after consideration of avoidable scientific and economic data, including a cost benefit analysis comparing emission control devices or systems which are or will be in general use and require the proposed control or prohibition with emission control devices or systems which are or will be in general use and do not require the proposed control or prohibition . . .
>
> **(C)** No fuel or fuel additive may be prohibited by the Administrator under paragraph (1) unless he finds, and publishes such finding, that in his judgment such prohibition will not cause the use of any other fuel or fuel additive which will produce emissions which will endanger the public health or welfare to the same or greater degree than the use of the fuel or fuel additive proposed to be prohibited.

EPA has relied on section 211(c) to regulate the composition of gasoline, imposing restrictions on the use of lead,[61] sulfur,[62] and other additives. While EPA has not previously regulated octane or other gasoline properties, such regulation is arguably permissible under section 211(c).The legislative history of the section indicates that it was intended to confer broad authority on EPA to regulate any aspect of a fuel that affects vehicle emissions. In its report on the section, the Senate Committee on Public Works noted that it is "concern[ed] with emissions from the [vehicle] tailpipe."[63] This concern is reflected in the language of the section, which links regulatory action to emissions. Based on that language, the court in *City of Park City v. Alon USA Energy Inc*. held that "EPA's authority to prescribe fuel regulations is a function of vehicle

[61] Regulation of Fuels and Fuel Additives, 38 Fed. Reg. 1,258 (Jan. 10, 1973) (adopting regulations requiring certain retail stations to offer for sale at least one grade of lead-free and phosphorus-free gasoline from July 1, 1973); Control of Lead Additives in Gasoline, 38 Fed. Reg. 33,734 (Dec. 6, 1973) (adopting regulations establishing a schedule for reducing the lead content of gasoline).
[62] Tier 3 Motor Vehicle Emission and Fuel Standards, 79 Fed. Reg. 23,414 (Apr. 28, 2014) (adopting regulations requiring a reduction in the sulfur content of gasoline).
[63] S. Rep. No. 91-1196 (1970).

emissions effects" and extends to all "fuel characteristics and components" affecting emissions.[64]

Gasoline octane levels determine the feasibility of using cleaner, high compression engines and thereby affect vehicle carbon dioxide emissions. Octane is, therefore, an appropriate target for regulation under section 211(c). Such regulation may take the form of a "control or prohibit[ion] on the manufacture, introduction into commerce, offering for sale, or sale of" low octane gasoline. The term "control" has been interpreted broadly to include restrictions on the sale of a particular fuel and other measures to promote the availability of substitutes.[65] Thus, for example, EPA could restrict the sale of low octane gasoline and/or require the introduction of gasoline with a higher octane rating.

3.1 Pre-Requisites for Regulation Under Section 211(c)

Section 211(c) of the Clean Air Act sets out various threshold requirements that must be met before fuel regulations can be adopted. Under section 211(c)(1), regulation can only occur if:

(A) the fuel, or any emission product thereof, causes or contributes to air or water pollution, reasonably anticipated to endanger public health or welfare; or

(B) any emission product of the fuel significantly impairs the performance of an emissions control device in or near general use.

Where EPA proposes to adopt regulations under paragraph (A), it must consider available medical and scientific evidence, including "other technically or economically feasible means of achieving emissions standards" under section 202 of the Clean Air Act.[66] If regulations are to be adopted under paragraph (B), EPA must consider available scientific and economic data and

[64] City of Park City v. Alon USA Energy Inc., 341 F. Supp. 2d 386, 408 (S.D.N.Y. 2004) (Scheindlin J.). See also Oxygenated Fuels Ass'n. v. Pataki, 304 F. Supp. 2d 337, 342 (N.D.N.Y. 2002) (Mordue J.) (holding that section 211(c) authorizes EPA to regulate fuels "for the purposes of motor vehicle emissions control").

[65] Amoco Oil Co. v. EPA, 501 F.2d 722, 743-744 (D.C. Cir. 1974) (upholding the validity of EPA regulations requiring certain fuel retailers to make available at least one grade of unleaded gasoline on the basis that the requirement "control[s] the sale of leaded gasoline, for the regulation provides in effect that the specified retailers may sell no leaded gasoline unless and until they also offer for sale one grade of unleaded gasoline. To so condition the sale of leaded gasoline is surely one way to "control" its sale"). See also S. Rep. No. 91-1196 (stating that "[a]t one time the Committee [on Public Works of the Senate] considered language that would give the Secretary only authority to "prohibit" a fuel's introduction into commerce. After evaluation, the Committee decided that such authority should also be extended to the "control" of a fuel's introduction into commerce. This authority to "control" the use of a fuels is intended to give the Secretary greater flexibility, than the authority to "prohibit"").

[66] Clean Air Act, § 211(c)(2)(A); 42 U.S.C. § 7545(c)(2)(A).

compare "emissions control devices or systems which . . . require the proposed [regulation] with emission control devices or systems which . . . do not"[67] The legislative history of section 211(c) and case law interpreting that section indicate that, to comply with these requirements, EPA must consider whether fuel regulation is "necessary or otherwise advisable" to achieve section 202 emission standards.[68]

Even if the above requirements are met, a fuel or additive may not be prohibited unless EPA finds that "such prohibition will not cause the use of any other fuel or fuel additive which will produce emissions which will endanger the public health or welfare to the same or greater degree than the use of the fuel or fuel additive proposed to be prohibited."[69] Such a finding is not required where EPA adopts regulations that control, but do not prohibit, a fuel or additive.[70]

3.2 Section 211(c)(1)(A): Risk to Public Health or Welfare

To regulate gasoline octane levels under section 211(c)(1)(A) of the Clean Air Act, EPA must find that low octane gasoline or any emission product thereof "causes, or contributes to air pollution . . . that may reasonably be anticipated to endanger the public health or welfare" ("endangerment finding"). This requirement is clearly met. As noted above, the current low octane rating of gasoline has resulted in widespread use of vehicles with low compression engines, which emit significant carbon dioxide. Carbon dioxide emissions are a form of air pollution, which contributes to climate change and thereby endangers public health and welfare.[71]

An endangerment finding is not the only pre-requisite for regulatory action under section 211(c)(1)(A). Subsection 211(c)(2)(A) provides that regulations may only be adopted under that section "after . . . a consideration of other technically or economically feasible means of achieving [vehicle] emissions standards" established pursuant to section 202.The legislative history indicates that this provision was adopted "for the purpose of assuring that . . . [fuel regulations] will not be

[67] Clean Air Act, § 211(c)(2)(B); 42 U.S.C. § 7545(c)(2)(B).
[68] See *infra* section 3.2.
[69] Clean Air Act, § 211(c)(2)(C); 42 U.S.C. § 7545(c)(2)(C).
[70] For a discussion of this issue, see Ethyl Corp, 541 F.2d 1, 31-32.
[71] In December 2009, EPA issued an endangerment finding in relation to motor vehicle emissions of carbon dioxide, under section 202 of the Clean Air Act. See Endangerment & Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496 (Dec. 15, 1990) (finding that carbon dioxide emissions contribute to "greenhouse gas air pollution" and thereby "endanger both the public health and the public welfare of current and future generations."

imposed lightly if other equally satisfactory alternatives are available."[72] Congress viewed section 202 standards as preferable to fuel regulation as they interfere less with manufacturing processes.[73] It emphasized that manufacturers "should be given the greatest possible latitude" to determine the composition and characteristics of fuel and only regulated when "necessary" to achieve section 202 standards.[74]

Consistent with the legislative history, in *Ethyl Corp v. EPA*, the court noted that:

> Section 202 . . . allows the [EPA] Administrator to set standards for emission of pollutants from automobiles (as opposed to standards for the composition of the gasoline that produces the emissions), and is thus the preferred . . . alternative under the statutory scheme, presumably because it minimizes [EPA] interference with manufacturer prerogatives.[75]

The court suggested, in *obiter dictum*, that subsection 211(c)(2)(A) requires EPA to consider establishing vehicle emissions standards before adopting fuel regulations.[76] The court did not indicate what, if anything, is required in situations where emissions standards have already been adopted.

Some guidance on this issue is provided in *Amoco Oil Co. v. EPA*.[77] That case concerned fuel regulations adopted under section 211(c)(1)(B). As noted above, section 211(c)(1)(B) permits regulatory action where a fuel's emissions products significantly impair performance of vehicle emissions controls, in or near general use. Notably however, under section 211(c)(2)(B), no regulations may be adopted "except after" a cost benefit analysis comparing emissions controls

[72] H. Rep. No. 91-1146 (1970).
[73] Ethyl Corp, 541 F.2d 1, 11 (holding that "[w]hen EPA acts under § 211(c)(1)(A) it is essentially telling manufacturers how to make their fuels, a task Congress felt the Agency should enter upon only with trepidation . . . On the other hand, when the Agency acts under § 202, it is only mandating an end product – regulated emissions. The method for achieving the required result is entirely in the hands of the manufacturers."
[74] S. Rep. No. 91-1196. See also H. Rep. No. 91-1146 (noting that "[t]he Government is not particularly well equipped to design cars or to determine the composition of fuels" so as to reduce tailpipe emissions and expressing hope that "automobile manufacturers and automotive fuel producers will join hands to develop the most effective technologies" for this purpose).
[75] Ethyl Corp. v. EPA, 541 F. 2d 1, 10 (D.C. Cir. 1976).
[76] *Id*. at footnote 66 (holding that section 211(c)(2)(A) "demands "consideration" not only of the relevant scientific and medical evidence, but also of the possibility of regulation under § 202").
[77] 501 F.2d 722.

that require the proposed regulations with those that do not.[78] *Amoco Oil* held that:

> Section 211(c)(2) is centrally concerned with EPA's determination whether or not to regulate a particular fuel. In effect, the provision establishes a rebuttable presumption that [EPA] should maintain a *laissez faire* posture with regard to fuel regulation. To rebut the presumption [EPA] must determine . . . that fuel regulation is a necessary or otherwise advisable component in [its] overall strategy to meet the Section 202 emissions standards.[79]

Like the provision interpreted in *Amoco Oil*, subsection 211(c)(2)(A) establishes a threshold requirement, which must be met before EPA can regulate a fuel. The legislative history strongly suggests that this requirement was intended to ensure fuel regulations are only adopted where necessary to achieve vehicle emissions standards. This is reinforced by the language of the subsection which, unlike the provision considered in *Amoco Oil*, expressly requires EPA to consider the potential for achievement of vehicle emissions standards.

In recent administrative decisions, EPA has complied with section 211(c)(2)(A) by showing that the adoption of fuel regulations is "required" or "essential" to achieve vehicle emissions standards, previously adopted under section 202.[80] EPA has further justified the need for fuel regulations by showing that they would result in "large emissions reductions for vehicles" not subject to the emissions standards.[81] The evidence currently before EPA does not appear to support the making of similar findings with respect to low-octane gasoline.

As noted above, EPA's LDV Emissions Standards limit emissions of carbon dioxide from MY2012 to MY2025 LDVs.[82] In its mid-term evaluation of the LDV Emissions Standards, EPA found that vehicle manufacturers outperformed the standards in MY 2012 to 2016.[83] EPA further

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[78] Clean Air Act, § 211(c)(2)(B); 42 U.S.C. § 7545(c)(2)(B).

[79] Amoco Oil Co., 501 F.2d 722, 736 - 737.

[80] See, for example, Tier 3 Motor Vehicle Emission and Fuel Standards, 79 Fed. Reg. 23,414, 23,567 (Apr. 28, 2014) (indicating that a shift to low-sulfur fuel "is an essential part of achieving" vehicle emissions standards for non-methane organic gases and nitrogen oxides).

[81] *Id*. (noting that "reducing fuel sulfur will achieve large emissions reductions for vehicles already in use").

[82] Light-Duty Vehicle Greenhouse Gas Emissions Standards & Corporate Average Fuel Economy Standards, 75 Fed. Reg. 25,324 (May 7, 2010) (establishing emissions standards for MY2012 through 2016 LDVs); 2017 & Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions & Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,623 (Oct. 15, 2012) (establishing emissions standards for MY2017 through 2025 LDVs).

[83] EPA, *supra* note 4, at A-63.

found that manufacturers will be able to meet future standards by deploying new technologies, many of which are already being implemented in new vehicles and can be used with current fuels. This finding has been challenged by some stakeholders, however. The American Coalition for Ethanol, for example, claims that "[i]f high-octane fuels aren't available, the standards won't be met."[84] It argues that the engine technologies identified by EPA "will tolerate today's low octane fuel, but they will not be able to generate substantial fuel economy and [emissions] reduction benefits . . . unless they operate on a higher-octane fuel."[85] Similarly, the Renewable Fuels Association asserts that the technologies would "generate fewer emissions if operating on fuels with higher octane ratings."[86] It cites numerous studies to support this view.[87] Those studies do not, however, show that high octane fuel is necessary to achieve the LDV Emissions Standards. They merely indicate that using such fuels would enable larger emission reductions than can be achieved through engine changes alone.[88]

Given the above, further evidence is arguably required before EPA can regulate low octane gasoline under section 211(c)(1)(A) of the Clean Air Act. Evidence demonstrating that use of high octane fuel would significantly reduce the costs of achieving the standards may be sufficient. As noted above, the court in *Amoco Oil* held that fuel regulations may be adopted where "necessary or otherwise advisable" to achieve emissions standards, suggesting that cost is a relevant factor to be

[84] Letter from American Coalition for Ethanol, to EPA & Others (Sep. 26, 2016), *available at* https://perma.cc/2F9Y-YU84 (arguing that "[t]he goals of the CAFÉ-GHG program [under which the emissions standards were adopted] will go unrealized until a compliance mechanism is set in motion for higher-octane fuel . . . a pathway needs to be established for low-carbon, high octane fuels like ethanol to help automakers comply with the 2022-2025 standards").
[85] *Id*. at 5.
[86] Letter from Renewable Fuels Association, to EPA & Others (Sep. 26, 2016), *available at* https://perma.cc/Y3YJ-PVV2.
[87] For example, in its comments on the Draft TRA, RFA provided the EPA and DOT with a copy of a report prepared by Ricardo, Inc., assessing the role that ethanol-based high octane fuels might play in facilitating increased fuel economy and reduced emissions under the federal standards. See RICARDO, INC., THE DRAFT TECHNICAL ASSESSMENT REPORT: IMPLICATIONS FOR HIGH OCTANE, MID-LEVEL ETHANOL BLENDS (2016), *available at* https://perma.cc/5TRM-8EFC.
[88] Renewable Fuels Association, *supra* note 86, at 2 (noting that Ricardo Inc.'s analysis indicates that "[p]airing the advanced IC [internal combustion] engine technologies examined in the TAR with high octane low carbon (HOLC) fuels with 98-100 RON octane would result in greater fuel economy and emissions benefits"). See also *Id*. at 4 (finding that "[t]he use of high octane fuels in these [advanced] engines would ensure they produce the maximum possible fuel economy and emissions reductions").

taken into account.[89] Fuel regulations are arguably "advisable" where they enable emissions standards to be met at significantly reduced cost.

A number of vehicle manufacturers have claimed that shifting to higher octane fuel would reduce the costs of meeting the LDV Emissions Standards. Little empirical data has, however, been provided to support these claims. If EPA obtains such data and/or other evidence demonstrating the need for fuel regulations, it could take immediate action to regulate gasoline octane levels under section 211(c)(1)(A) of the Clean Air Act. In the absence of such evidence EPA could not regulate octane at this time but may do so in the future if it adopts more stringent emission standards, achievement of which would be impossible or significantly more costly without a shift to high octane gasoline.

3.3 Section 211(c)(1)(B): Interference with Emissions Controls

To regulate low octane gasoline under section 211(c)(1)(B) of the Clean Air Act, EPA must find that "*emissions products* of [the] fuel . . . will impair to a significant degree the performance of any emission control device or system" in or near general use (emphasis added). By its express terms, section 211(c)(1)(B) limits EPA regulation to situations where a fuel produces emissions that impair performance of an emissions control device. Regulation is not permitted where the fuel itself, as opposed to its emissions products, significantly impairs emission controls. This is the case with low octane gasoline.

As noted above, the current low octane rating of gasoline has prevented deployment of high compression engines. When used with low octane gasoline, high compression engines are likely to experience knock, which significantly impairs performance. This impairment is not due to any emissions produced by low octane gasoline but rather its inherent nature and, in particular, its potential to self-ignite when compressed.

In any event, regulations may only be adopted under section 211(c)(1)(B) after "consideration of available scientific and economic data, including a cost benefit analysis comparing emission control devices or systems which are or will be in general use and require the proposed [regulations] with emissions control devices or systems which are or will be in general

[89] Amoco Oil Co, 501 F.2d 722, 737. While this decision related to regulations issued under section 211(c)(1)(B), the courts are likely to adopt the same approach when reviewing regulations under section 211(c)(1)(A).

use and do not require the" regulations.[90] In *Amoco Oil*, the court held that this requires EPA to "state findings, drawn from a study of emission control devices in or near "general use," to the effect that fuel regulation is a necessary or otherwise advisable component in the Agency's overall strategy to meet the Section 202 emission standards."[91]

As discussed in part 3.2 above, research by EPA suggests that the LDV Emissions Standards can be achieved using existing technologies, without moving to high octane gasoline. This view has been disputed by some stakeholders, who claim that high octane gasoline is necessary to achieve the LDV Emissions Standards, but provide little evidence to support those claims. If EPA is provided with evidence, showing that a switch to high octane gasoline is required to comply with the LDV Emissions Standards or would substantially reduce compliance costs, it could regulate octane immediately. Otherwise, regulation of octane could only occur in the future if EPA adopts more stringent standards and there is evidence of the need for fuel regulations to achieve those standards at minimum cost.

3.4 Section 211(c)(2)(C): No Increase in Other Emissions

In considering EPA's authority to regulate gasoline octane levels, it should be noted that switching to high octane gasoline will reduce vehicle carbon dioxide emissions, but could increase emissions of other air pollutants. Following the switch, new vehicles would be developed with high compression engines, which combust fuel at increased temperatures, leading to greater nitrogen oxide emissions.[92] The potential for these emissions to endanger public health or welfare must be considered by EPA when regulating gasoline octane levels.

Under Section 211(c)(2)(C) of the Clean Air Act, before prohibiting a fuel, EPA must find that "such prohibition will not cause the use of any other fuel . . . which will produce emissions

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[90] Clean Air Act, § 211(c)(2)(B); 42 U.S.C. § 7545(c)(2)(B).

[91] Amoco Oil Co, 501 F.2d 722, 737. See also *Id*. at 736 (stating that "[s]ection 211(c)(2)(B) is centrally concerned with EPA's *threshold* determination *whether or not* to regulate a particular fuel or additive. In effect, the provision establishes a rebuttable presumption that the [EPA] should maintain a *laissez faire* posture with regard to fuel regulation. To rebut the presumption the [EPA] must determine, through consideration of "available scientific and economic data, including a cost benefit analysis," that the emission standards established under Section 202 of the Act cannot be achieved in acceptable fashion by relying on emission control devices in "general use" which "do not require the proposed control or prohibition"" on the fuel or additive (internal citations omitted)).

[92] For a discussion of this issue, see B.M. Masum, *Effect of Ethanol-Gasoline Blend on NOX Emissions in SI Engine*, 24 RENEWABLE & SUSTAINABLE ENERGY REVIEWS 209 (2013).

which will endanger the public health or welfare to the same or greater degree than the use of the fuel . . . proposed to be prohibited." EPA's finding must indicate "that the proposed regulation will not cause use of an equally harmful fuel."[93] This requires an assessment of the type and amount of pollutants emitted by the substitute fuel.

Switching from low to high octane gasoline could lead to an increase in vehicle emissions of nitrogen oxides, a class of air pollutants, which contribute to the formation of ozone, smog, and acid rain.[94] Any such increase is likely to be small, however.[95] In these circumstances, and given the potential for significant reductions in carbon dioxide emissions, EPA may find that high octane gasoline is less harmful than current low octane blends. This finding would enable EPA to adopt regulations prohibiting the manufacture and/or sale of low octane gasoline. Such regulations could not be adopted if low and high octane gasoline are found to be equally harmful. Even in this situation, however, EPA could adopt regulations to control low octane gasoline.

4. STATE REGULATION OF GASOLINE OCTANE LEVELS

EPA officials have previously raised the possibility of regulating gasoline octane levels, suggesting that the agency may require a shift to high octane gasoline in the future, most likely when it adopts new tailpipe emissions standards for post-2025 MY LDVs.[96] The 2016 Presidential election has, however, raised doubts about whether EPA will act. If action is not taken by EPA state environmental agencies may wish to intervene and adopt their own regulations with respect to octane. The possibility of state regulatory action is considered in this part.

In the Clean Air Act, Congress expressed a clear preference for federal regulation of gasoline and other motor vehicle fuels, curtailing state regulatory authority.[97] Under section

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[93] Amoco Oil Co., 501 F.2d 722, 738.

[94] For a discussion of nitrogen oxides, see EPA, TECHNICAL BULLETIN: NITROGEN OXIDES (NOX), WHY & HOW THEY ARE CONTROLLED (1999), *available at* https://perma.cc/XJE4-7M2B.

[95] See *supra* section 2.2.

[96] *EPA Eyes Higher Octane in Gasoline as Post-2025 GHG Control Strategy*, INSIDEEPA/CLIMATE, https://insideepaclimate.com/climate-daily-news/epa-eyes-higher-octane-gasoline-post-2025-ghg-control-strategy?destination=node/177585 (May 14, 2015),

[97] In this regard, EPA has observed that "[a]s opposed to commodities that are produced and sold in the same area of the country, gasoline produced in one area is often distributed to other areas. The national scope of gasoline production and distribution suggests that federal rules should preempt State action to

211(c)(4) of the Act, states are pre-empted from regulating fuels, except in limited circumstances. The section provides, in relevant part:

> **(4)(A)** Except as otherwise provided in subparagraph (B) or (C), no State (or political subdivision thereof) may prescribe or attempt to enforce, for purposes of motor vehicle emission control, any control or prohibition respecting any characteristic or component of a fuel or fuel additive in a motor vehicle or motor vehicle engine—
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> **(i)** if the [EPA] Administrator has found that no control or prohibition of the characteristic or component of a fuel or fuel additive under paragraph (1) is necessary and has published his finding in the Federal Register, or
>
> **(ii)** if the Administrator has prescribed . . . a control or prohibition applicable to such characteristic or component of a fuel or fuel additive . . .
>
> **(B)** Any State for which application of section [209, prohibiting state regulation of motor vehicle emissions,] has at any time been waived . . . may at any time prescribe and enforce, for the purpose of motor vehicle emission control, a control or prohibition respecting any fuel or fuel additive.
>
> **(C)(i)** A State may prescribe and enforce, for purposes of motor vehicle emission control, a control or prohibition respecting the use of a fuel or fuel additive in a motor vehicle or motor vehicle engine if an applicable implementation plan for such State under section [110] so provides. The [EPA] Administrator may approve such provision in an implementation plan, or promulgate an implementation plan containing such a provision, only if he finds that the State control or prohibition is necessary to achieve the national primary or secondary ambient air quality standard which the plan implements. The Administrator may find that a State control or prohibition is necessary to achieve that standard if no other measures that would bring about timely attainment exist, or if other measures exist and are technically possible to implement, but are unreasonable or impracticable. The Administrator may make a finding of necessity under this subparagraph even if the plan for the area does not contain an approved demonstration of timely attainment.

A flow chart outlining when state fuel regulation is permitted under section 211(c)(4) the Clean Air Act is included in Appendix 2. As indicated there, in general, , states may regulate fuels if EPA

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avoid an inefficient patchwork of potentially conflicting regulations . . . Congress provided in the 1977 Amendments to the Clean Air Act that federal fuels regulations preempt non-identical state controls except under specified circumstances." *See* Regulation of Fuels and Fuel Additives: Standards for Reformulated and Conventional Gasoline, 59 Fed. Reg. 7716 (Feb. 16, 1994).

fails to do so.[98] As EPA has itself acknowledged, under section 211(c)(4)(A) of the Clean Air Act, "states have authority to regulate a fuel's components or qualities for the purpose of emission control until . . . federal regulations" are adopted or found to be unnecessary.[99] Federal action will, however, only pre-empt state regulation of the *same* fuel component or quality as has been targeted by EPA. State regulatory authority is not affected by EPA action with respect to a *different* component or quality of the fuel. Thus, the fact that EPA has previously regulated the composition of gasoline (e.g., by prohibiting the addition of lead) would not prevent states adopting their own regulations with respect to gasoline octane levels.

If EPA takes action with respect to octane – whether by regulating it or declaring regulation unnecessary – state regulation thereof would be pre-empted by section 211(c)(4)(A).[100] That section is, however, subject to two exceptions. One, contained in section 211(c)(4)(C), applies to all states. It allows EPA to waive pre-emption and approve state fuel regulations where necessary to meet federal air quality standards.[101] In this context, "necessity" is defined narrowly, with EPA required to find that no other reasonable or practice measures are available to bring about timely attainment of the federal standards.[102]

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98 *See generally* Am. Fuel & Petrochemical Mfrs. v. O'Keeffe, 134 F. Supp. 3d 1270, 1285 (D. Or. 2015) (noting that section 211(c)(4)(A) only operates to pre-empt state fuel regulation where there is some affirmative action by EPA. "[S]ubsection (i) is preemption by affirmative, negative EPA regulation" and "[s]ubsection (ii) . . . is preemption by affirmative, positive EPA regulation").

99 Ozone Hearings, 100th Cong., 1st Sess. (daily ed. Apr. 24, 1987), *discussed in* City of Park City, 341 F. Supp. 2d 403-407.

100 *See generally* Exxon Corp. v. New York, 548 F. 2d 1088, 1092 (2d Cir. 1977) (noting that section 211(c)(4)(A) "explicitly precludes a state . . . from prescribing or attempting to prescribe any controls or prohibitions respecting the use of fuels or fuel additives in motor vehicles if [EPA] has prescribed an applicable control or prohibition, unless the state prohibition or control is identical to that prescribed by the" EPA).

101 *See generally Id*. at 1093 & 1095 (indicating that "the federal scheme does not impose a complete straight jacket on the states . . . [Section 211(c)(4)] which in subdivision (A) precludes local regulation unless identical to federal regulation, provides a relevant exception in subdivision (C). That section allows a state to prescribe a control or prohibition respecting the use of a fuel or fuel additive in a motor vehicle if such restriction is included as a provision in an applicable implementation plan for such state." Such state regulation must be "approved [by] the Administrator" of the EPA). *See also* Motor Vehicle Mfrs. Ass'n v. New York State Dep't of Envtl. Conservation, 17 F.3d 521, 527 (2d Cir. 1994) (noting that the Clean Air Act "restricts the states' power to enact motor vehicle fuel requirements, though the EPA may approve state regulations if necessary to meet federal air quality standards").

102 Clean Air Act § 211(c)(4)(C)(i); 42 U.S.C. § 7545(c)(4)(C)(i).

A second exception is set out in section 211(c)(4)(B). That section provides a waiver of pre-emption for any state that has been exempt from the prohibition, in section 209, on states adopting their own vehicle emissions standards.[103] As California is the only state to have been granted such an exemption,[104] section 211(c)(4)(B) "in effect grants California a special waiver" of pre-emption.[105] The waiver is automatic, meaning that California can develop fuel regulations, without approval from EPA.[106]

The California Air Resources Board ("CARB") is authorized, under state law, to adopt "motor vehicle fuel specifications for the control of air contaminants and sources of air pollution which [it] has found to be necessary, cost effective, and technologically feasible."[107] Prior to exercising that authority, CARB must determine the cost-effectiveness of adopting the standards, compared to other methods of reducing vehicle emissions,[108] and undertake a study of technical feasibility[109] and economic impacts.[110] Assuming it finds evidence of necessity, cost effectiveness, and technical feasibility, CARB could adopt standards with respect to gasoline octane levels. Those standards would only apply in California. The Clean Air Act does not allow other states to apply California's fuel standards, in preference to federal regulations, as is permitted with respect

[103] Clean Air Act § 209(a); 42 U.S.C. § 7543(a) (declaring that "[n]o State or any political subdivision thereof shall adopt or attempt to enforce any standard relating to the control of emissions from new motor vehicles or new motor vehicle engines").

[104] California is the only state that had adopted vehicle emission standards prior to March 30, 1966.

[105] American Petroleum Inst. v. Jorling, 710 F. Supp. 421, 425 (N.D.N.Y 1989)

[106] *Id*. (holding that EPA approval is not required for the adoption of state fuel regulations under section 211(c)(4)(B)).

[107] CAL. HEALTH & SAFETY CODE § 43013(a).

[108] *Id*. § 43013(e)(1).

[109] *Id*. § 43013(e)(2) (requiring CARB to, "[b]ased on a preponderance of scientific and engineering data in the record, determine the technical feasibility of adoption . . . of the standards . . . That determination shall include, but is not limited to, the availability, effectiveness, reliability, and safety expected of the proposed technology").

[110] *Id*. § 43013(f) (requiring CARB to "quantitatively document the significant impacts of the proposed standard or specification on affected segments of the state's economy. The economic analysis shall include, but is not limited to, the significant impacts of any change on motor vehicle efficiency, the existing motor vehicle fuel distribution system, the competitive position of the affected segment relative to state borders and the cost to consumers").

to its vehicle emissions standards.[111] The courts have held that, even where fuel controls form part of California's vehicle emissions standards, they cannot be adopted by other states.[112]

Of course, if regulatory action has not been taken at the federal level, states would be free to adopt their own fuel regulations based on those in California.[113] This would be the optimal solution. However, even if other states do not or cannot act, California should. We recommend that California adopt regulations specifying a minimum RON for all gasoline sold in the state. This would facilitate the deployment of more efficient, high compression engines in LDVs used in California. To ensure those LDVs can be refueled in other states, the RON set by California should not exceed 98, being the RON of premium fuel available across the U.S. Use of such fuel would not impair the operation of existing vehicles and, as noted above, may actually result in modest improvements in their fuel economy.[114] Larger fuel economy improvements could be realized in new vehicles. The 2014 MIT found that new vehicles, designed to use gasoline with an RON of 98, may consume up to five percent less fuel than existing models.[115] Given the current high level of gasoline use in California, such improvements could have significant benefits.

5. CONCLUSION

Under section 211(c)(1) of the Clean Air Act, EPA may regulate the composition and/or characteristics of vehicle fuels, including their octane rating. EPA regulations could, for example, restrict the sale of low octane gasoline and include other measures to promote the availability of higher octane alternatives. Such regulations can, however, only be adopted if EPA finds that:

(A) low octane gasoline or emissions it produces contribute to air pollution that endangers public health or welfare, or

(B) emissions produced by low octane gasoline significantly impair the performance of an emission control device in or near general use.

[111] See Clean Air Act, § 117; 42 U.S.C. § 7507.

[112] Motor Vehicle Mfrs. Ass'n v. New York State Dep't of Envtl. Conservation, 810 F. Supp. 1331 (N.D.N.Y 1993), *affirmed in* Motor Vehicle Mfrs. Ass'n of the United States v. New York State Dep't of Envtl. Conservation, 79 F.3d 1298 (2d Cir. 1996).

[113] In these circumstances, section 211(c)(4)(A) would not apply.

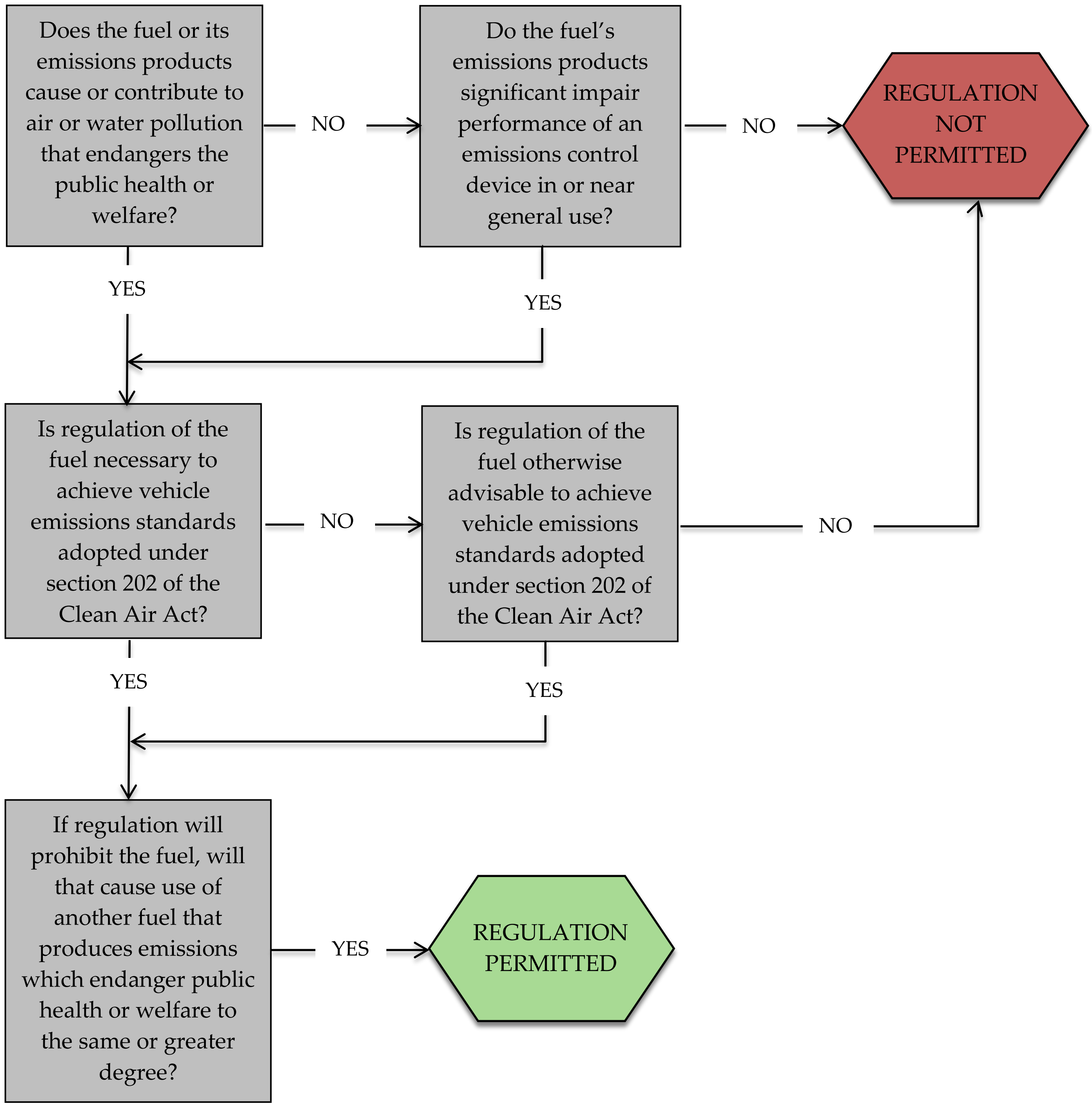
[114] See *supra* section 2.1.

[115] Speth et al., *supra* note 6, at 6563 – 6564. For a discussion of this issue, see *supra* section 2.1.

Requirement (A) is arguably met with respect to low octane gasoline. The low octane rating of gasoline has led to the use of low compression engines that emit various air pollutants, including carbon dioxide, which contributes to climate change and thereby endangers public health and welfare. Prior to regulating octane on this basis, however, EPA must consider "other technically or economically feasible means of achieving [vehicle] emissions standards" established pursuant to section 202. This arguably requires EPA to consider whether fuel regulation is necessary or otherwise appropriate to achieve the standards. If EPA determines that compliance with the LDV Emissions Standards requires an increase in gasoline octane levels, or that the increase would significantly reduce compliance costs, it may adopt regulations limiting the sale of low-octane gasoline and/or requiring the introduction of gasoline with a higher RON. If such regulations are not adopted, state agencies could step in to regulate octane, provided EPA has not determined such action to be unnecessary, and published a finding to that effect. Even in these circumstances, however, octane could be regulated in California.

APPENDIX 1: CAN EPA ADOPT FUEL REGULATIONS?

Questions EPA must consider prior to regulating a fuel under section 211(c) of the Clean Air Act.



APPENDIX 2: IS STATE FUEL REGULATION PRE-EMPTED?