April 23, 2018

Chair Mary D. Nichols
Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: Proposed amendments to the Low Carbon Fuel Standard regulation and to the regulation on Commercialization of Alternative Diesel Fuels

Dear Chair Nichols,

LanzaTech appreciates the opportunity to provide comments regarding the proposed changes to the Low Carbon Fuel Standard (LCFS) currently under consideration by the Air Resources Board (ARB). We would like to firstly express our strong support for the inclusion of Alternative Jet Fuel (AJF) in the LCFS, and to acknowledge the exemplary work of ARB staff and management in positioning California as the global leader in supporting low carbon fuels. LanzaTech has worked with ARB on a number of projects and regulatory items, and we have always found ARB staff to be exceptionally professional, responsive, and supportive.

LanzaTech is commercializing novel technologies for the production of low carbon chemicals and fuels, particularly ethanol and AJF, from industrial waste gases and residue streams. This work includes a commercial project in California converting agricultural residues into cellulosic ethanol. Ethanol was also recently qualified as an acceptable feedstock under ASTM D7566 (https://www.astm.org/Standards/D7566.htm) for producing AJF, and LanzaTech is developing a pre-commercial scale facility to demonstrate its novel alcohol-to-jet (ATJ) technology. Including AJF in the LCFS makes California an even more attractive location to build a commercial scale ATJ facility.

Overall we agree with the approach ARB has taken with respect to the proposed regulatory changes to the LCFS. We would like to propose a few modifications to further strengthen the proposed regulation. These comments are in addition to our concurrence with the comments submitted by Noyes Law Corporation on behalf of the AJF Producers.

1. Refer to ASTM Standards and Methods without specifying the year of publication

When referencing an ASTM Standard only the standard # should be given not the year it was issued. ASTM standards are updated frequently to represent available equipment, latest methodologies etc. Referencing outdated standards and methods makes it difficult to comply with the regulation as written and creates the potential for confusion.

For referencing ASTM standards, provide the link to the ASTM website, www.astm.org.

Please see Attachment A for a list of references to ASTM Standards and Methods within the regulation with a recommendation for how to modify them.

2. Modify the definition of "Biomass"

The definition of "Biomass" excludes the use of algae, cyanobacteria and other microbes, as well as other types of biological organisms that can be used as biocatalysts, fuel sources, or feedstocks for the production of fuels. It is also unnecessarily limited in its references to wastes, which are a high priority source of feedstock for low carbon fuels. We recommend the following more technology-neutral definition in order to ensure that the LCFS remains a robust regulation as new technologies come online:

"Biomass" means biogenic ~~plant and animal~~ material from plants, animals, and other organisms, especially agricultural ~~or~~, forest, or other waste products, which can be used as a biocatalyst, a source of fuel, or a feedstock for the production of fuel, soil amendment, or fertilizer.

3. Redefine "Biomass-based Diesel" as "Alternative Diesel"

The "biomass-based diesel" definition is overly prescriptive in its specification only of biodiesel and renewable diesel. Other technologies, such as ethanol based Alcohol-to-Jet, are able to produce Synthetic Paraffinic Diesel (SPD) meeting ASTM D975 (http://www.astm.org/Standards/D975.htm) from ethanol feedstocks. To maximize the pool of low carbon diesel for the California road market, we recommend one of two options:

Option 1: Rename "Biomass-based diesel" as "Alternative diesel" with the following definition:

"Alternative diesel fuel" means a biodiesel (mono-alkyl ester), a renewable diesel, or any other non-petroleum diesel that complies with ASTM D975, Specification for Diesel Fuel Oils, which is incorporated herein by reference."

This option would be consistent with the proposed definition and use of Alternative Jet Fuel throughout the regulation

Option 2: Add a separate definition for "Alternative diesel fuel":

"Alternative diesel fuel" means any non-petroleum-based diesel other than biodiesel or renewable diesel that complies with ASTM D975, Specification for Diesel Fuel Oils, which is incorporated herein by reference."

This option will require that all references to "Biomass-based diesel" be updated to read "Biomass-based diesel or Alternative Diesel Fuel".

Please see Attachment B for a list of references to "Biomass-based Diesel" within the regulation.

4. Add an energy density for fossil jet to Table 4

All fuels except for Alternative Jet Fuel have both the fossil baseline energy density and the alternative fuel energy density listed in Table 4. For jet fuel only the Alternative value is listed. Per

ASTM, the minimum fossil jet energy density is 42.8 MJ/kg, while the average is 43.2 MJ/kg. Using an average density of 0.8 kg/L (6.67 lb/gal) gives a minimum energy density of 129.6 MJ/gal and an average of 130.8 MJ/gal.

5. Relabel "biomass-based jet fuel" as "Alternative Jet Fuel" in Table 5

There is no definition for "biomass-based jet fuel". This reference should be relabeled "Alternative Jet Fuel".

6. Reword Section 95483(a)(1)(C)

The language in the above-reference paragraph is confusing and appears to overlook the fact that Alternative Jet Fuel must be blended with conventional jet fuel, which may take place at an interim facility. We recommend the following clarification:

Specifics for Alternative Jet Fuel. For an alternative jet fuel or the alternative fuel portion of a blend with conventional jet fuel, the first fuel reporting entity is the producer or importer of the alternative jet fuel first delivered to either (1) a blending facility; or (2) a storage facility where alternative jet fuel is stored before blending, or a blended fuel is stored before being uploaded to an aircraft in California. Conventional jet fuel, including the conventional jet fuel portion of a blend, is not subject to the LCFS and must not be reported.

7. Increase the baseline carbon intensity value for fossil jet fuel

We concur with the AJF Producers' assessment that the fossil jet fuel carbon intensity baseline is overly optimistic in its assessment of the processing required to produce jet fuel. We support the suggested approach of either utilizing the current diesel curve as defined in Table 2 or using a hybrid approach with a fixed benchmark through 2022, then using the benchmark CI for diesel for the corresponding year from 2023 on. We believe these approaches would not negatively affect renewable diesel production due to the economic constraints on the ATJ market.

8. Expand the provision for Carbon Capture and Sequestration to include chemicals produced via Carbon Capture and Utilization

The eligibility for refinery investment project credits is unnecessarily narrow and excludes non-geological sequestration, such as through chemical conversion into durable goods such as plastic materials. It also restricts carbon capture to carbon dioxide and does not provide credit for the capture of carbon precursors to carbon dioxide, including carbon monoxide. We recommended to reword Section 95489(e)(1)(E)(1.):

"Carbon oxide capture at refineries, or at hydrogen production facilities that supply hydrogen to refineries, and subsequent ~~geologic~~ sequestration;"
Other references to CO_2 specifically should be broadened to include carbon oxides generally, using "carbon" as a shorthand for this general class of molecules.

The eligibility for fuels produced using carbon capture and sequestration is unnecessarily narrow and excludes non-geological sequestration, such as through chemical conversion into durable goods including plastic materials. We recommended to reword the following Sections of 95490:

(a)(1)	*"(1) Alternative fuel producers, refineries, and oil and gas producers that capture carbon oxides on-site and ~~geologically~~ sequester carbon either on-site or off-site."*
(a)(2)	*"(2) An entity that employs direct air capture to remove carbon from the atmosphere and ~~geologically~~ sequester the carbon. If carbon derived from direct air capture is converted to fuels, it is not eligible for project-based CCS credits. However, applicants may apply for fuel pathway certification using the Tier 2 pathway application process as described in section 95488.7."*
(c)(2)(B)	"An engineering drawing(s) or process flow diagram(s) that illustrates the project and clearly identifies the system boundaries, relevant process equipment, mass flows, including the quantity of carbon injected into pipeline or delivered by other modes of transport for carbon injection or sequestration by other means, and energy flows necessary to calculate the CCS credit;"
(g)(2)	"Energy use and chemical use data for the carbon capture facility and carbon sequestration ~~injection~~ facility;"

9. Modify the references to ASTM Methods in the regulation on Commercialization of Alternative Diesel Fuels

In the Regulation on Alternative Diesel Fuels, Tables outlining fuels properties should be harmonized with the referenced ASTM Standard. For example, ASTM D6751 (http://www.astm.org/Standards/D6751.htm), Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels, defines a minimum flash point in °C, while Table A.8 calls for results to be report in °F. Ensuring technical and regulatory reporting formats match as closely as possible will make reporting easier and result in fewer mistakes.

Thank you for your consideration of our input. Please contact us if any further input would be helpful. We look forward to continuing to provide input to this proceeding.

Sincerely,

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CEO, LanzaTech

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Attachment A: List of References to ASTM Standards with the LCFS Regulation

Section	Current	Modification
95481(9)	D910-17	D910
95481(18)	D975-14a, (2014)	D975
95481(27)	D1655-17 (2017)	D1655
95481(34)	D975-14a, (2014)	D975
95481(36)	D4806-14 (2014)	D4806
95481(113)	D1835-16, (2016)	D1835
95491(d)(1)(B)(2)(b)	D1250-08 (Reapproved 2013)	D1250
95491(d)(1)(B)(3)	D1250-08 (Reapproved 2013)	D1250
ADF-4 Table A.8	D5453-93	D5453
ADF-4 Table A.8	D4629-12	D4629
ADF-4 Table A.8	D613-14	D613
ADF-4 Table A.8	D6890-13be1	D6890
ADF-4 Table A.8	D7170-14	D7170
ADF-4 Table A.8	D7668-14a	D7668
ADF-4 Table A.8	D287-12b	D287
ADF-4 Table A.8	D445-14e2	D445
ADF-4 Table A.8	D93-13e1	D93
ADF-4 Table A.8	D86-12	D86
ADF-5 Table A.9	D5453-93	D5453
ADF-5 Table A.9	D5186-03(2009)	D5186
ADF-5 Table A.9	D4629-12	D4629
ADF-5 Table A.9	D613-14	D613
ADF-5 Table A.9	D6890-13be1	D6890
ADF-5 Table A.9	D7170-14	D7170
ADF-5 Table A.9	D7668-14a	D7668
ADF-5 Table A.9	D287-12b	D287
ADF-5 Table A.9	D445-14e2	D445
ADF-5 Table A.9	D93-13e1	D93
ADF-5 Table A.9	D86-12	D86

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Attachment B: List of References to "Biomass-based Diesel" within the LCFS Regulation

Section	Number of references
95481(a)(18)	2
95482(a)(8)	1
95482(a)(10)	1
95483(a)	1
95483(a)(1)	1
95483.1(a)(1)(B)	1
95484(e)	1
95484(e)(1)	1
95484(e)(2)	1
95484(f)	2
95488.3(d) Table 6	3
95488.9(b)(4) Table 8	1

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