December 10, 2013

SUBMITTED ELECTRONICALLY

Clerk of the Board
Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: ARB's Proposed Regulation on the Commercialization of New Alternative Diesel Fuels

Dear Sir or Madam:

Robert Bosch LLC (Bosch), a U.S.-based subsidiary of Robert Bosch GmbH, is pleased to submit these comments on the Air Resources Board's (ARB) proposed regulation on the commercialization of new alternative diesel fuels (hereinafter, the proposed ADF regulation).

One of the largest global automotive original equipment suppliers, Bosch develops, manufactures, and supplies precision components and systems for motor vehicle manufacturers and other entities in the automotive industry. The light-, medium-, and heavy-duty vehicle solutions and technologies offered by the Bosch Diesel Systems division include fuel injection systems, exhaust-gas treatment, glow systems, and other systems and components. As the world leader in the development of cleaner, more fuel efficient diesel engine systems and components, Bosch has a strong interest in the proposed ADF regulation.

The following comments focus on Appendix 1 of the proposed ADF regulation, and more specifically on the di-tert-butyl peroxide (DTBP) mitigation option contained in section (a)(1)(A) of Appendix 1.

DTBP Needs Further Investigation Before ARB Establishes It as a NOx Mitigation Option for Biodiesel Blends

Notwithstanding the ARB staff's view that it is "unlikely . . . that higher biodiesel blends [will be] used in legacy, heavy-duty diesel vehicles"[1] and the staff's conclusion "that mitigation is highly unlikely to be needed,"[2] Bosch believes, particularly given the high volumetric composition of DTBP that would be required for B10 to B20 blends to be deemed NOx mitigated under the additive mitigation option (i.e., ≥0.75 percent DTBP in blends of B10 to < B15, and ≥1.0 percent DTBP in blends of B15 to B20), that thorough consideration needs to be given to the potential impact of DTBP on low- and high-pressure fuel system components before this particular mitigation option is put in place by ARB.[3] The Mitigation Study referenced in the Initial Statement of Reasons evaluated the effect on NOx and other pollutant emissions of adding DTBP to biodiesel blends, but it did not assess safety, material compatibility, and other potential issues.[4] Bosch maintains that these issues, which are discussed briefly below, must be investigated and taken into account by ARB prior to the establishment of this NOx mitigation measure.

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1 Initial Statement of Reasons at 23.

2 *Id.* at 59.

3 A 1.0 percent level of DTBP in B20 would mean an overall blend composition of 80 percent CARB diesel, 19 percent B100, and 1 percent DTBP. As CARB made clear in an earlier version of the proposed ADF regulation, this composition can be obtained by blending 80 percent CARB diesel with 20 percent B100, where the B100 itself consists of 95 percent neat biodiesel and 5 percent DTBP.

4 *See Final Report – CARB Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California, "Biodiesel Characterization and NOx Mitigation Study"* (Oct. 2011), available at http://www.arb.ca.gov/fuels/diesel/altdiesel/20111013_CARB%20Final%20Biodiesel%20Report.pdf.

As an organic peroxide, DTBP may cause the embrittlement of elastomer-based fuel system components such as hoses and sealings. In this regard, the strong, negative effect that peroxides present in aged gasoline and E10 have been shown to have on such automotive components is highly relevant.[5]

Moreover, compared to CARB diesel, DTBP (CAS No. 110-05-4) has a low boiling point (111 °C), a low flash point (12 °C), and is a volatile substance.[6] Adding it to a blend of CARB diesel and B100 will reduce significantly the flash point of the resulting fuel blend, thereby leading to a potential safety hazard, while DTBP's high volatility creates a serious risk of cavitation in the high-pressure pumps and fuel injectors used in diesel engines and fuel systems. DTBP's thermal decomposition to acetone and other low-boiling point hydrocarbons further increases the volatility of the resulting fuel blend,[7] thus exacerbating these safety and cavitation concerns.

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5 *See, e.g.,* Chevron Corp., *Motor Gasolines Technical Review* (2009), at 41 ("Peroxides can . . . attack plastic or elastomeric fuel system parts"), available at http://www.chevronwithtechron.com/products/documents/69083_MotorGas_Tech_Review.pdf; DuPont Dow Elastomers, *Viton® - Excelling in Modern Automotive Fuel Systems* (1999), at 13 (hydroperoxides "decompose, forming free radicals that may attack some elastomers . . . [and] ultimately result[] in "embrittlement"), available at http://www.biofuels.coop/archive/viton.pdf.

6 *See* NIOSH, *International Chemical Safety Card #1019*, available at http://www.cdc.gov/niosh/ipcsneng/neng1019.html; *see also* National Library of Medicine Toxicology Data Network, Hazardous Substances Databank, available at http://toxnet.nlm.nih.gov/cgi-bin/sis/search/r?dbs+hsdb:@term+@na+BIS(1,1-DIMETHYLETHYL)PEROXIDE.

7 *See* Sebbar and Bockhorn, *Di-Tert-Butyl Peroxide Combustion with Air: Ignition, Laminar Flame Velocities*, available at http://cost.ensic.univ-lorraine.fr/cost/fileadmin/utilisateurs/COST_Documents/Sofia/WG5/WG5_11_Sebbar.pdf; Cafferata and Manzione, *Kinetics and Mechanism of Gas-Phase Thermolysis Using Headspace-Gas Chromatographic Analysis*, available at http://chromsci.oxfordjournals.org/content/39/2/45.full.pdf.

DTBP is commonly used as a polymerization catalyst in olefin chemistry. If added to biodiesel that has been produced through the transesterification process, it can be expected that the DTBP, separate and apart from any NOx emissions effect, will catalyze the polymerization of unsaturated fatty acid methyl esters in the biodiesel, eventually resulting in severe lacquer formation in the fuel circuit. Ultimately, the sticking/seizure of hydraulic system components may occur; at the very least, such events cannot be ruled out as a possibility. These events, of course, could lead to improper fuel control in the diesel engine, potentially resulting in:

- Rough and erratic vehicle operation;
- Under-fueling (with an inability to start the engine and/or low power); or
- Over-fueling (with excessive tailpipe emissions of NOx and other pollutants, consequential failures, and/or sudden vehicle breakdowns).

The last possibility is particularly important given that the DTBP is meant to mitigate the NOx emissions impact of biodiesel blend (i.e., ≥B10) usage.

Bosch also observes that the temperature inside high-pressure hydraulic systems often exceeds 140 °C. This temperature may promote the decomposition of DTBP before it is able to serve its intended purpose as a NOx mitigator during the combustion process. Notably, the thermal decomposition of DTBP is considerably faster than the thermal decomposition of 2-ethylhexyl nitrate.[8]

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[8] *See* Nandi, *The Performance of Di-Tertiary-Butyl Peroxide as Cetane Improver in Diesel Fuels*, available at http://web.anl.gov/PCS/acsfuel/preprint%20archive/Files/41_3_ORLANDO_08-96_0863.pdf.

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For all of the above reasons, Bosch strongly believes that before ARB establishes DTBP as a NOx mitigation option for biodiesel blends, substantial work should be done to assess the potential safety concerns and material compatibility and system performance and durability issues associated with using DTBP as a biodiesel blend additive.

Bosch appreciates the opportunity to comment on the proposed ADF regulation. Should ARB have any questions or need any additional information, please feel free to contact either one of us.

Sincerely,

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