SUMMARY RESULTS FROM NBB/USEPA TIER I HEALTH AND ENVIRONMENTAL EFFECTS TESTING FOR BIODIESEL UNDER THE REQUIREMENTS FOR USEPA REGISTRATION OF FUELS AND FUEL ADDITIVES (40 CFR Part 79, Sec 21 1 (b)(2) and 21 1 (e))

FINAL REPORT

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The National Biodiesel Board has recently completed the first phase of emissions testing programs on biodiesel (known as Tier I testing) under USEPA regulations governing the introduction of new fuels and fuel additives. (40 CFR part 79) These programs include the most stringent emissions testing protocols ever required by USEPA for certification of fuels or fuel additives in the U.S. The data gathered through these tests provide as nearly a complete inventory of the environmental and human health affects attributes of biodiesel as current technology will allow. NBB submitted the final results from the Tier I testing programs to USEPA in March 1998.

Currently, biodiesel is the only alternative fuel that is participating in this comprehensive, multi-year USEPA emissions testing program. Other alternative fuels were provided with special legislative exemptions from these emissions testing programs as part of the Clean Air Act Amendments of 1990. The costs of the emissions testing programs and related fuel certification requirements for the biodiesel industry will eventually run into several millions of dollars. These are expenses that must eventually be recouped through profits on future fuel sales.

In evaluating the results of the Tier I Health Effects Testing Program several caveats need to be noted.

First, the study was not designed to present final conclusions related to the appropriate policies to promote the use of biodiesel. Instead, the study is designed to provide USEPA with information that can be used to formulate appropriate policies regarding biodiesel.

Second, the study does not provide any economic comparisons or valuations based on current market prices for biodiesel.

Third, the study directly compares the exhaust emissions attributes of biodiesel and biodiesel blended fuels to diesel fuel. The study does not directly compare the exhaust emissions of biodiesel or biodiesel blended fuels, such as B20, to any other alternative fuel.

With these caveats in mind, the major findings of the study are:

*The *overall ozone (smog) forming potential of exhaust emissions from biodiesel* is 50% less that the overall ozone forming potential of exhaust emissions from diesel fuel.

*The exhaust emissions of *carbon monoxide (*a poisonous gas and a contributing factor in the localized formation of smog and ozone) from biodiesel are 50% lower than carbon monoxide emissions from diesel.

*The exhaust emissions of *particulate matter* (recognized as a contributing factor in respiratory disease) from biodiesel are 30% lower than overall particulate matter emissions from diesel. Exhaust emissions of the insoluble portions of the particulate matter emissions (such as PM 10) were reduced by 80% for biodiesel compared to petroleum diesel.
The study also finds that biodiesel reduces the insoluble portions of the particulate matter emissions ie, *particulate matter soot such as PMI* 0, in exhaust emissions by 80%. Soot is the heavy black smoke portion of the exhaust that is essentially 1 00% carbon that forms as a result of pyrolysis reactions during fuel combustion.

*The exhaust emissions of *sulfur oxides and sulfates* major components of acid rain) from biodiesel are completely eliminated compared to sulfur oxides and sulfates emissions from diesel.

The exhaust emissions of aldehyde compounds such as formaldehyde and acetaldehyde that are suspected of contributing to human health problems) from biodiesel are 30% lower than the aldehyde compound emissions from diesel.

The exhaust emissions of *nitrogen oxides* a contributing factor in the localized formation of smog and ozone) from biodiesel are 13% greater than overall nitrogen oxide emissions from diesel. However, the study results strongly suggest that because biodiesel contains no sulfur, existing catalytic converters and other technologies that can not be used with diesel fuels that contain high amounts of sulfur may be able to be used with biodiesel and biodiesel blended fuels, such as B20, to control NOx emissions in biodiesel vehicles to an even greater degree possible than in current diesel vehicles.

*The exhaust emissions of *hydrocarbons* (a contributing factor in the localized formation of smog and ozone) are 95% lower for biodiesel than diesel fuel.

*The exhaust emissions of *aromatic compounds* known as PAH and NPAH compounds (suspected of causing cancer) are substantially reduced for biodiesel compared to diesel exhaust. All PAH compounds were reduced by 75% to 85%, with the exception of benzo(a)anthrancene, which was reduced by 50%. All NPAH compounds were reduced by more than 90%, with most NPAH compounds reduced to only trace levels. Diesel fuel may contain up to 40% aromatics. Biodiesel contains no aromatic compounds as part of its fuel chemistry

*A review of existing health effects studies of biodiesel and diesel fuel demonstrate that the *mutagenicity effects* (the tendency to cause mutations in mammals) of exposure to biodiesel and biodiesel exhaust emissions (both from 1 00% biodiesel fuels and blended fuels) is substantially lower than the overall mutagenicity effects of exposure to diesel. **Of** the 10 studies on mutagenicity effects reviewed, all showed substantial reductions in mutagenicity effects for biodiesel compared to diesel fuel. biodiesel blends were less mutagenic than diesel fuel but more mutagenic than 1 00% biodiesel.

* The overall *biodegradability* of biodiesel (the tendency of the fuel to harmlessly degrade rapidly and extensively into carbon monoxide in an aquatic environment) is 4 to 5 times greater than the biodegradability of diesel fuel. 100% biodiesel and high percentage biodiesel blends were shown to degrade from 64% to 91 % after 14 to 28 days. The corresponding degradation of diesel fuel was between 15% to 18% over the same period of time. Even B20 blends were shown to biodegrade twice as fast as diesel fuel over the same time period.