Study File!

Susan Thornton

From: Ralph Groschen [RGrosche.CORP.STP@mda.state.mn.us]
Sent: Tuesday, May 25, 2004 1:11 PM
To: Susan Thornton
Cc: ron.mundahl@ci.stpaul.mn.us; paul.keranen@dot.state.mn.us; Kurt Markham; mike@mnsoybean.com; streb002@tc.umn.edu; bicke006@umn.edu
Subject: RE. Soy-Based Diesel Fuel Study. Mn Law 1997 Ch 216, Sec. 15,Subd. 12(h)

Susan,

1997 12(h)

As you recall, the biodiesel study involved shipping a 20% biodiesel mixture from the Williams terminal in Roseville to the Hennepin County Garage in Medina, MN where the fuel and equipment were monitored over three winters for any performance or cold flow problems. The test was a success as there were no performance or cold flow problems experienced and the delivery system performed as designed with little inconvenience to the jobber. After the above mentioned study was completed the biodiesel tank and delivery system, which was purchased to accomplish the goals of the study, were moved from the Williams Pipeline Terminal in Roseville to the MNDOT pavement research facility in Albertville. DOT personnel planned to use the equipment to handle fuels and possibly test biodiesel use on vehicles in Albertville. Unfortunately it was not possible for them to use the tank as planned.

This is to advise you that plans are being made to move the equipment from the Albertville facility to the City of St. Paul Municipal Garage where City staff plan to use the equipment to dispense biodiesel or biodiesel blended products into their equipment. I believe this is compatible with the desire of the LCMR to keep the equipment in public service and, if possible, continue to demostrate the feasibility of renewable fuels like biodiesel. Thanks again for your assistance.

Sincerely,

Ralph

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October 10, 2000
LCMR Work Program Update
Date of Next Status Report: _ _

Date of Work Program Approval: ___ July 22, 1997_

Project Completion Date: June 30, 2000

LCMR Work Program 1997

I. PROJECT TITLE: SOY BASED DIESEL FUEL STUDY

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Total Biennial Project Budget:

LCMR: $83,000.00
LCMR Amount Spent: $60,892.69
= LCMR Balance: $22,107.31 (as of July 1, 1999) (some transactions are not complete, final financial report will follow)

A. Legal Citation: Minn. Laws 1997, Chap. 216, Sec. 15, subd. 12(h)

Appropriation Language: SOY BASED DIESEL FUEL STUDY. This appropriation is from the future resources fund to the commissioner of agriculture, in cooperation with one or more commissioners of appropriate state agencies, for a pilot project to test the use of soy-based biodiesel fuel to operate fleet vehicles. The study must include an analysis of the environmental effects, operational characteristics, and obstacles to widen use of soy-based biodiesel.

Carryforward:

ML 1999, Chapter 231, Section 16, Subd. 25. [Carryforward] , (a) The availability of the appropriations for the following projects is extended to

June 30, 2000: Laws 1997, Chapter 216, Section 15, Subdivision 12, paragraph (h), soy-based diesel fuel study.

II. PROJECT SUMMARY AND RESULTS:

Soydiesel, sometimes referred to as "biodiesel" fuels, are clean burning products from renewable resources such as soybeans. Soydiesel can also be blended with recycled cooking oils and greases, reducing the load on waste water treatment facilities, and used in place of diesel fuel made from imported oil.

Definitions: (These terms will be used in the narrative)

"Biodiesel" is diesel fuel derived from renewable resources. This particular project will use methyl ester (a product with superior performance attributes) derived from soybean oil.

"Petrodiesel" is diesel fuel derived from petroleum feedstocks. We will use this word to differentiate from biodiesel.

"B-20" is a blend of 20% biodiesel and 80% petrodiesel. This is the fuel that will be used in the heavy duty diesel test vehicles.

Biodiesel is an alternative fuel recognized by the US DOE under the National Energy Policy Act (EPACT) and by the EPA under the Clean Fuel Fleet Program, The Emission Credits Program and the Clean Air Act of 1990.

In order to make B-20 commercially viable, year-round tests with significant mileage must be conducted in cold climate states like Minnesota to:

- prove that no adverse effects will occur to the fuel or engines,
- prove that B-20 will function year round in cold climate states,
- provide fleet managers and purchasing agents with information so they can determine the viability of B-20 as an alternative fuel,
- educate the general public as to the benefits of B-20 use.

The project will include four B-20 fueled vehicles and one petrodiesel fueled vehicle as a control, operating for approximately 12 months. Other aspects of the project include:

- monitoring of fuel and vehicle performance,
- obtaining drivers' impressions of vehicle performance,
- using existing emissions data to analyze the environmental impact of B-20 fuel,

- and analysis of obstacles to wider use of B-20 in the Minnesota fleet market.

Project dollars will be allocated to the purchase of storage facilities, biodiesel acquisition, biodiesel, B-20 and engine oil sampling, quality control and analysis, review and documentation of equipment maintenance and repair, project supervision, review of existing research and marketing information, data analysis and reporting.

Field Study:

Hennepin County has tentatively agreed to cooperate on an 16-month field study. The County will provide 6 trucks used for road maintenance, and the petrodiesel fuel that they will burn during the evaluation. Four trucks will be powered by B-20. Two trucks, burning petrodiesel, will be used as a control.

After the project is initiated, University of Minnesota, Center for Diesel Research (CDR) personnel will obtain fuel consumption data and interview drivers and mechanics monthly. Oil samples will be taken every 5,000 miles and the oil analyzed for wear metals. Fuel samples will be taken as needed. Hennepin County will be asked to examine each fuel system at the beginning and end of the project, to identify any effects using the B-20 might have on the truck's fuel system.

In addition to the field study, a study examining market profiles for soy feedstocks and petroleum products will be conducted. The existing infrastructure used for diesel fuel will be examined, and the cost for changes that may be required using B-20 will be projected. A project that determines the reduction in engine emissions using B-20 in Hennepin County's fleet is beyond the scope of this study. However, the potential environmental benefit will be projected using data from emissions studies of engines burning blends of biodiesel and diesel fuel.

At the conclusion of the study, the field study protocol, data and results will be summarized for inclusion in the final report.

III. PROGRESS SUMMARY:

March 31, 1998 Progress Summary Update:

Project efforts since July of 1997 have been directed towards developing contractual agreements with two contractors and three cooperators, determining the requirements and cost for storing and transferring the

biodiesel and B-20 fuel, and obtaining additional funding needed for buying a biodiesel fuel tank and installing it at one of the cooperator's facilities.

Research contracts have been initiated with the University of Minnesota, Center for Diesel Research (CDR) and the Agricultural Utilization Research Institute (AURI). CDR will be responsible for the field study, and AURI will conduct fuel analyses throughout the project. Formal cooperative agreements have been written and are undergoing review by the legal departments of Williams Pipeline Company (WPL) and Hennepin County. WPL, a primary supplier of petrodiesel fuel in Minnesota, will store the biodiesel fuel, and provide petrodiesel fuel for the project. A heated fuel tank for storing the biodiesel will be located at their facility in Roseville. Another cooperative agreement has been prepared for Tracy Tripp Fuels, who will deliver the B-20 to Hennepin County after picking it up at WPL. The process of obtaining these cooperative agreements has taken much longer than anticipated, and is a main reason the field study has not yet started.

A significant amount of work was directed towards obtaining specifications and costs for the biodiesel fuel, a fuel additive, and a heated storage tank for the biodiesel fuel. Preliminary bids for a heated 1000 and 2500 gallon tanks were obtained. After making contact with WPL, the cost and requirements for a 3000 gallon tank that can be used at their facility was specified. This tank will include an explosion proof pump, a heated enclosure for the transfer hose, and other items that were not anticipated when the project was conceived. This tank will cost much more than originally estimated. Development of storage tank related costs and specifications are another reason for the project delay.

Bids for the biodiesel fuel were received from several biodiesel fuel suppliers. Ag Environmental Products (AEP) is the low cost provider and will most likely supply the fuel. Biodiesel fuel samples were obtained from AEP, and petrodiesel fuel samples from WPL. Bench tests were conducted to determine the low temperature properties of the biodiesel, the B-20, and the effect of the fuel additive.

The project will cost more than originally planned, primarily due to changes in specifications and cost of the fuel tank. The Minnesota Soybean growers Association has agreed to provide an additional $50,000 so the project can continue.

June 30, 1999 Progress Summary Update:

Professional technical contracts between the state and five program participants have been executed; the requirements and cost for storing and transferring the biodiesel fuel were determined; and a special heated biodiesel tank had was designed, built and installed. The $56,000.00 cost estimate for the construction and installation of the tank and equipment, plus site management and contingency measures greatly exceeded our preliminary estimates. The Minnesota Soybean Growers Association (MSBGA) provided $50,000.00 to defer the cost of the biodiesel tank and the need to extend the study through the winter of 1999-2000. The National Biodiesel Board is providing 600 gallons of biodiesel at a reduced cost to help get the study through the winter.

The bid for supplying biodiesel was awarded to Ag Environmental Products (AEP). Biodiesel samples were obtained from AEP and petrodiesel fuel samples were supplied by WPL. Before the field study began, the CDR conducted bench tests to determine the low temperature properties of the biodiesel fuel, the B20 blend, and the effect of fuel additives on the cold flow properties of the B20.

Because the special biodiesel storage tank was not available until February, arrangements were made with Hennepin County to begin the field demonstration in December of 1998. Hennepin County provided a mobile storage tank to receive the first 1000 gallon shipment of biodiesel on December 17, 1998. A few days later, 600 gallons of the biodiesel was dispensed into the county's dedicated underground storage tank and thoroughly blended with 2400 gallons of petrodiesel fuel. The resulting 3000 gallons B20 was then treated with a fuel additive to improve fuel stability and cold flow properties. The remaining 400 gallons of biodiesel was stored in the mobile storage tank until February when it was also blended.

Before Hennepin County trucks began using B20 on December 21, 1998, meetings were held with maintenance personnel and drivers to brief them about the new fuel. The drivers began pumping B20 from a designated pumping station, which automatically records refueling time, amount of fuel pumped, vehicle mileage, vehicle operator, and other information. The County has been using B20 in the same four trucks since the test began.

The special heated biodiesel storage tank and associated hardware was installed at the Williams Pipeline Terminal in Roseville on February 10 - 12, 1999. A shipment of approximately 2600 gallons of biodiesel was received by the terminal on February 12. Midwest Tracy Tripp Oil blended and transported 2500 gallons of B20 from WPL to Hennepin County on February 17. Tracy Tripp made a second 2500 gallon delivery of B20 to Hennepin County on April 6.

Samples of the biodiesel and B20 were taken several times throughout the field study. AURI and an independent outside laboratory analyzed the samples for fuel characteristics and cold flow properties.

June 30, 2000 Progress Summary Update

The field demonstration is now complete. No problems have been encountered in storing, transferring or using the B20 fuel. The trucks were used extensively during this period, due to a long stretch of nice weather with little rain that allowed Hennepin County to conduct more road maintenance than normal. Six deliveries totaling 14,000 gallons of B20 were made to Hennepin County from Williams Pipeline Company since June of last year. The heated storage tank at WPL also continued to function without problems.

Ten barrels of biodiesel fuel was donated to the project from the National Biodiesel Board. Unfortunately, samples collected from several barrels revealed that the fuel was marginal or out of specification for moisture content and acid number. The fuel was not used for this project, so AURI provided funding to purchase 1,500 gallons of biodiesel, that will allow the field demonstration to continue into March of this year.

IV. OUTLINE OF PROJECT RESULTS:

March 31, 1998 Outline of Results Update

The primary results thus far are discussed in the project summary. The contractual arrangements for the study have been made or will be completed soon with six different organizations. Arrangements for storage and transport of the fuel have been made, and an additional $50,000 in funding has been obtained. Bench tests of the fuel and fuel blend have shown that the biodiesel should mix well with diesel fuel which is at a temperature of 0° F. This is the coldest the diesel fuel is expected to be when it is mixed with the biodiesel fuel.

During the field study, data will be obtained on the operational characteristics of using biodiesel. Experience will be obtained on fuel mixing, storage, and transfer of the fuel under both hot and cold conditions. Any problems with fuel gelling or oxidation, and possible tank corrosion will be identified. Fuel storage and handling will be discussed with maintenance personnel. Data will be gathered on fuel economy. Drivers will be interviewed for their perceptions of change in vehicle performance; including engine starting and response. Any effect of the use of the blend on the fuel tank, pump, filter, fuel lines, and injectors, will be determined.

June 30, 1999 Outline of Results Update:

Thanks to the specially designed tank, WPL is gaining knowledge and positive experience in the storage and handling of biodiesel. The tank and its placement at a major terminal of a regional petroleum supplier is a very effective method of promoting the commercial use of this domestic renewable fuel.

The field study is in its seventh month and is expected to continue another nine months. As of May 31st, Hennepin County has used approximately 8300 gallons of B20 (1660 gallons of biodiesel) in four trucks used for plowing and road maintenance. The trucks have been driven over 42,000 miles. Hennepin County has experienced trouble free operation in the storage, transfer and use of the fuel, despite temperatures that dipped below -20° F. County drivers were interviewed and say they observed no change in vehicle starting or performance. The results from lube oil analyses indicate no premature engine wear, fuel dilution or other potential problems.

The fuel storage tank at WPL is working very well. The tank's heating system was able to maintain the biodiesel at 65° F during the winter. Fuel gelling, or associated problems with filters or the fuel transfer hose, was not experienced. The superintendent of the WPL terminal in Roseville commented on the smooth operation with use of the new fuel and equipment.

The results from the fuel analyses conducted by AURI and an independent lab indicate that the biodiesel meets all of the specifications of a quality biodiesel fuel. More importantly, the results of the tests indicate that the pour point and cold filter plugging point of the blend used by Hennepin County this winter was comparable to a normal winter blend of diesel fuel. This is a very significant finding and compliments anecdotal evidence indicated in product demonstrations at other cold climate locations. The fuel

additive chosen for use in this study is one of several that are commercially available and its use will be continued.

This project took more time and money than expected to initiate. Fortunately, the quality of the program and equipment components along with the heavy private sector involvement have created a unique opportunity to take advantage of new federal legislation. The Energy Conservation Reauthorization Act of 1998 allows the use of biodiesel to meet up to one half of the annual vehicle purchase requirements of the Energy Policy Act of 1992 (EPACT). A large regional refinery has recently inquired about the use of the Williams terminal facility to begin marketing B20 fuels to Minnesota fleets. Some fleets must begin compliance with EPAC requirements as of 2001. This related development will help biodiesel penetrate the heavy duty diesel fleet fuel market.

Meanwhile, the National Biodiesel Board (NBB) completed Tier I of a multi-year Health and Environmental Effects testing program for biodiesel following USEPA test protocol. Initial findings are that, compared to petrodiesel fuel, biodiesel exhaust emissions demonstrated; 1) 50% less ozone forming potential, 2) 50% lower carbon monoxide emissions, 3) complete elimination of sulfur oxides and sulfates (acid rain components), 4) 30% lower aldehyde emissions, 5) 13% increase in oxides of nitrogen (but lower sulfur may allow greater use of catalytic converters which reduce NOx, 6) 75 to 85% reduction in aromatic compounds, and 7) 30% to 80 % lower particulate matter (soot) emissions. In addition, the biodiesel fuel demonstrated "substantial reductions" in "mutagenicity effects" and overall biodegradability is 4 to 5 times greater than petrodiesel.

September 30, 2000 Outline of results Update:

Two final reports are included as a part of this Work Program Update. The first is a technical report on the results of the field study conducted in cooperation with the Hennepin County Department of Public Works. Six Ford LT9000 heavy duty diesel trucks were fueled and monitored from their fleet maintenance headquarters located in Medina, MN. Four trucks burned B20 and two trucks burned conventional diesel fuel.

The University of Minnesota Center For Diesel Research final field study report entitled **Final Report for "Soy-Based Diesel Fuel Study"** is attached

to this report as Attachment A. The report concludes that when compared with petroleum diesel, the B20 fuel used in the study displayed, 1) cold flow properties comparable to a winter blend diesel fuel, 2) the same average fuel consumption rate, 3) no unusual engine wear or fuel dilution problems, 4) no observable materials compatibility effects on fuel systems, 5) no change in vehicle performance. Recommendations include more cold weather testing, use of cold flow additives and lower cost for biodiesel.

The second report is from the Minnesota Department of Agriculture. The intent of the report is to establish a basis of fundamental market factors that that relate to the potential for the production of soy-based diesel fuels to replace a portion of conventional diesel fuel made from petroleum.

The Minnesota Department of Agriculture market report **"Supply And Demand Of Soybeans As A Feedstock For Soy Diesel"** is attached as Attachment B. The study indicates that: 1) in 1997 soybeans was Minnesota's largest cash crop, including livestock. 2) Minnesota ranks third in soybean production, seventh in soybean meal consumption and fifth in meal production. 3) Minnesota has a 40% processing capacity, compared to 66% of the crop processed nationwide. 4) Minnesota farmers receive lower soybean prices relative to leading soybean producing states. 5) Minnesota wholesale petroleum diesel prices are 22% higher than the national average. 6) since 1980, the price of a gallon of soybean oil averaged $1.71 per gallon or $1.07 higher than diesel fuel. In the first three months of 2000, Minnesota diesel prices doubled. In the second and third quarters of 2000 Twin City rack prices of diesel exceeded $1.00 per gallon.

It is clear from the study that the price of biodiesel is presently the greatest barrier to the rapid increase in its use. The cost of biodiesel for the study was abnormally high partly because of small sized shipments. The cost of the first shipment received in December of 1998 was $4.12 per gallon. The last shipment received in October of 1999 had fallen to $3.09. This is a dramatic price decrease in less than a year and yet it represents a shipment of only 1,500 gallons in a relatively small truck capable of transporting 4,500 gallons. Another factor affecting the cost of the first purchase was that some manufacturers were not yet prepared to document that their product met ASTM specifications for biodiesel.

As the use of biodiesel becomes more common, shipping and handling costs will decrease and meeting product specifications will not be a problem. Recent bids received by the National Biodiesel Board for large bulk shipments of biodiesel indicate prices of $2.00 per gallon for soy based biodiesel and less than $1.40 per gallon for biodiesel from waste fats and oils.

Recently EPA recommended that the sulfur level in diesel fuel be reduced from 500 to 15 parts per million (ppm). This reduction is expected to drastically reduce the lubricity (lubrication properties) of diesel fuel. A 5% blend of biodiesel and petroleum diesel fuels is expected to offset the lost lubricity without any complications that may be experienced with other lubricity additives. Therefore there may be issues other than price that make biodiesel a viable option.

From a process point of view, a gallon of soybean oil yields a gallon of methyl ester plus additional products. As the biodiesel market expands, production efficiencies will likely increase and co-product markets will be developed. These factors could decrease production costs and add new profit centers to the process, which could in turn reduce the cost of soydiesel.

National soybean oil carryover stocks from previous years have been increasing for the past two decades exceeding 2 billion pounds in 1998. This amount is more than enough to cover initial demand for soydiesel. By comparison, recent scientific review of world petroleum reserves suggest that world crude oil production could peak in the next five to 20 years. Whenever that peak occurs, experts say, production of conventional (cheap) oil will be less each year than the year before.

A growing number of world scientists are expressing great concern over the effects of global warming. Continued political volatility in the middle east indicates that petroleum prices may be more volatile than ever. Finally, some petroleum experts suggest that non-OPEC oil reserves are being depleted in an attempt to keep the world price of oil stable. They expect this to accelerate middle-east dominance in world oil reserves. In the midst of these developments Twin City rack diesel prices for the second and third quarters of 2000 often exceeded $1.00/gallon.

Analysis of the environmental effects of the use of Biodiesel.

Environmental concerns and energy security issues have prompted legislation spurring demand for alternate fuels such as biodiesel. Biodiesel fulfills the need for a clean burning alternate fuel that does not require special vehicles, vehicle modification, or sacrifice operating performance. From an environmental standpoint, biodiesel and biodiesel blends have the following attributes:

Biodegradability: Studies conducted at the University of Idaho revealed that biodiesel degrades about four times faster than petrodiesel. Within 28 days, pure biodiesel degrades 85 to 88 percent in water. Dextrose (a test sugar used as the positive control when testing biodegradability) degraded at the same rate. Blending biodiesel with diesel fuel accelerates its biodegradability. For example, blends of 20 percent biodiesel and 80 percent diesel fuel degrade twice as fast as #2 diesel alone.

Life cycle carbon dioxide emissions: The May 1998 National Renewable Energy Laboratory (NREL) study, "An Overview of Biodiesel and Petroleum Diesel Life Cycles" found that the production of biodiesel requires relatively small amounts of fossil fuel, so its life cycle CO_2 emissions are low compared to petrodiesel. When used in a conventional bus engine, B100 reduces net CO_2 life-cycle emissions by 78% compared to petroleum diesel. For B20, CO_2 emissions are reduced by 16 %.

Energy Balance: The same May 1998 NREL study concluded, "Biodiesel yields 3.2 units of fuel product energy for every unit of fossil energy consumed in its life cycle." It continues, "By contract, society uses 1.2 units of fossil resources to produce 1 unit of petroleum diesel. This means that every unit of fossil energy used in the production of biodiesel yields 3.8 times the amount liquid fuel energy yielded in the production of petrodiesel.

Aquatic toxicity: The University of Idaho conducted acute aquatic toxicity tests with Daphnia Magna (an aquatic microorganism). The toxicity of biodiesel was compared to table salt (NaCl) and diesel fuel. The LC50 count (the concentration where 50 percent of the Daphnia Magna died and 50

percent were still alive) was determined for all three substances. The LC50 for table salt was 3.7 parts per million (ppm) and 1.43 ppm for diesel fuel. The LC50 for biodiesel ranged from 23 ppm to 332 ppm. Biodiesel was found to be is less toxic than diesel fuel and table salt.

Engine emissions reduction: The use of biodiesel in a conventional diesel engine results in substantial reductions of unburned hydrocarbons, carbon monoxide, and particulate matter. Emissions of nitrogen oxides are either slightly reduced or slightly increased depending on the duty cycle of the engine and testing methods employed. In a literature review of the environmental effects of biodiesel, Iowa State University of Science and Technology found that B20 yielded reductions ranging from 16-33% in total particulates, 11-25% in carbon monoxide, and 19-32% in total hydrocarbons.

Diesel particulates consist mainly of combustion generated soot and adsorbed or condensed hydrocarbons. Smaller amounts of sulphates are often present. Each component is present in varying degrees depending on fuel properties, engine design and operating parameters.

The use of biodiesel decreases the carbon fraction of particulate matter (since the oxygen in biodiesel enables more complete combustion), reduces the sulfate fraction (as there is little or no sulfur in the fuel), while the soluble, or hydrocarbon, fraction stays the same or is increased. Therefore, biodiesel works well with new technologies such as catalysts (which reduces the soluble fraction of diesel exhaust), particulate traps, and exhaust gas recirculation.

Health effects of engine exhaust: The compounds that are present in biodiesel and diesel fuel exhaust are different. Research conducted by Southwest Research Institute on a Cummins N14 engine indicates that biodiesel exhaust has a less harmful impact on human health than petrodiesel. Biodiesel emissions have decreased levels of all target polycyclic aromatic hydrocarbons (PAH) and nitrited PAH compounds, as compared to petroleum diesel exhaust. PAH and nPAH compounds have been identified as potential cancer causing compounds. All of the PAH compounds were reduced by 75 to 85 percent, with the exception of benzo(a)anthracene, which was reduced by roughly 50 percent. The target nPAH compounds were also reduced dramatically with biodiesel fuel, with

2-nitrofluorene and 1-nitropyrene reduced by 90 percent, and the rest of the nPAH compounds reduced to only trace levels.

In addition, the total speciated hydrocarbon mass of biodiesel is nearly 50 percent less than that measured for conventional diesel fuel, and the associated ozone potential is reduced by the same amount. Significant reductions in most aldehyde compounds were also observed with biodiesel, with formaldehyde and acetaldehyde 30 percent lower than the levels observed for conventional diesel fuel.

DUE TO DELAYS IN FINALIZING PROGRAM BILLINGS AND PAYMENTS THE FINAL BUDGET REPORT WILL BE SUBMITTED AT A FUTURE DATE.

ESTIMATED PROGRAM BUDGET as of 6/30/99

~~(See attachment "A" project budget analysis)~~

The cost of the biodiesel storage and dispensing equipment increased considerably. This was necessary to meet the safety and commercial specifications required to locate the system at the WPL terminal. Since the equipment was being purchased with LCMR funds, other budget categories were shifted to MSBGA funds. Accounts or contracts that had already been established were generally left under the LCMR column.

A. U of M Center for Diesel Research (CDR) Responsibilities:

LCMR	MSBGA	
$7,115.00	$29,608.00	Budget
$0.0	$21,173.02	Balance

During the field study, data will be obtained on the operational characteristics of using biodiesel. Experience will be obtained on fuel mixing, storage, and transfer of the fuel under both hot and cold conditions. Any problems with fuel gelling or oxidation, and possible tank corrosion will be identified. Fuel storage and handling will be discussed with maintenance personnel. Data will be gathered on fuel economy. Drivers will be interviewed for their perceptions of change in vehicle performance; including engine starting and response. Any effect of the use of the blend on the fuel tank, pump, filter, fuel lines, and injectors, will be determined.

B. Agricultural Utilization Research Institute (AURI) Responsibilities:

LCMR	MN SBGA	
$10,000.00	$0.00	Budget
$10,000.00	$0.00	Balance

Fuel quality and stability will be monitored through appropriate quality assurance tests upon delivery, and while in storage. The quality and stability of the biodiesel fuel will also be examined in the laboratory environment.

C. MDA Responsibilities:

The Department will assist in the coordination and monitoring of project activities, execution of contracts and procurement of fuel and equipment, collection of data and preparation of reports, and in the acquisition and development of relevant market profiles for soy production feedstocks, petroleum products, related equipment and supplies and infrastructure for potential storage and distribution of biodiesel.

LCMR Funds	MSBGA Funds	
$4,681.98	$11,391.57	Fuel and related cost budget
$600.00	$1,160.00	Balance
$41,139.23	$0.00	Tank Purchase
$1,611.15	$0.00	Balance
$10,063.79	$4,000.43	Additional Tank & Management Cost
$2,825.77	$4,000.43	Balance
MDA Marketing Division (Research)		
$10,000.00	$5,000.00	
$7,070.52	$5,000.00	Balance
$83,000.00	$50,000.00	Total Project Cost. (Including costs from Page #8)
$22,107.44	$31,333.45	Balance

The above costs are an estimate which may change depending upon the specific circumstances that arise as technical issues and equipment design are finalized. The Soybean Growers Association has committed funding to offset increased costs.

V. DISSEMINATION: The project will involve communication, data sharing, technical papers, presentations, publications and other activities

with the LCMR and other entities identified in the Project Summary section above. Information will be included in the MDA web site and other appropriate web sites to be identified as the project progresses.

VI. CONTEXT:

A. Significance: From a historical perspective, the application of oils derived from crops and animal products has been used as a potential source of energy to replace petroleum based fuels since the late 30's. More recently the use of chemically modified soybean oil, rapeseed oil and animal derived oils has grown in acceptability internationally. Western Europe and more recently Japan has promoted their use as a substitute or partial substitute to petroleum based diesel fuel. In these countries biodiesel is available at prices comparable to petroleum based diesel fuels.
Considerable efforts were launched in the early 90's by federal agencies within the United States to improve environmental air quality. The comprehensive Clean Air Act of 1990 was designed to remove 56 billion pounds of air pollution, reduce toxic air pollutants by 50% and reduce oil imports. Further, the Energy Policy Act of 1992 (EPACT) requires government fleets to increase purchases of alternatively fueled vehicles. These efforts target diesel and gasoline powered engines. New federal standards and laws present challenges and opportunities for the use of renewable fuels within the state of Minnesota.

The National Biodiesel Board, an arm of the United Soybean Board, has taken a leadership position in the furtherance of renewable diesel substitutes since the early 90's. Their efforts are concentrated on current and needed research, regulatory and legislative requirements and as a champion for renewable substitutes for petro chemically derived fuels. They stand ready to partner with Minnesota during the pilot demonstration project.

March 31, 1998 Update.
The National Biodiesel Board has been assisting in some of the more technical aspects of the program. It has been suggested that when the program is complete it will become a model for other states. The concept of establishing the fuel delivery system in cooperation with members of the private sector makes the program more complex initially. It will however, improve the quality of the study, make the program easier to replicate and provide a head start to commercialization once the fuel is proven effective.

The State of Minnesota can benefit from the use of biodiesel through:

1. providing options for the state to meet the requirements of EPA's Clean Air Act of 1990. Alternative Fuel Vehicles (AFV) will reduce toxic emissions associated with diesel engines,
2. reducing the state's cost of imported petroleum,
3. expanding markets for and adding value to the state soybean crop,
4 creation of additional value added soybean processing and marketing in the state,
5. helping the state to comply with the US DOE National Energy Policy Act (EPACT) fleet program requirements. (New vehicle purchases by states must include 75% AFV's by 2001. Federal fleets must purchase 75% AFV's by 1999)

Biodiesel has physical properties that are similar to those of petroleum diesel fuel. Biodiesel can be blended with petroleum diesel fuel in any combination with no costly modification to the engine or refueling equipment. Biodiesel provides an opportunity to safely recycle waste cooking oils and greases into a value added product that otherwise may have to be disposed of as solid waste or through waste water treatment facilities. The use of biodiesel could help the state of Minnesota meet federally mandated fleet requirements for alternatively fueled vehicles in a more cost effective way. It is biodegradable, which is especially advantageous for marine applications. Biodiesel conserves our natural resources as for every one unit of energy needed for production, 3.24 units are gained.

Biodiesel fuels can be mixed as a half percent to five percent blend as a fuel additive to make a premium diesel, or as a twenty or more percent blend as a fuel enhancer to reduce emissions (the formulation proposed for this study), or used as one hundred percent pure to achieve the maximum exhaust emissions benefit of biodiesel. Its cetane rating (a fuels ignition characteristic as is octane for gasoline) is higher than petroleum diesel. Biodiesel use has proven to be a benefit because of its increased lubricity as compared to petroleum diesel. Many of these scientific benefits were first determined in Minnesota by what is now the University of Minnesota Center for Diesel Research (CDR). Manufacture of biodiesel is a simple proven technology. Testing and greater usage will reduce biodiesel and B-20 fuel cost and increase the level of confidence for consumers.

B. Time: The project developers will work to locate and gain the cooperation of sufficient fleet vehicles to log the required miles and operational conditions to thoroughly test the fuel usage. It is expected that

cooperators, and the necessary equipment will be established and the project initiated by December, 1998. The project will require approximately 16 months from start to finish of fleet operation to allow for adequate seasonal variation and mileage to represent a significant operational trial. It may be beneficial to run these vehicles longer if possible to more fully document long term benefits of the fuel. We expect that Hennepin County trucks will be utilized for the project.

C. Budget Context: This budget presentation includes LCMR and MN. Soybean Growers Association Funds. The exact figures are pending the final agreement with the terminal facility where the fuel will be stored and dispensed.

	July, 1995- June, 1997 Prior Expenditures on this project	**July, 1997- June, 1999 Proposed Expenditures on this project**	**July, 1999- June, 2001 Anticipated future expenditures on this project**
1. LCMR		**$83,000**	Extended until 6/30/2000
2. Other State			
3. Non State Cash		**$50,000**	
Total		**$133,000**	

Budget:	Total	CDR	AURI	MDA
Personnel			~~8,000~~	
	$49,955.00	$31,955	$3,000	$15,000.00
Equipment & Supplies	$6,768.00	$4,768	$2,000	
Acquisition (tank)	$55,203.45			$55,203.45
Fuel	$21,073.55		$5,000	$16,073.55
Total	**$133,000.00**	**$36,723**	**$10,000**	**$86,277.00**

VII. COOPERATION:

The project will involve personnel and technical resources of the Minnesota Department of Agriculture (MDA), the Agricultural Utilization Research

Institute (AURI), the University of Minnesota Center for Diesel Research (CDR), the National Biodiesel Board (NBB) the Minnesota Soybean Research and Promotion Council (MSRPC) and other public or private, entities that can enhance the quality of the project. Members of the project team include the following: (note that Mr. McDonald is no longer with the CDR, his duties will be taken over by Mr. Bickle).

1. Dr. David Kittelson, Associate Director, University of Minnesota, Center for Diesel Research (CDR). ($300 LCMR dollars, .2% of time on project.)
2. Mr. Kelly Strebig, Research Engineer, University of Minnesota, Center for Diesel Research (CDR). ($4,000 LCMR dollars, 5% of time on project.)
3. Mr. Kenneth Bickel, Research Fellow, University of Minnesota, Center for Diesel Research (CDR) staff ($27,955 LCMR & MSBRPC dollars, 22% of time on project.)
4. Rose Patzer, Process Chemist, full time temporary, ($3,000.00~~8,000.00~~ AURI dollars)
5. Mr. Max Norris, Senior Scientist Commercial Development, Agricultural Utilization Research Institute (AURI). ($ 0.00 LCMR dollars, 5% of time on project)
6. Mr. Jerry Crawford, Analytical Chemist, Agricultural Utilization Research Institute (AURI). ($ 0.00 LCMR dollars, 8% of time on project)
7. Mr. Ralph Groschen, Senior Agricultural Marketing Specialist, Minnesota Department of Agriculture (MDA). (0 LCMR dollars, 5% of time on project)
8. Ms. Su Ye, Program Leader, Market Opportunity Research, Minnesota Department of Agriculture (MDA). (0 LCMR dollars, 3% of time on project)
9. Program Intern. (MDA) ($15,000, 100% of time on project)

VIII. LOCATION: The administrative, research and some program activities will take place at the locations of the CDR in Minneapolis, the MDA in St. Paul, at the AURI office in Marshall, Minnesota. Field testing and data collection will occur at the Williams Pipeline Terminal, Roseville, MN. and the Hennepin County CMED Garage in Medina, MN. These are sites where the storage and delivery of the fuel and the operation, fueling and maintenance of the vehicles involved in the project are taking place.

IX. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than June 30 of each year. A final Work Program report and associated products will be submitted by June 30, 2000, or by the completion date as set in the appropriation.

X. RESEARCH PROJECTS.