# APPENDIX C

# ECONOMIC SUPPORTING INFORMATION

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Introduction:

This Appendix describes the methodology used to determine the annual costs of NOx mitigation for the volume of biodiesel blends above B5 in 2018 through 2024. The annual projected volumes of these blends in peak in 2018 with 28 million gallons of B100 used to make blends above B5, and, subsequent years remain steady at 27 million gallons of B100 used to create blends above B5. The annual costs provided here do not account for options available to biodiesel producers in lieu of additive mitigation or seeking an ADF certified formula or the allowed blends up to B10 during the months of November through April. The costs presented here are meant to provide an upper range of costs resulting from this regulation, in the unlikeliest of compliance scenarios.

The ARB sponsored study, ***Biodiesel Characterization and NOx Mitigation Study (2011)***, resulted in the identification of potential options to mitigate the NOx increases for biodiesel fuel use. These options include:

- Use of approved $NO_x$ control additives; or
- Use of a certified ADF (i.e., biodiesel) formulation.

Staff assessed the cost of each compliance option for controlling NOx from biodiesel blends.

1. Use of Approved $NO_x$ Control Additives

Staff assumed that for widespread additive use, fuel terminals would be best suited to provide the ability to inject the additive for all biodiesel production, due to higher throughput, economy of scale and resulting lower costs. In 1992, ARB implemented the gasoline deposit control additive regulation (title 13 CCR section 2257), which requires all gasoline in California to contain additives, similarly to DTBP in biodiesel. As a result, virtually all gasoline deposit control additives are currently injected into gasoline at the terminal level.

Staff estimated the cost of additives for $NO_x$ control based on the cumulative cost of new wide scale infrastructure (including the annual cost of operation) and the cost of the DTBP additive.

*a. Additive Cost:*

To determine the costs of compliance using approved NOx control additives, staff estimated the cost of using di-tert butyl peroxide (DTBP) at a treat rate of five percent by mass for B100. This treat rate amounts to a one percent treat rate by mass for biodiesel blends of B20 and below.

To determine the cost of the DTBP additive, staff solicited quotes from several chemical production companies based on bulk volumes. Staff received a quote of $3.45 per kg for every 10 metric tons purchased and delivered to California[1]. Using conversion factors and DTBE density to calculate the cost per gallon, we get:
$3.45/kg x 0.79 kg/L x 3.7854 L/gal = $10.32/gal DTBP.

To add DTBP at five volume percent to 5 million gallons of B100 would require 250,000 gallons of DTBP (i.e., 5,000,000 gal x 0.05) and would total an annual additive cost of:
250,000 gallons DTBP x $10.32/gallon DTBP= $2,580,000.

The additive cost on a per gallon basis to treat 25,000,000 gallons of B20 or below (or 5,000,000 of B100 gallons) will result in:
$2,580,000/25,000,000 B20 gallons = $.103 per gallon of B20.

*b. Infrastructure, Operations and Maintenance Costs:*

To accommodate the 5 million gallons of B100 used in B20 that will need NOx controls, we would need 1-2 small scale blending stations. These stations would include 30,000 gallon carbon steel tank with concrete dike and truck pad, pump, piping, manual and control valves and a metering device for the DTBP additive. While one facility could accommodate the 250,000 gallons of DTBP that would be needed, staff would expect that more than one business would additize, and therefore we project two facilities would invest in the additizing infrastructure.

To calculate total annualized capital cost, staff utilized the following capital recovery factor: CRF =Interest rate / [1-(1+interest rate)$^{\text{-years of loan}}$]

Therefore, for a seven year amortization (2018 through 2024) at a five percent loan interest rate, the capital recovery factor is:
$CRF_{10}$= 0.05 / [1-(1.05)$^{-7}$] = 0.1728,

Using the capital recovery factor the annual cost of capital is:
Annual Capital Cost = Total Capital Cost x $CRF_7$, or
$1,000,000 x 0.1728 = $172,800/ year,

Together with the operations and maintenance costs at $10,000, as well as one person at $40 an hour part time to oversee the additizing (at $40 an hour) per facility, the total annual cost to provide infrastructure to additize at one facility would be:

Cost per year of faciliites+ operations cost + operator
$172,800+ $10,000 +$41,600 = $224,400

[1] Email from Karl Wang, Orchid Chemical, March 21/2013

For two facilities the annual cost is $448,800 and would accommodate the 5 million gallons of B100 that would require NOx controls.

Likewise, if each facility treats B100 with DTBP at the five percent treat rate for downstream use in blends up to B20, then the incremental cost of additizing biodiesel will be $224,400/5,000,000 gallons per year, or $0.045 per gallon of B100. Each gallon of B100 could then be blended down to five gallons of B20 at a cost of $0.009 per gallon of B20.

This cost achieves full NOx mitigation of blends up to B20. Therefore:
Total cost of adding DTBP to biodiesel = Cost of Injection/gal + Cost of Additive/gal, or
= $0.009/gal B20 + $0.103/gal B20
= $0.112/gal per gallon of B20
The total for all 5,000,000 gallons of B100 used in B20 (or 25,000,000 B20), the cost would be:
$0.112 cost/gallon* 25,000,000 gallons = $2,800,000

c. High Saturation Biodiesel

Additionally, high saturation biodiesel can make B10 without any $NO_x$ controls. However, to determine if a biodiesel is high saturation, testing is required. Staff contacted a company specializing in this testing and was provided a quote of $575 per batch, with three tests required per batch. ARB estimates a batch contains 40,000 gallons of B100. Therefore, the cost of testing on a per gallon basis is:
= $1725(tests)/40,000 gallons per batch
= $.043/ gallon of B100 (or .04/10=$.004/gallon of B20, blended at B10)

Assuming that all batches tested are in fact high saturation biodiesel, producers of high saturation biodiesel could choose to test and therefore incur lower costs to make while still making B20 (at the B10 blend level). Assuming 36% of all B100 used in B20 requiring $NO_x$ controls is high saturation, we would expect that the costs in 2018 for testing is:
(10 million gallons (B100 used in B20) x $.043 per gallon)= $430,000

2. <u>Use of a Certified Biodiesel Blend Formulation</u>

This mitigation option is being proposed by staff and is modeled after the existing certification program contained in the California diesel fuel regulation under title 13 CCR section 2282(g). In the proposed certification program, a prescribed engine test protocol is followed for a candidate biodiesel blend fuel to derive emissions data and that data is compared to emissions data derived using the same test protocol on a conventional diesel reference fuel. Based on a statistical evaluation of the data, staff could determine if the candidate biodiesel blend demonstrates the same emissions performance as the conventional diesel reference fuel. If the statistical criteria is met, then the candidate biodiesel blend would achieve $NO_x$ mitigation and thereby be deemed a certified biodiesel blend.

Given the highly confidential and competitive nature of certifying specific fuel formulations, it is likely that all individual biodiesel producers may need to obtain their own individual certification to optimize their particular biodiesel blend formulations. The notable exception may be the case in which a trade association obtains a certification which subsequently is made available to their membership. However, for purposes of this analysis staff assumed that all 22 biodiesel producers listed in Table 10.7 would need to incur the cost of certification. Furthermore, there may be additional production costs associated with certified biodiesel blends such as in the case of designer blends using combinations of Low-NOx diesel, additives and specialized biodiesel feedstocks. However, it is impossible for staff to predict these costs.

3. Total Anticipated Cost of the Proposed Regulation 2016-2023

Although certain provisions of the proposed regulation will continue indefinitely, the majority of the costs are anticipated to be incurred in the years 2016-2023. The table below shows the costs of compliance in each of these years, and the total costs from 2016 to 2023.

| *$Thousand* | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **Total** |
|---|---|---|---|---|---|---|---|---|---|
| Regulation | $56 | $56 | $3,071 | $1,865 | $1,305 | $1,262 | $659 | $56 | $8,330 |

As shown in the table above and explained elsewhere in the staff report, in years 2016 and 2017 minimal reporting costs are expected. From 2018 to 2022, staff expects higher blends of biodiesel (above B5) to incur costs to control NOx, as expressed in the higher amounts in the table above. Starting in 2023 and continuing indefinitely staff expects costs to return to a minimal for reporting due to the sunset provisions and increases in NTDE use. All told staff expects the proposed regulation to result in costs of approximately $8.3 million from 2016 to 2023.