

White Paper

Discussion of Conceptual Approach to Regulation of Alternative Diesel Fuels

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Note: The discussion of regulation concepts that are presented in this paper are intended for informational purposes only. The mention of commercial products, their source, or their use in connection with the materials presented herein do not constitute actual or implied endorsement of any such products.

I. Purpose

This white paper was prepared by the staff of the California Air Resources Board (ARB) to encourage stakeholders to consider the need for, and appropriate degree of, regulation regarding California motor vehicle alternative diesel fuels (ADFs) and diesel fuel blendstock substitutes. The concepts presented herein will inform the discussions anticipated during an upcoming public workshop to be scheduled in spring 2013. Staff plans to conduct a rulemaking to address diesel fuel substitutes and ADFs with a new proposed regulation to be considered by the Air Resources Board in the fall 2013.

II. Overview

The evolving California motor vehicle fuels market is starting to become more diverse. Clearly, conventional gasoline and diesel fuel have been the established norm when it comes to motorists' fueling options. Likewise, gasoline and diesel have served as the standard for engine powerplant designs over the years as well. However, many other recognized motor vehicle fuel replacements exist today, such as ethanol, hydrogen, natural gas, and liquefied petroleum gas, just to name a few.

With the advent of the federal Renewable Fuels Standard (RFS) and the California Low Carbon Fuel Standard (LCFS), fuel suppliers will now look to expand their product slates to include more renewable and low carbon replacements for conventional gasoline and diesel. While more innovation may be anticipated in ensuing years of lower carbon and higher renewable fuel standards, there are already notable innovations today. Biodiesel, with its unique chemistry, has the potential to replace conventional petroleum diesel and can be considered an ADF. Likewise, other innovative diesel fuel replacements are entirely hydrocarbon based and may be used as blendstocks to produce commercial CARB petroleum diesel. The latter innovations include renewable diesel, gas to liquid (GTL) diesel and other synthetic diesels.

Some of these diesel fuel substitutes legally exist in commerce today and are controlled through industry consensus standards. Such fuels-related industry consensus standards seek mainly to address both vehicle performance and fuel production quality issues. By contrast, the multimedia impacts from the substitute diesel fuels are generally addressed by state or federal government agencies.

The ARB's current diesel fuel regulations are geared toward providing a pathway for certifying hydrocarbon-based variations on petroleum diesel formulations, but they are ill-suited to providing a market pathway for newer, innovative alternative diesel fuels that are now coming into California in limited quantities. Over the past several years, California Air Resources Board (CARB) staff has endeavored to solicit stakeholder input via meetings and public workshops regarding the need for new regulations to address

this gap. Likewise, staff has conducted essential research to understand the air quality impacts of biodiesel and various other diesel fuel substitutes. Much of this information had previously been presented at prior workshops. Based on stakeholder information and conclusions drawn from research, staff has developed regulatory concepts described below for establishing certainty for innovative fuels providers by setting forth a reasonable, multi-option process for getting their fuels approved for sale by ARB.

III. Current CARB Policies Regarding Alternative Diesel Fuels (i.e., biodiesel)

As a prelude to staff's proposed regulatory concepts, it is useful to summarize the current CARB policy regarding biodiesel as either an ADF or biodiesel blend made with CARB diesel. For details concerning CARB's policy on biodiesel use, readers are recommended to visit our Regulatory Guidance document, dated October 2011, which can be found at

<http://www.arb.ca.gov/fuels/diesel/altdiesel/20111003Biodiesel%20Guidance.pdf>.

In general, the Regulatory Guidance requires neat biodiesel (B100, or 100 percent biodiesel) to contain no more than 15 parts per million (ppm) sulfur, no more than ten volume percent aromatic hydrocarbons, and must meet the specifications contained in ASTM 6751-08.

Blends consisting of one volume percent biodiesel (B1), to 50 volume percent biodiesel (B50), mixed with CARB diesel, will be considered to meet the requirements for CARB diesel (title 13, California Code of Regulations, sections 2281-2285; 13 CCR 2281-2285). More specifically, the neat biodiesel portion of the blend must meet the requirements described above, whereas the petroleum diesel portion of the blend must meet the CARB diesel requirements.

The Regulatory Guidance also recognizes that biodiesel blends greater than 50 volume percent biodiesel, are not subject to 13 CCR 2281-2285. Testing and recordkeeping requirements also apply to biodiesel blenders for B100 and blends of B1 through B50.

Finally, the Regulatory Guidance states that five volume percent biodiesel blends (B5) will be considered compliant with the CARB diesel regulation under 13 CCR 2281-2285.

IV. General Elements of Conceptual Alternative Diesel Fuel Regulation

While developing the general requirements for alternative fuels, staff adhered to the underlying principles to: 1) Protect public health, 2) Preserve or improve air quality, 3) Rely on the best scientific knowledge available, 4) Strive for practicality in compliance and enforcement, and 5) Provide a regulatory framework for future ADF innovations.

Furthermore, for purposes of this rulemaking B5 blends will be considered a legal California diesel fuel with no emissions mitigation required. Staff is currently contracting

with the University of California at Riverside to develop data to determine whether there are significant adverse air-related impacts from the use of B5 blends sufficient to warrant mitigation in the future. Likewise, the rulemaking will not affect gaseous motor vehicle fuels (i.e., compressed natural gas, liquefied petroleum gas and hydrogen) that are currently used in compression ignition engines pursuant to existing fuel specifications under title 13, California Code of Regulations section 2292 (13 CCR 2292).

Staff also recognizes that new innovative hydrocarbon-based diesel fuel substitutes, like renewable and synthetic diesels, are also available in the market and could be addressed in this rulemaking. However, the physical properties of renewable and synthetic diesels meet all applicable petroleum diesel fuel quality requirements under 13 CCR 2281-2285. Therefore, staff believes that it would be appropriate to allow the use of compliant hydrocarbon-based renewable diesel and synthetic diesels either as neat fuels, or as blendstocks in the production of conventional petroleum CARB diesel fuel under 13 CCR 2281-2285. The CARB biodiesel/renewable diesel study showed that renewable and synthetic diesels have comparable or better emission characteristics as compared to conventional petroleum-based CARB diesel.

A. Generic Requirements Applicable to Alternative Diesel Fuels

As fuel researchers develop new diesel fuel replacements, general concerns will arise with the introduction of any new chemical fuel. Some of these concerns may relate to potential human health hazards, adverse environmental impacts, public safety, or quality controls, which make it appropriate to use new chemical fuels in existing and future vehicles. For purposes of this white paper, the conceptual requirements are introduced below. As staff develops the proposed regulation order for the rulemaking, more specific requirements will follow. However, in general the generic provisions would require:

1. Formal Governmental Recognition- For any new fuel, this provision would require that the fuel proponent obtain some formal recognition by either state or federal government, such as through the United States Environmental Protection Agency (USEPA) registration under 40 CFR Part 79.
2. Public Health and Safety Information: For any new candidate fuel or blendstock, the fuel proponent must develop relevant information regarding any adverse public health effects from exposure, as well as any information regarding public safety. An example of this information may include the development of a Material Safety Data Sheet (MSDS),
3. Multimedia Assessment: For any new ADF or hydrocarbon-based diesel fuel blendstock that requires ARB to establish new specifications, a multimedia assessment would be required in full accordance with Health and Safety Code, Division 26, Part 5, Chapter 4, Article 3, section 43830.8. A multimedia evaluation requires the identification and evaluation of any significant adverse

impact on public health or the environment, including air, water, or soil, that may result from the production, use, or disposal of the motor vehicle fuel that may be used to meet the state board's motor vehicle fuel specifications.

As indicated by the Health and Safety Code, the multimedia assessment is an evaluation, which is based on the best scientific information available that must address at a minimum, the impacts to:

- (1) Emissions of air pollutants, including ozone forming compounds, particulate matter, toxic air contaminants, and greenhouse gases.
 - (2) Contamination of surface water, groundwater, and soil.
 - (3) Disposal or use of the byproducts and waste materials from the production of the fuel.
4. Development of Fuel Specifications: For any new ADF or hydrocarbon-based petroleum diesel substitute, specifications must be developed to address vehicle performance, public safety and fuel production issues. Examples may include industry consensus standards such as those developed by ASTM International, American National Standards Institute or those developed by state or federal government,
 5. Approved ADF use in Certified Engines: For ADFs and drop-in diesel fuel substitutes, an evaluation must be conducted to address any adverse impacts associated with the use of the new diesel replacement in certified diesel engines in California. It is possible that future diesel fuel replacements may require engine and/or fuel system modifications, especially for retroactive use in the existing fleet. In this regard, fuel proponents would be required to obtain the necessary government approvals to use the replacement diesel fuel in current and new certified engines.
 6. Other State and Federal Regulations: Staff will include a provision that clarifies that fuel proponents are to comply with any other applicable state or federal regulations regarding the use of the new ADF or hydrocarbon-based diesel fuel substitute.
 7. Detection Test Methods: Staff proposes to require well established and validated test methods for the measurement and detection of properties contained in the established specification/s discussed in paragraph 4, above.
 8. Enforcement Protocol: As with any motor vehicle fuel, enforceability is a major concern for CARB. As such, staff proposes to require the development of appropriate enforcement provisions to address blending, labeling, product transfer documentation, test methods, reporting, and recordkeeping.

V. *Biodiesel as the First Alternative Diesel Fuel*

Over time, staff intends to develop regulations to establish a list of CARB recognized ADFs, with biodiesel as the first fuel to be formally recognized. For biodiesel, the proposed provisions effectuate the generic ADF requirements discussed in section IV above. Below is a conceptual outline for fuel quality, blending, labeling and recordkeeping, as well as enforceability.

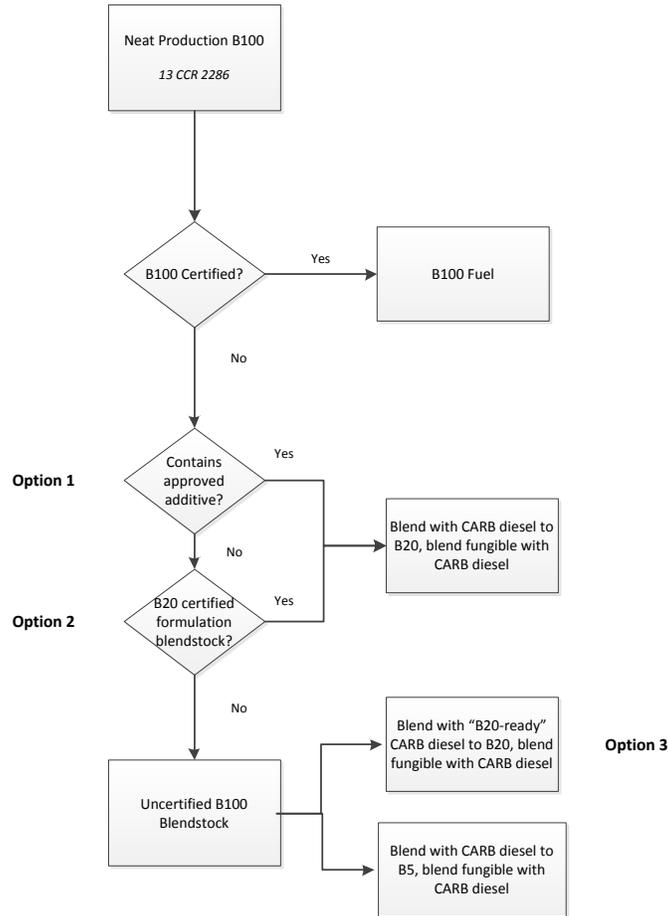
To set the basis for the proposed concepts, staff considered the comprehensive biodiesel emissions research that confirmed that NOx emissions increase with increased biodiesel use. This increase in NOx emissions can be viewed as a NOx “emissions bias.” Additionally, the “Biodiesel Characterization and NOx Mitigation Study” concluded that biodiesel blends with CARB diesel can cause up to a seven percent NOx increase for B20, and up to almost 50 percent NOx increase for B100, in diesel engines certified to pre-2010 on-road truck emission standards. Given CARB’s mission to lower ozone emissions to meet ambient air quality standards, any NOx increase from biodiesel use is untenable.

A. Applicability for NOx Mitigation

Both B100 and blends of twenty volume percent biodiesel with CARB diesel (B20) have been shown to be viable commercial replacements to conventional CARB motor vehicle diesel fuel. However, given the higher NOx emissions from biodiesel use anticipated in today’s California diesel vehicle fleet, staff proposes to require NOx mitigation to levels anticipated for CARB diesel produced in compliance with 13 CCR 2281-2285.

Figure 1 below illustrates staff’s concept of how a neat production biodiesel will be allowed in commerce to create an emissions neutral finished motor vehicle fuel, an emissions neutral B20, or typical B5. For purposes of this discussion, “emissions neutral” means that the NOx emissions from biodiesel use are the same as CARB diesel fuel, whereas “emissions biased” means that biodiesel use results in incremental NOx emissions (compared to CARB diesel) that will need to be mitigated prior to sale as motor vehicle fuel.

Figure 1- Proposed Regulatory Framework for Biodiesel as an ADF



B. Emissions Neutrality of B100 for Use as a Finished Motor Vehicle Fuel or for the Production of B20

Currently, biodiesel is either used as a fuel in its neat form or is used to make a blend with CARB diesel. In either case, the proposed regulation requires emissions neutrality of all motor vehicle biodiesel blends above B5, including B100.

Several individual users, municipalities and other groups currently comprise the nascent market for B100 as a neat motor vehicle fuel. Under staff's proposal, the motor vehicle B100 fuel would be required to achieve emissions neutrality and meet minimum quality specifications contained in ASTM 6751-08, with the additional specifications listed in the following table.

Biodiesel (B100) Specifications

Property	Specification	ASTM Test Method
Natural Cetane Number	47, minimum	D613-84
API Gravity	27, minimum	D287-82
Sulfur Content (ppmw)	15, maximum	D5453-93
FAME (volume %)	96.5, minimum	EN 14103

Staff proposes to require emissions neutrality of incremental NO_x emissions from B100 as a motor vehicle fuel, or for B100 as a constituent of a subsequent B20 blend. Emissions neutrality for motor vehicle B100 may be achieved through a formal certification process, described later. Likewise, emissions neutrality for B100 used in B20 blends may be achieved by the various compliance options presented in subsection C. below.

Staff is also currently considering the benefit of including other fuel quality requirements to improve fungibility, such as elements of BQ-9000. Moreover, due to the significant cost of creating an emissions neutral B100, staff are also considering a *de minimus* use exemption.

C. Emissions Neutrality of B20 Blends

Under these regulatory concepts, staff proposes three regulatory compliance paths in order to produce an emissions neutral B20 blend. These options include:

1. Use of approved NO_x control additives,
2. Use of a certified ADF (i.e., biodiesel) formulation, and
3. Blending biodiesel with "B20-ready" CARB diesel

i. Use of approved NO_x control additives

Staff proposes to allow fuel producers to use additives that have been demonstrated to mitigate NO_x emissions from B20 blends. These additives can be either additives that CARB staff will identify in the regulation, or additives that subsequently undergo a demonstration process to show its effectiveness.

Additives Allowed in the Regulation- The CARB biodiesel study showed that certain additives are able to bring some blends of biodiesel into emissions neutrality when compared to CARB diesel. Specifically, we found that a B20 blend containing one percent di-tert butyl peroxide (DTBP) was effective in mitigating the NO_x emissions increase that was observed in the fuel without the additive. In addition, DTBP is being addressed by the on-going biodiesel multimedia evaluation. Therefore, staff proposes to allow the use of the DTBP additive as a compliance option for B20 blends.

Staff also proposes to allow CARB-approved additive packages to be added to the B100 and then be blended with compliant CARB diesel to the appropriate blend level. Therefore, for DTBP the neat B100 would be required to contain five volume percent DTBP, such that it would contain the required dosing rate of one percent DTBP when the B100 gets subsequently blended with CARB diesel to produce B20.

In the future, as staff identifies additional NOx mitigating additives for biodiesel blends, those could be added to the regulation via subsequent rulemakings. However, future NOx mitigating additives may require a multimedia evaluation under Health and Safety Code, Division 26, Part 5, Chapter 4, Article 3, section 43830.8.

Demonstrated Biodiesel Additives- This option would allow fuel and additive proponents to apply to CARB staff and demonstrate the effectiveness of their biodiesel additives in accordance with prescribed testing procedures. Applicants will receive an Executive Order upon successful completion of all requirements. In general, the applicant would test a candidate fuel containing their additive against a California reference diesel. A predetermined amount of additive will be required to be blended into a “Reference B100” demonstration fuel and that mix will be blended with California reference diesel to produce a B20 (i.e., 80 volume percent California reference diesel).

Staff intends to develop a fuel additive emission test comparison program in which a high NOx emitting reference biodiesel standard formulation is used for emissions testing. Staff considers that a biodiesel additive which is able to successfully complete a demonstration program would be able to mitigate any potential NOx increase associated with current commercially available neat B100, regardless of production feedstock. The proposed draft specifications of the neat reference biodiesel (B100) used for demonstration are shown in the following table.

Proposed Specifications for “Reference B100” used for Additive Demonstration

Property	ASTM Test Method	Fuel Specifications
Natural Cetane Number	D613-84	47-50
API Gravity	D287-82	27 – 33
Viscosity at 40°C, cSt	D445-83	2.0 – 4.1
Flash Point, °F, minimum	D93-80	266
Distillation, °F	D86-96	
90 % Recovered		620-680
FAME content %	EN 14103	96.5 minimum
Sulfur Content	D5453-93	15 ppm maximum
Nitrogen Content	D4629-96	10 ppm maximum
Feedstock	N/A	Virgin Soy Oil

ii. Use of Certified Alternative Diesel Fuel (i.e., Biodiesel) Formulations

This conceptual approach would allow maximum flexibility for qualified parties to certify any biodiesel/CARB diesel formulation from B6 to B100, including any proprietary additives. Under this proposed certification program, candidate fuels would be tested to demonstrate emissions equivalence to a CARB reference diesel. The procedure for this certification would be modeled after the procedure for certifying diesel formulations contained in title 13, CCR, section 2282(g).

Assuming successful completion of certification program requirements, CARB would issue an Executive Order to the successful applicant certifying their unique biodiesel/diesel fuel blend formulation as emission neutral at the blend levels specified in the Executive Order.

iii. Use of "B20 Ready" CARB Diesel Fuel

Under this option, a fuel producer may use a special "B20-ready" CARB diesel formulation for the CARB diesel portion of any biodiesel blend up to B20. The CARB biodiesel study showed that one way to mitigate the NOx emissions increase of biodiesel blends is to mix biodiesel with a lower-emitting version of CARB diesel, such as a renewable diesel. The mitigating effect of "B20-ready" CARB diesel results from lower sulfur and aromatic hydrocarbon content, higher cetane, and higher API gravity limits (relative to standard CARB diesel). Staff estimated the appropriate specifications for a CARB diesel that could achieve the same emissions neutrality demonstrated by renewable diesel in the CARB biodiesel study. Moreover, since the "B20-ready" specifications are a subset of possible CARB diesel formulations, no additional multimedia evaluation is legally required.

Draft Specifications for "B20-ready" CARB Diesel

Property	Test Method	Limit
Cetane Number	ASTM D613-84	≥ 67
Total Aromatics	ASTM D5186-96	≤ 6.4 mass%
PAH	ASTM D5186-96	≤ 0.6 mass%
API Gravity	ASTM D287-82	≥ 47.4 degrees API
Nitrogen Content	ASTM D4629-96	≤ 164 ppmw
Sulfur Content	ASTM D5453-93	≤ 5 ppmw

D. Proposed Blending Requirements for Biodiesel as an ADF

Staff anticipates that under the proposed compliance concepts, neat motor vehicle biodiesel (B100) will be used by fuel producers to produce one of four legal motor vehicle fuels, including: emissions neutral B100, emissions neutral B20 blends, emissions neutral certified ADF formulations, and B5 blends. In the marketplace, CARB staff proposes to consider any of the legal blends as totally fungible with petroleum

CARB diesel under 13 CCR 2281-2285 and legal for comingling with any other legal CARB diesel.

Staff plans to develop specific requirements that apply to both emissions neutral and emissions biased motor vehicle B100. If the motor vehicle B100 is emissions neutral, then it is considered a commercially legal fuel. Alternatively, if the motor vehicle B100 is emissions biased and the incremental NOx emissions have not mitigated, then it would be legal for blending to produce B5, an emissions neutral B20 blend, or a certified ADF formulation.

In developing the biodiesel blending provisions, staff recognizes the need to address the five areas below affecting the blending of B100 to subsequently produce legal biodiesel-containing motor vehicle fuels.

- Certified Motor Vehicle B100: This designation refers to a certified B100 that has demonstrated emissions neutrality. Upon successful completion of the certification procedures, this fuel can be is considered a finished motor vehicle fuel for the California market.
- Emissions Neutral B100 for Blending: This designation refers to B100 that has been NOx mitigated as described in section V.C., so that when it subsequently gets blended with CARB diesel to produce B20 the resulting fuel blend will be emissions neutral. This includes compliance through additives or certified ADF formulations,
- Emissions Biased B100: This describes B100 that has not been NOx mitigated. This fuel can either be blended with CARB diesel to produce B5, or blended with a “B20-ready” diesel to produce an emissions neutral B20 blend.
- Intermediary Emissions Biased Biodiesel Blends: This designation refers to biodiesel blends between B21 and B99 in which the blend has not demonstrated emissions neutrality. These blends are not legal to be sold as motor vehicle fuels and will likely be used for B5 production, or potentially for the production of certified ADF formulations.
- “B20-ready” Diesel: Refers to unique CARB diesel formulation described in section V.C.iii.. This unique CARB diesel would be recognized as a non-fungible blendstock for specific use in “B20-ready” emissions neutral B20 blends.

E. Proposed Labeling and Recordkeeping Requirements for Biodiesel as an ADF

Staff plans to develop a comprehensive set of product transfer documentation, labeling and recordkeeping requirements to facilitate the production and sale of legal and emissions neutral biodiesel motor vehicle fuels.

Over the next several months CARB will consult with stakeholders to develop more specific requirements for the logistical tracking of B100 fuel quality and its corresponding use. Likewise, staff recognizes the need for labeling and recordkeeping

relative to intermediary blends to document the biodiesel content of the blend, the diesel fuel mixed into the blend and whether the blend is emissions neutral or emissions biased.

Furthermore, federal requirements will require labeling at the pump to designate biodiesel blends under title 40, Code of Federal Regulations, part 79.

F. Enforcement of Biodiesel as an ADF

Staff plans to develop compliance provisions for three primary groups who would have compliance obligations under this regulation concept: biodiesel producers and importers, fuel blenders and refiners. A conceptual approach for compliance requirements is summarized below.

Biodiesel Producers and Importers: Biodiesel producers and importers who sell, offer for sale, or supply an ADF product in California would have the following compliance requirements:

- **Submit quarterly reports** to CARB showing how much ADF was sold, offered for sale, or supplied in California, the specific method of compliance that was followed for each batch, and test data showing that each batch met the required properties; and
- Upon request by inspector, **produce records** showing the specific method of compliance that was followed for each legal batch of biodiesel-containing motor vehicle fuel sold. Records are to be maintained for a period of two years; and
- Upon request by inspector, **produce records** showing that the product transfer documents are properly labeled for any ADF sold, offered for sale, or supplied in the past two years.
- Additionally, random samples of current production may be tested to ensure compliance.

Refiners: Refiners who sell, offer for sale, or supply diesel fuel that is marketed as “B20-ready” diesel would have the following compliance obligations:

- **Submit quarterly reports** to CARB detailing the amount of “B20-ready” CARB diesel that was sold, offered for sale, or supplied in California, and the chemical properties of each batch; and,
- The “B20-ready” diesel must meet all “B20-ready” chemical or physical property specifications to be established in the proposed ADF regulation.
- Additionally, random samples of current production may be tested to ensure compliance.

General enforcement. At any point in the commercial distribution system, CARB seeks to sample and test biodiesel for sulfur, which is not to exceed a cap of 15 ppm, and aromatic hydrocarbon content, which is not to exceed a cap of 28 mass percent.

Provisions for the enforcement of neat biodiesel sales and supply would be included in staff's newly proposed provisions under title 13 California Code of Regulations, section 2286, and would largely be similar to the current enforcement of CARB diesel.

VI. Proposed Modifications to the California Code of Regulations

To effectuate the intent of this rulemaking, various sections within title 13 of the California Code of Regulations (CCRs) would be impacted.

Staff proposes to **amend title 13, CCR, section 2282** to include the "B20-ready" diesel specifications, to update the diesel certification program (including updated certification engine), and other minor updates and changes. Staff also proposes to amend the certification program to include specific health and toxicity tests that were previously only required when additives were used. Additionally, staff proposes to add a cap limit of 28 percent by mass, aromatic hydrocarbon content.

Under this rulemaking, staff proposes to **add a new section 2286** to title 13 of the CCR. This section would specify requirements for ADFs and ADF blendstocks, including a mitigation option based on the "B20-ready" diesel specifications added to section 2282 and mitigation options based on certification, additives and other specifications.

For the new proposed certification program, staff also proposes to transition from the current 1991 Detroit Diesel Company Series-60 diesel certification engine under section 2282, to the more modern 2004-2006 Cummins ISM, by January 1, 2015. Finally, staff proposes to use the same engine for ADF certification.

VII. Staff Contacts

For more information regarding the content of this white paper, please contact Alexander "Lex" Mitchell at (916) 327-1513 or by email at amitchel@arb.ca.gov.

VIII. Future Work

In addition to the regulatory concepts outlined here, CARB staff is also actively engaged in research on biodiesel and other alternative diesel fuels, to determine if regulations that would address alternative diesel blends B5 and below are necessary. We will also be continuing to monitor the alternative diesel fuel market to determine if other categories of ADFs become prevalent and are appropriate to include in the ADF regulation.