A Fleet Managers Guide for the Handling, Receipt and Storage Of Biodiesel Fuel

Version 1

A Fleet Managers Guide for the Handling, Receipt and Storage of Biodiesel Fuel
Version 1, April 2005

Authors

Paul Nazzaro
Stuart Porter

Reviewers and Contributors

We would like to thank the following reviewers and contributors for their valuable feedback and suggestions: Ray Barton, Claude Bourgault, Mitchell Brogan, Kenneth Dack, Ken Fryer, Jeffrey Guthrie, Chris Hill, William Kemp, Robb Miller, Malcolm Morris, Melanie Nadeau, Kevin Norton, Christine Paquette, Andy Pickard, Greg Rideout, Debbie Rosenblatt, Roger Smith, Vernel Stanciulescu, Ajaleigh Williams

This publication was made possible by the following organizations:

Natural Resources Canada (NRCan)
National Biodiesel Board (NBB)
National Renewable Energy Laboratory (NREL)
United States Department of Agriculture (USDA) Education Grant

Biodiesel Association of Canada
Ottawa, Ontario
Canada
Email: info@biodiesel-canada.org
Web site: www.biodiesel-canada.org

Table of Contents

1.0 Introduction

North American dependence on electrical energy and fossil fuels is, per capita, the highest in the world. In the early 1900s the United States was the world's largest producer of oil. Over the last 100 years many of the domestic wells have been sucked dry, leaving the country to import the majority of its oil from domestically unstable and expensive sources. This importation of large amounts of fossil fuel causes the *exportation* of equally large numbers of dollars that could have been invested in the domestic economy, helping to develop clean-source fuel technologies, efficiency, and perhaps the hope of energy self-sufficiency.

Although Canada enjoys its status as a developed-country, net energy exporter, it will only be a year or two before it will stand alone in this regard on the world stage. Forecasts indicate that natural gas and light, sweet-crude oils will be on the decline shortly, in turn necessitating the throttling of the southward-running lifeline to American modern society.

What about the environment? Climate change is one of the key challenges facing worldwide sustainable development. Global warming, caused mainly by the burning of fossil fuels, deforestation, and inefficient use of energy, is pushing ecosystems to the brink of catastrophic failure.

Atmospheric concentrations of carbon dioxide (CO_2) have increased dramatically with the industrialization of society over the last 150 years and are at the highest levels measured during the past 500,000 years. Global energy use amongst industrialized countries is continuing to increase unabated. Underdeveloped countries, where more than one–third of the world's population does not have access to electricity, are starting to ask for their fair share of the energy pie. Exponential human population growth and accompanying energy consumption are expected to cause global temperatures to increase between 2 and 5.8°C over the coming century, according to the *Intergovernmental Panel on Climate Change* report issued in 2001.

Although energy efficiency and conservation are not currently in vogue, there are signs that world leaders, governments, and industry are beginning to grapple with these challenges. The worldwide leap in renewable energy deployment, concerns about air quality, and concern for the environment are becoming driving forces in the demand for clean energy technologies.

1.1 Clean Energy Technologies

North Americans are addicted to oil in a manner that is not comprehensible to Europeans or to the developing world. While the rest of the world has developed pricing signals and public transit to achieve greater fuel and energy economy, we in North America still show up at the altar of the mighty “SUV.”

North America has less than 6% of the world’s population (330 million out of 6.4 billion) and consumes a whopping 34% of ***all*** of the world’s resources. This includes not only energy but also water, steel, aluminum, timber, and just about everything else. Present levels of consumption are not sustainable in the long term. Indeed, with China, Russia, India, and many other emerging-economy nations with combined populations many times that of the United States and Canada, it will not take long before our natural resources and ecosystems give up in frustration.

Energy efficiency and demand-side management will only go so far. No matter how efficient our trucks or appliances, energy is still required to power our homes, factories, and society. Reducing our reliance on fossil fuels and working towards cleaner energy supplies based on the efficient use of natural gas, geothermal, and renewable sources will go a long way toward creating a carbon-neutral energy supply.

Alternative fuels such as biodiesel (which is derived from oilseed and waste plant and animal oils) and ethanol have become more prevalent within the last ten years as a result of increased use and awareness. These energy sources reduce atmospheric pollutants and life cycle CO_2 emissions. In the case of biodiesel, improvements in fuel lubricity, economy, and engine wear are additional benefits.

By adopting demand-side management and efficient homes and transportation systems, focusing on conservation, and shifting to cleaner fuels and renewable energy supplies, Canadians will be less vulnerable to energy price increases and problems associated with security of supply and will also help to protect the world’s ecosystems. After all, if we don’t get involved, who will?

William H. Kemp
Author, Environmentalist

April 2005

1.2 Biodiesel in Canada

Over the last ten years in Canada, biodiesel has been researched at educational and private institutions, petroleum industry laboratories, and government facilities. From coast to coast, research has continually proven that biodiesel is an effective, environmentally friendly, and infrastructure-compatible fuel source.

Biodiesel has received support from many sectors including all levels of government. The federal government announced its production target of 500 million litres (132.1 million gallons) by 2010, exempted biodiesel from the federal CAN $0.04 road tax, and committed CAN $11.9 million to biodiesel initiatives over a four-year period (2003–2007) in order to support demonstration projects in various applications, blend ratios, regions and temperatures. The 2005 budget commits to working with the provinces and territories, industry, and other interested stakeholders in an effort to expand the production and use of renewable transportation fuels.

Provincial governments have also shown their support for biodiesel by introducing tax exemptions, conducting studies, and establishing provincial working groups. In BC, the BC Biodiesel Association formed in March 2005. In Quebec, the Conseil québécois du biodiésel (CQB) formed in 2004.

The greatest efforts, however, towards the introduction and use of biodiesel in Canada have come from industry and municipal leaders. In 2004, approximately 3.5 million litres (875,000 gallons) of biodiesel were used in Canada, and that number will increase in 2005. Toronto Hydro, which introduced biodiesel into its daily operations in 2001, was the first commercial fleet to use it in Canada. Since then, a number of municipalities, private fleets, transit systems, and personal vehicles have embraced biodiesel use.

With the use and awareness of biodiesel on the rise in Canada, a key group of stakeholders came together to create a not-for-profit industry association, the Biodiesel Association of Canada (BAC). The BAC was formed in December 2003: www.biodiesel-canada.org.

One of BAC's key mandates is to educate and create consumer awareness and acceptance. This *Fleet Manager's Guide* is one such tool to educate fleet managers and users. The guide is intended to introduce the fleet manager to biodiesel and its definition, to educate the fleet manager on the benefits of using biodiesel, and to discuss the transportation, blending, and storage of biodiesel. This document is the first release of the *Guide***.** We welcome your comments and feedback on areas that need further clarification, further information as well as general comments about the usefulness of the document. Your comments will be kept confidential. Please forward your comments to: info@biodiesel-canada.org

Christine Paquette
Executive Director
Biodiesel Association of Canada

April 2005

2.0 What is Biodiesel?

The following is a brief introduction to biodiesel and is only intended to provide an overview. For more detailed information visit the BAC Web site www.biodiesel-canada.org or NBB Web site www.biodiesel.org.

Biodiesel is the generic name of an alternative diesel fuel produced from renewable resources that are converted into fatty acid methyl esters. It is a versatile fuel that can be used as a substitute or additive in a range of diesel fuel applications.

Biodiesel is derived from domestic, renewable resources such as animal fats and plant oils. By a chemical process called transesterification, using an alcohol such as methanol and a catalyst such as sodium hydroxide, raw fats and oils are converted into a stable product. Different fats and vegetable oils produce somewhat different biodiesel fuels, but they all must meet the same biodiesel fuel standard.

Biodiesel has proven to be effective as a lubricity additive and for use in automotive engines, home heating systems and other equipment designed to use diesel fuel.

Any product marketed as biodiesel must meet the high standard set by the ASTM D6751. The Canadian General Standards Board CAN/CGSB-3.520 Biodiesel B1-B5 Standard also requires the B100 blend stock to comply with either ASTM D6751 or the European biodiesel standard EN14214.

Raw or refined vegetable oils, or recycled greases that have not undergone chemical manufacturing into stable biodiesel **ARE NOT BIODIESEL** and should not be identified as such. Potential purchasers should ensure that any alternative fuel product that they are considering as a biodiesel complies with either ASTM D6751 or EN14214. The European specification EN14214 is very similar to the ASTM D6751, and is in fact slightly more stringent in a few areas. Therefore, the ASTM D6751 is the minimum acceptable specification that is acceptable as B100 biodiesel blend stock.

In its neat form as B100 (100% biodiesel), biodiesel offers significant environmental benefits. The greatest virtue of biodiesel is that it contains virtually no sulphur. Furthermore, according to a report issued by the EPA in October 2002, burning B100 reduces the emissions of PM and CO by almost 50% and unburned hydrocarbons by almost 70%. There is, however, a slight increase in NOx emissions, but blending reduces NOx emissions to a negligible amount. Research is currently being conducted to lower these NOx emissions. According to the NBB, biodiesel is the only alternative fuel to have fully completed the health effects testing requirement of the U.S.1990 Federal *Clean Air Act*

Amendments, which required a four-year, $2 million health effects testing program.

Biodiesel is a legally registered fuel and fuel additive with the EPA and is a legal fuel for U.S. commerce. The Canadian Government does not regulate additives or have an agency which governs fuel in the same manner as the EPA.

The Biodiesel Association of Canada defines biodiesel as the following:
"*Biodiesel* means the mono alkyl esters of long-chain fatty acids that are derived from fats and oils and that meet or exceed the specifications or ASTM D6751 and/or EN 14214 or any legal successor thereto."

2.1 Biodiesel and Emissions Reductions

The use of biodiesel as a fuel is viable as it is produced from a renewable resource, non-toxic, biodegradable, and has potential beneficial effects on exhaust emissions.

Characterization of exhaust emissions from diesel engines powered with varying blends of biodiesel has typically shown emissions reductions in particulate matter (PM), carbon monoxide (CO), and hydrocarbons (HC) with increases in oxides of nitrogen (NO_X) in some engines. On-going Canadian studies will verify the effects of biodiesel blends on toxic emissions, smog precursors, and the physical and chemical characteristics of the particulate matter. Tailpipe carbon dioxide emissions from blends of B20 (20% biodiesel, 80% petroleum diesel) or less are shown to have little difference when compared to conventional diesel tailpipe emissions. However, greenhouse gas benefits are enhanced when looking at the emissions from biodiesel based on a life cycle analysis.

Through the requirements of the Canadian Environmental Protection Act – CEPA (1999), Canada's approach to reducing emissions that are harmful to human health and the environment has, in general, been to harmonize emission standards, with provisions, to those of the United States Environmental Protection Agency (EPA).

For model year 2007 and later heavy-duty highway engines, emissions standards for NO_X and PM are dramatically reduced compared to previous standards. Also, beginning in 2006, diesel fuel regulations reduce the allowable sulphur content in on-highway diesel fuel from 500 ppm to 15 ppm.

To address PM emissions it is speculated that most on-highway engines will utilize diesel particulate filters and or diesel oxidation catalyst (DOC) technologies. To address NO_X emissions the technology path is less defined. It is anticipated emissions control equipment required to meet 2007 standards will provide 90% or greater PM reduction. Emissions testing has demonstrated that these particulate emissions reductions observed on engines equipped with

DOC's are further reduced with the use of B20. This presents an opportunity for optimizing DOC formulations for biodiesel and lowering the platinum, or other catalyst material, loading. There is no fuel economy impact related to exhaust backpressure with the use of a properly designed DOC.

Early testing of biodiesel with older engines has indicated variability in engine out NO_X emissions. Technologies developed to enable future engines to meet the 2007 - 2010 limits for NO_X should be compatible for biodiesel blends.

Further work on NO_X reduction additives and technologies with biodiesel and biodiesel blends is currently underway. The Biodiesel Association of Canada (BAC) is working in conjunction with the National Biodiesel Board (NBB) in joint efforts to that end.

For a detailed summary of the NO_X reductions related to fleets in Canada, see Appendix G.

2.2 Biodiesel and Sulphur in Diesel Regulations

Biodiesel could possibly become the ideal additive for meeting the diesel fuel lubricity standards that changed in January 1, 2005 with the recent amendment to ASTM (American Society for Testing and Materials) D975 (specification for diesel fuel) and the emerging 2006 ultra-low sulphur diesel fuel standard, which becomes effective in June of 2006. The process that reduces the sulphur in diesel fuel to very low levels also removes some of the lubricity properties normally found in the diesel fuels with higher sulphur levels. Biodiesel has superior lubricity properties and in most cases is almost sulphur free. Both of these properties make it an attractive blend fuel for the introduction of Ultra-Low Sulphur Diesel (ULSD). The *Sulphur in Diesel Fuel Regulations,* which set regulated limits for on-road diesel, were first published in Part II of the *Canada Gazette* on July 31, 2002. These regulations continued the sulphur limit for diesel fuel used for on-road diesel use at 500 ppm until June 1, 2006, reduced to 15 ppm thereafter. The regulations did not address off-road applications such as rail, marine, construction and farm use. There is a three -month phase-in period for implementation, to allow retail sales to turn over all of their fuel to the new, low sulphur levels.

The *Regulations Amending the Sulphur in Diesel Fuel Regulations* (October, 2004), proposed regulations that limit sulphur in diesel fuel for off-road rail and marine use. These proposed regulations introduced the same requirements that are starting in 2007.

The proposed legislation in 2004 included the following:

- The initial limit of 500 ppm sulphur in diesel fuel would apply to diesel fuel used in off-road (i.e. construction, agriculture, mining), rail and marine diesel engines effective June 1, 2007.

- The sulphur limit of 15 ppm would apply to diesel fuel used in off-road diesel engines effective June 1, 2010, and is necessary to ensure that the level of sulphur in diesel fuel will not impede the effective operation of advanced emission control technologies.

- Rail and marine diesel fuel limits would be lowered to 15 ppm effective June 1, 2012.

    - The sales limit for 500 ppm sulphur diesel fuel for use in off-road, rail and marine diesel engines comes into effect October 1, 2007
    - The sales limit for 15 ppm sulphur diesel fuel for use in off-road diesel engines come into effect October 1, 2010
    - The sales limit remains at 500 ppm for rail and marine diesel fuel

- For diesel fuel sold in the northern supply area as defined in the *Sulphur in Diesel Regulations*, the 500 ppm limit for use in on-road, rail and marine diesel fuels would come into effect December 1, 2008, and the 15 ppm limit for off-road diesel fuel would come into effect December 1, 2011.
    - Biodiesel is now captured under the definition of diesel fuel

Biodiesel as an alternative fuel offers many advantages.[i]

Advantages of Biodiesel
• **It is renewable** • **It is energy efficient** • **It is nontoxic, biodegradable, and suitable for sensitive environments** • **It can be used in most diesel equipment** • **It reduces global warming emissions (reductions in CO_2, HC, and PM)** • **It is made domestically from either agricultural or recycled resources** • **It can be distributed into the existing diesel fuel storage and distribution network** • **It can be used as a blend stock for diesel fuel and heating oil**

2.3 Biodiesel Blends

Biodiesel can be used in its pure form (B100) or as a blend (Bxx) with conventional petroleum diesel fuels. The blend is identified using B followed by the percentage of biodiesel in the finished product. Common blends include B2, a 2% biodiesel blend, which is often used for added lubricity; and B20, a 20% biodiesel blend. B20 is popular with fleets and buses because the benefits of emissions reductions and performance are more fully realized with the higher blend. In addition, in the U.S., the tax incentives make the B20 blend attractive.

In Canada, because of the harsh winters in many parts of the country, B20 blends may be more seasonal once a CGSB B20 standard is passed.

Currently the home heating oil industry is evaluating biodiesel as a potential blend stock of approximately 5% for home heating oil. Testing has been done on blends of up to 20% with positive environmental and operational results. More work needs to be done in terms of the ASTM and CGSB Furnace Oil specifications before this can be fully endorsed. The greatest benefit of using biodiesel with home heating oil is the reduction of NOx. This reduction is due to the different combustion processes that occur in a furnace heater and a diesel engine.

In some biodiesel fuels for on-road or off-road applications, there has been some evidence biodiesel produced from tallow (and in some cases yellow grease) has a lower impact on NOx compared to canola and soy-derived biodiesel blends. These differences are small. While tallow-derived biodiesel fuels may be the best choice for minimizing emissions from a fleet manager's standpoint, tallow-derived biodiesel may have cold weather handling issues that need to be considered. Additional research is currently underway, testing NOx reduction additives in fleet vehicles and emission control equipment for 2007 engines.

The Technology Maintenance Council (TMC) is in the process of developing the *Recommended Practice for Cold-flow Operability of Diesel Fuel*. This recommended practice addresses low-temperature issues (cold-flow) for both diesel and biodiesel. The BAC will seek permission to either place the document on the BAC Web site or have a link to it for fleet managers once it is published.
The *Practice* deals with diesel cold-flow operability problems associated with ambient temperatures below freezing as well as the blending and use of biodiesel. Throughout the recommended *Practice* there are fuel operability recommendations for fleets.

In the winter, Canadian petroleum refiners supply seasonally adjusted blends of diesel fuel to various regions of the United States and Canada. In the Canadian diesel fuel standards, CAN/CGSB 3.517 for Automotive Low Sulphur Diesel Fuel and CAN/CGSB-3.6 for Regular Sulphur Diesel Fuel, the cloud points specified for diesel fuel are based on a 2.5% low end design temperature for each half-month and specific region.

In the U.S., ASTM D975 only contains guidelines for cloud point, based on tenth percentile temperatures for various regions and seasons.

A recent Engine Manufacturers Association (EMA) statement concluded that biodiesel blended up to a maximum of 5% (B5) should not cause engine or fuel system problems. The engine manufacturer should be consulted if a higher percentage biodiesel blend is used.

The joint Engine Manufacturers Association and Technical Maintenance Committee recommendation is a fuel cloud point 4˚C below the minimum anticipated ambient temperature in which the fuel is expected to operate. Refer to www.enginemanufacturers.org. Consult your own engine manufacturer's technical bulletins for similar low temperature operability recommendations.

Pure biodiesel (B100) can be used as a blending agent or as a pure fuel in diesel applications. B100 has the following key physical properties.

- **Less than 15 ppm Sulphur for most Biodiesel Fuels**
- **No Aromatics**
- **High Cetane**
- **High Lubricity**
- **Biodegradable**
- **Non Toxic**
- **High Flash Point, (minimum 130°C)**
- **Comparable BTU value (7-9 less than #2 diesel)**

Although it will be unknown until full production of Ultra-Low Sulphur Diesel (ULSD) comes into effect, the BTU value of ULSD may actually be closer to that of B100.

B100, used as either a blending agent or as a pure fuel, must meet the requirements as listed by ASTM D6751 *Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels.*

Requirements for Biodiesel (B100) Blend Stock as Listed in ASTM D6751

Property	ASTM Method	Limits	Units
Flash Point	D93	130.0 min.	°C
Water and Sediment	D2709	0.050 max	% vol.
Kinematic Viscosity,40˚C	D445	1.9 - 6.0	mm2/sec.
Sulfated Ash	D874	0.020 max.	% mass
Sulfur (S 15 Grade)	D5453	0.0015 (15) max.	% mass (ppm)
Sulfur (S 500 Grade)	D5453	0.05 (500) max.	% mass (ppm)
Copper Strip Corrosion	D130	No. 3 max.	
Cetane	D613	47 min.	
Cloud Point	D2500	Report Customer	°C
Carbon Residue	D4530*	0.050 max.	% mass
Acid Number	D664	0.80 max.	mg KOH/gm
Free Glycerin	D6584	0.020 max.	% mass
Total Glycerin	D6584	0.240 max.	% mass
Phosphorus Content	D4951	0.001 max.	
Distillation Temperature Atmospheric Equivalent Temperature 90% Recovered	D1160	360 max.	°C

**The carbon residue shall be run on the 100% sample.*

Notes: A considerable amount of experience with a B20 blend exists in the United States. Although B100 can be used, blends higher than B20 should be evaluated on a case-by-case basis until further knowledge is available. To meet special operating conditions, modifications of individual limiting requirements may be agreed upon between purchaser, seller, and manufacturer.

The aforementioned tests are outlined by ASTM D6751 to ensure the quality of biodiesel (B100).

The CAN/CGSB-3.520 Biodiesel B1-B5 Standard references the D6751 in the requirements of the B100 blend stock. The CAN/CGSB-3.520 Standard contains the same diesel specifications as the CAN/CGSB-3.517 – Automotive Low Sulphur Diesel Fuel Specification, including cloud point. It is therefore the responsibility of the blending facility (whether at the refinery or at the terminal), to ensure that all specifications are met. If the blending is done at the terminal, the cloud points of the blended material must be known.

2.4 Low Temperature Properties

In the U.S., B20 is popular with fleets because it represents a good balance of cost, emissions, and cold weather performance. B20 is also the minimum blend level that can be used for *Environmental Protection Act* compliance for covered fleets in the United States.

Cold weather operability is one of the biggest concerns in Canada when considering B20 blends. Blends of B2 and B5 are less of a concern in this area, although they are still a consideration in the cloud-point certification of the blended fuel.

Blending biodiesel with petroleum diesel may lower the low temperature operability of the fuel. Thus, the petroleum diesel may need to be blended at the refinery to a slightly lower (colder) cloud point to accommodate the biodiesel blend. The blend also makes the use of cold-flow additives practical because they are effective in the diesel portion of the blend. When biodiesel is blended with petroleum diesel, the key variables are the cold-flow properties of the diesel fuel, the properties of the biodiesel, the blend level, and the effectiveness of cold-flow additives, if used.

Although it is true that the B100 cold-flow properties depend upon composition and the feedstock from which it was derived, the same can be said for petroleum diesel.

In Canada, most of the petroleum-diesel blending is done at the refinery or at the distribution terminal prior to sale to customers. Adjusting the blend of No.1 LSD in the diesel fuel alone or with additives can modify the cold-flow properties. The No. 1 LSD fuel typically costs more than the No. 2 LSD fuel, so blenders may prefer to use additives, depending upon their particular situation and the relative economics involved. Some cold-flow additives are available for diesel fuel. Most reduce the crystal size or shape, or inhibit the agglomeration of crystals. As such, they tend to affect the pour point—ability of the fuel to flow—but have little effect on the cloud point, which is critical to most diesel engine operations. Most cold-flow additives for B100 that have been developed to date have had limited success, but work is ongoing. There have been varying degrees of success with cold-flow improvers using B20 blends. For B2 and B5 blends, the conventional diesel-cold-flow additives will work, as that is the predominant composition of the fuel.

Note that in Canada, B1 to B5 biodiesel fuel blends, if they comply with CAN/CGSB-3.520 must meet the same detailed specification requirements as the current low sulphur diesel fuel, including low temperature flow requirements.

To obtain a copy of the standard contact:

CGSB Sales Centre
Gatineau, Quebec Canada K1A 1G6
Phone: 800-665-2472 or 819-956-0425
Fax: 819-956-5644

Web site: www.ongc-cgsb.gc.ca

Online standards store for petroleum and related products:
www.techstreet.com/cgi-bin/browsePublisher?publisher_id=58&subgroup_id=13684

E-mail: ncr.cgsb-ongc@pwgsc.gc.ca

2.5 Colour and Odour

Biodiesel will not have one specific colour or odour. Both of these properties depend upon a number of factors including the feedstock and manufacturing process. Therefore, biodiesel can meet ASTM D6751 and have a variety of odours and colours.

2.6 Energy Content

Biodiesel contains the highest BTU content of any alternative fuel. Biodiesel (B100) contains 7-9% less energy by volume (per gallon/litre) than most #2 diesel fuel. As mentioned previously, this delta may become smaller when the ultra-low sulphur diesel fuels come into effect. The difference in power, torque, and fuel economy can be noticeable when using B100. As the proportion of biodiesel within the fuel blend is decreased from the B100 blend stock, such as in a B20 blend, these differences become less apparent.

2.7 Cetane Number

All B100 fuels meeting the ASTM D6751 standard must have a cetane number above 47. Therefore, biodiesel has a higher cetane number than most petroleum diesel fuel produced in North America, which, in turn, will provide easier starting, quieter operation, and a more complete burn that will result in lower emissions.

2.8 Acid Number

All B100 fuels meeting the ASTM D6751 standard must have an acid number below 0.80. The acid number is used to determine the level of free fatty acids or processing acids that may be present in biodiesel. Biodiesel with a high acid number has been shown to increase fueling system deposits and may increase the likelihood for corrosion.

3.0 Specifying, Transport, Blending and Storage of Biodiesel

3.1 Vendor Requirements/Fuel Supplier Controls

Product quality begins at the biodiesel source. The following guidelines are designed to ensure receipt of a quality product. The vendor and receiver should establish a contractual agreement using these guidelines, or modifications of them, to ensure proper product quality on a consistent basis.

3.2 Product Specifications

The biodiesel product must meet all of the criteria of the latest version of ASTM D6751, *Standard Specification for Biodiesel Fuel Blend Stock (B100) for Distillate Fuels*. This standard identifies the parameters the pure biodiesel (B100) must meet before being blended with petroleum diesel. The basic physical property specifications are found in Appendix B. The user should acquire and become familiar with the complete standard. It can be purchased from the ASTM Web site www.astm.org. The Canadian General Standards Board (CGSB) requires that the B100 component comply with the ASTM D6751 in their B1-B5 Biodiesel Blend Standard. Once published, the CAN/CGSB-3.520 Biodiesel B1-B5 Standard may be purchased from the CGSB.

Each shipment of B100 should be delivered with a Certificate of Analysis (COA) and a current Material Safety Data Sheet (MSDS). In most cases, the carrier will already have an MSDS. In the event the carrier does not, the fuel producer must provide one.

A purchaser should retain a sample of biodiesel from the transport in the event a dispute concerning product quality arises. This protocol is covered in the **BQ-9000 Quality Assurance Accreditation Program**. Refer to Appendix H for a brief summary of the program and visit www.biodiesel-canada.org or www.bq-9000.org for further details.

3.3 Stability

Oxidative and thermal stability present no more of a concern to biodiesel users than that of generic petroleum diesel fuel. At this time there is no ASTM test that can predict the stability of either diesel or biodiesel. In biodiesel, poor stability can lead to high acid numbers, high viscosity, and the formation of gums and sediments that clog filters. If these numbers exceed the limits in ASTM D6751, the biodiesel is degraded beyond specification and should not be used. Comparing B100's acid number and viscosity over time can provide insight on the oxidation of the fuel in storage. Sampling should be done upon receipt of the fuel, and periodically during storage, to ensure that the fuel meets specifications.[ii]

Storage life and the stability of biodiesel are contingent on the biodiesel being stored properly. Short-term storage (1-4 months) of B100 has been very successful with little or no stability problems. The ASTM D4625 *Test Method for Distillate Storage Stability at 43°C* data suggests that biodiesel can be stored safely for eight months to a year depending on the type of fuel and the stability of that fuel. The NBB recommends a six-month storage life for B100. This statement is also included in the ASTM D6751 *Specification for B100 Blend Stock*. Any fuel stored for over six months may warrant the use of antioxidants and should be tested periodically for acid number, viscosity, and sediments.

Additives are available that will address biodiesel with poor stability levels. Contact your additive supplier with questions and concerns.

Tips on Ensuring Biodiesel Stability[iii]

Know the level of saturation of your biodiesel. The lower the level of saturation—less compounds containing double bonds—the more likely the fuel will oxidize. Tallow-derived biodiesel has the least number of double bonds, followed by soy- and then canola-derived biodiesel fuels. Saturated fatty acids are stable, and each time the level of saturation decreases the stability of the fuel goes down.

Do not store B100 in clear or translucent plastic totes in the summer. Heat and sunlight will accelerate the oxidation process.

Do not store B100 for long periods of time in systems containing reactive metals. Certain metals such as copper, brass, bronze, lead, tin, and zinc will serve to accelerate the degradation process and form even higher levels of sediment than would be formed otherwise. Metal chelating additives may reduce the negative impact of the presence of these metals.

Know how your fuel is processed. Bleaching, deodorizing or distilling oils and fats before or as a part of the biodiesel process can remove natural antioxidants, which will lessen fuel stability. If some or all of the aforementioned have been part of the biodiesel production process, stability additives are recommended.

Keep oxygen away from fuel. By limiting the fuel's exposure to oxygen the risk of fuel oxidation can be greatly reduced or eliminated. This will increase the storage life of the biodiesel.

Antioxidants protect stability. Antioxidants, whether natural or incorporated as an additive, can significantly increase the stability of biodiesel. The current data from field tests and studies have shown that **biodiesel has good thermal stability** and therefore, this does not appear to be an area of concern.

3.4 Guidelines for Transporting B100

Tankers dedicated to biodiesel fuel should be used. If tankers dedicated to biodiesel use are not available, non dedicated tankers (i.e. tanks that last carried diesel fuel, kerosene, or heating oil) should be washed, rinsed, drained and dried prior to loading the biodiesel.

Dedicated hoses that are compatible with biodiesel should be used to avoid cross contamination from residue left in the hoses. Hoses should be capped or shielded during transportation.

Tankers that have been used for heavy fuel oils or asphalt should **never** be used to carry biodiesel fuel.

Note: In some circumstances, tank trucks with internal coils for steam heating may be required. Such tank trucks can require careful cleaning.

The custody transfer papers from the customer will dictate the conditions and requirements of the vessel used for product loading. Typically, if the previous load (truck or rail car) had the same or a compatible material in it in the previous load, the wash certificate is waived. It is at the customer's discretion, however. The loading papers will include the washing requirements and declare if the washing has been waived.

B100 should be transported in a way that avoids contamination. The following guidelines are recommended and are similar to those used by distributors and transporters of middle distillate fuels. Therefore, in order to protect product integrity, the supplier and shipper should agree to adhere to the guidelines.

Appendix A contains generic transport inspection procedures and checklists. These are guidelines designed to protect the integrity of the product. The guidelines should be adapted to meet any unique need of the facility.

- Trucks and rail cars should be made of aluminum, carbon steel, or stainless steel.

- Proper inspection and washout certificates should arrive with the tank or rail car or be faxed to the receiver prior to cargo arrival.

- Check composition of the previous load carried and if any residual material is present. The receiver, at their discretion, may determine that diesel fuel, kerosene or jet fuel is acceptable as a residual. A closed cap flash point test (ASTM D93) should be performed if light hydrocarbon material was in the transport as residual material. Certain residuals may not be acceptable. They include but are not limited to:

    - Food products or raw vegetable oils
    - Gasoline
    - Light solvents
    - Lubricants
    - Chemical surfactants
    - Caustics
    - Residual water
    - Surfactants/detergents
    - Heavy fuel oils
    - Asphalts

- Hoses and seals are clean and compatible with B100. Viton or teflon-lined hoses are recommended.

- Cold climate conditions may impose product transfer difficulties. Determine the need for insulation or the method to heat truck or rail car contents if shipping during cold weather. B100 is generally shipped in one of the following ways during cold climate conditions:

    - Hot in trucks for immediate delivery (27°C to 45°C);
    - Hot (49°C to 54°C) in rail cars for delivery within 7-8 days—***arrives warm if only about 1 week has passed since loading***;
    - Unheated in rail cars equipped with steam coils. The fuel in the tank car can be re-liquefied at the final destination with steam or hot oil—***this is not the preferred approach***; or
    - Pre-blended with diesel fuel, kerosene, or other low cloud point fuel in either rail cars or trucks—***recommended***.

Biodiesel must be stored and handled using procedures that do not allow the temperature of B100, or blend, to drop below the cloud point, regardless of how it arrives. The cloud point of the biodiesel, the biodiesel temperature, the ambient temperature, and the time the fuel is in transit are all factors that must be taken into consideration. All handling procedures should be discussed and agreed to by both the supplier and receiver.

Key Points for Transporting Biodiesel[iv]

- **Aluminum, carbon steel, or stainless steel containers during transport**
- **Proper inspection and/or washout of transport**
- **Check for previous load carried and residual**
- **Food products or raw vegetable oil, gasoline, and lubricants are not acceptable residuals**
- **No residual water in transport**
- **Hoses and seals are clean and compatible with B100**
- **Determine need for insulation or method of heating the transport if shipped during winter months**

3.5 Transport Unloading

Prior to transport unloading:

Samples should be taken from the transport vehicle for retention and later testing, if necessary.

The Bill of Lading (BOL) should be checked against the product order.

The Certificate of Analysis (COA) should be compared to and meet D6751 specifications.

The Material Safety Data sheet (MSDS) should be current—no more than three years old—and checked.

It is the responsibility of the shipper—whether truck or rail car—to ensure that the requirements of the shipping orders have been met. This includes the washing prior to shipment, the proper loading of the proper fuel, and the loading of the correct volume—corrected to 15°C.

If an error in loading or incorrect order fill is suspected, testing at the receiving point is recommended. This testing can guard against the delivery of a wrong product or a B100 that has been contaminated with another product in the transportation system. While there is no strict colour requirement, any noticeable change in colour should be questioned.

Additional receiving tests are valuable in preserving the integrity of the B100.

Water and solids, or both, can accidentally get into transport during loading and must be detected before unloading.

If the receiver of the fuel has an in-house chemical testing laboratory, the receiver should be able to conduct density, flash point, and appearance by clear and bright as well as proper colour tests on fuel samples taken from transport before unloading. The truck or rail car used in prior shipments for the materials in Table 1 should never be used to transport biodiesel.

Table1

Material
Vegetable Oil
Aromatic Solvents
No. 6 Fuel Oil

Two additional tests, density and visual appearance, are recommended even though they are not part of ASTM D6751. The density test most readily identifies other petroleum products (i.e. kerosene) and visual appearance further validates the expected result of the ASTM D6751 sediment and water test. B100 deliveries not meeting these limits should be rejected or segregated for further laboratory analysis.

3.6 Receiver/Terminal Requirements[v]

This section identifies the controls to be applied by the terminal operator. The combined supplier and receiver controls, form a single package and any steps not carried out by the supplier have to be compensated for by the terminal operator.

The receiver is responsible for ensuring an optimum storage environment for all fuels. The three main contaminants that negatively impact fuels are air, water, and the fuel itself. Controlling these contaminants will minimize their effect on the fuels, both middle distillates and biodiesel, and a blend of both.

The first consideration in receiving B100 is ensuring proper storage for the biodiesel.

3.6.1 Storage Tank Considerations

Storage tanks in the distribution chain present a challenging maintenance process for fuel handlers. Composition of storage tanks, pipes and pumping equipment are critical in maintaining the integrity of the biodiesel. Construction materials such as carbon steel, stainless steel, or aluminum are recommended.

Deficiencies in fuel storage are not relegated to biodiesel alone. For decades petroleum handlers have faced numerous quality challenges resulting from the poor storage and handling of fuels. Stored fuel may form insoluble materials that plug filters, foul injectors and form combustion system deposits which all promote fuel-system corrosion. A lack of good housekeeping practices will only increase operational headaches and result in more time and money in the long run.

Improper placement of water draw-off taps can lead to accumulation of water in the system. Lack of attention to water evaluation may exacerbate any existing problems. Electronically or physically testing the tanks (*sticking*) with water-finding paste before and after each fuel delivery is imperative. Drawing down water levels in tanks will go a long way in preserving the quality of your stored fuels.

Biodiesel compatible gaskets and elastomeric materials are highly recommended. B100 may degrade some hoses, gaskets, seals' elastomers, glues and plastics with prolonged exposure. Natural or nitrile rubber compounds, polypropylene, polyvinyl, and Tygon materials are particularly vulnerable. More testing is being done to extend this list of vulnerable materials. Most elastomers (Viton/Teflon) used after 1993 are compatible with B100. Before handling or using B100 contact the equipment vendor to determine compatibility with fatty acid methyl esters.

B100 permeates some plastics typically used in petroleum applications. Materials such as polyethylene and polypropylene should not be used for storing B100.

Biodiesel blends of 20% or less have shown a much smaller effect on these materials. The effects are virtually non-existent in low-level blends such as B2. When handling blends of B20 or less, normal monitoring of hoses and gaskets for leaks is sufficient.

Teflon, viton, and nylon have very little reaction to biodiesel and are among the materials that can be used to update incompatible equipment. B100 suppliers and equipment vendors should be consulted to ensure the most recent findings on compatibility. For bulk fuel handlers of biodiesel it is highly recommended that you speak with your hose suppliers to source hoses that are compatible with neat biodiesel.

Most tanks designed to store diesel fuel will be adequate for storing B100. Acceptable storage tank materials include aluminum, steel, fluorinated polyethylene, fluorinated polypropylene, teflon, and most fiberglass materials.

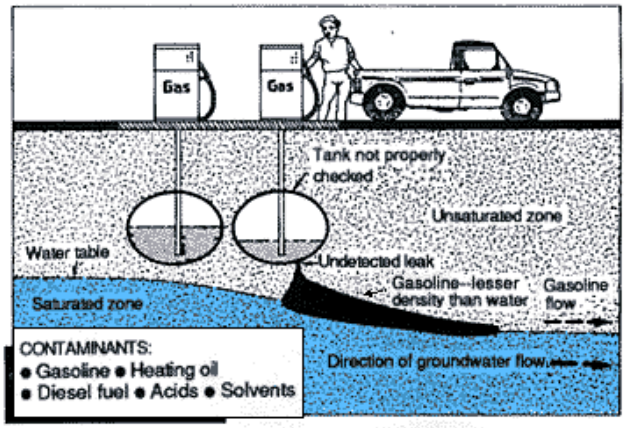
Brass, bronze, copper, lead, tin, and zinc may catalyze the oxidation process of biodiesel creating fuel sediments or gels and salts. Lead solders and zinc linings should be avoided, as should copper pipes, brass regulators, and copper fittings. Affected equipment should be replaced with stainless steel, carbon steel, or aluminum. **Blends of B20 and lower reduce the impact of metal compatibility issues.**

Table 2:

Material	**Effect of Biodiesel**
Teflon	Little change
Nylon 6/6	Little change
Nitrile	Hardness reduced 20% Swell increased 18%
Viton A401-C	Little change
Viton GFLT	Little change
Fluorosilicon	Little change in hardness Swell increased 7%
Polyurethane	Little change in hardness Swell increased 6%
Polypropylene	Hardness reduced 10% Swell increased 8-15%

Low temperature/cold weather properties need to be taken into consideration when discussing storage tanks. For terminal companies that are storing biodiesel in its neat form, you will need to heat your tanks, piping and associated delivery equipment to accommodate the pour point of biodiesel since it varies by feedstock. Section *3.6.6 Low Temperature Handling Properties*, discusses the issue of the range for cloud point for biodiesel fuels even from the same feedstocks. Keeping the biodiesel heated from 10°C-16°C is highly recommended until you can ensure that you have satisfactorily blended it into your distillate product of choice.

Key Points for Storing Biodiesel



- **Acceptable storage tank materials include aluminum, steel, teflon, fluorinated polyethylene, fluorinated polypropylene, and most fiberglass materials.**

- **Do not store B100 for long periods of time in systems containing reactive metals.**

- **B100 should be stored at temperatures at least 6°C higher than the cloud point. Generally, storage temperatures of 10°C to 13°C are acceptable for most B100, although some B100 fuels may require higher storage temperatures. Therefore, most underground storage facilities are adequate, but above ground fuel systems, depending on the climate, should be protected with insulation, agitation, heating systems or other methods.**

- **B100 is a mild solvent so carefully clean the tanks and fuel system where any sediments or deposits may exist. Prepare for more frequent filter changes while the system is being cleaned.**[vi]

3.6.2 Solvency/Cleaning Effect

Biodiesel is comprised of methyl esters. Methyl esters are mild solvents and have been used as low volatile organic-compound cleaners for years. Therefore, B100 **may** dissolve or dislodge the accumulated sediments in diesel storage tanks, pipes, fueling systems and engine fuel tanks. Dissolved or dislodged sediments can plug fuel filters and cause fuel injector failure. Existing tanks and transfer systems should be cleaned, dried, and inspected prior to introducing B100 into the tank.

Biodiesel and biodiesel blends will form high sediment levels when in contact with the following metals:

- Brass
- Bronze
- Copper
- Lead
- Tin
- Zinc

If you plan to use or store biodiesel the following considerations should be made:

1. Carefully **clean the tanks and fuel system** where any sediments or deposits may exist. Petroleum handlers should be evaluating bulk storage tanks regardless of possible biodiesel storage and distribution to ensure that the fuel quality preservation of conventional distillates is maintained.

2. Be prepared for the possibility of some **filter clogging*** and more **frequent filter changes*** until the system has been cleaned of old sediments. Once the system is cleaned the filter change interval should return to normal intervals.

3. **Wipe biodiesel spills** from painted surfaces immediately as it will dissolve some paints.

These effects are greatly reduced or eliminated in blends of 20% or less. (B20, B5, B2 etc.) Additional unscheduled filter changes have been reported in less than 2% of the cases when biodiesel blends less than 20% are first introduced. There have been no reports of additional filter changes with the use of B2. Tank maintenance and storage is crucial in all cases. However, this issue is vital for those organizations planning on using diesel fuel or heating oil tanks with years of accumulated sediment (tank bottoms). It is highly recommended that the tanks be cleaned before introducing B100 biodiesel.[vii]

In some cases, the cleaning effect or solvency of B100 has been confused with gums and sediments that could form over time in storage as fuel ages. It should also be noted that this *solvent effect* should diminish after the second load.

Tests of the acid number and the viscosity should be performed to determine the cause of the sediment. If these numbers are within ASTM specifications, the sediment is most likely the result of the solvency of B100.[viii]

3.6.3 Excess Air

As a fuel tank is emptied, air will enter through the vent pipes to displace the fuel in the tank. The excess air in the tank may lead to increased oxidation, particulate contamination, and increased water levels. These contaminants affect both the stability and quality of the fuel. In order to limit the effects of air in the tanks, it is recommended that fuel handlers do not store fuels for long periods of time in partially empty tanks without stabilizers. Additionally, one may consider desiccant filters on vents to reduce moisture and particulate contamination (dirt).

3.6.4 Water Contamination

Biodiesel is susceptible to water-related problems. Desiccant filters on breathing vents will greatly reduce condensation in the tank and are highly recommended. Sump drains are recommended where practical.

Both free and entrained water accelerate corrosion and fuel degradation. Free water may enter bulk fuel tanks via condensation, carry-over from the fuel distribution system or leakage through the fill cap, spill containment valve or piping.

In addition to accelerated breakdown of the fuel product, water also creates a fertile growing environment for microbial contamination. Microbial activity, surfactants, alcohols, particulates, and poorly designed additives may be the cause of entrained water problems.

Poor tank design can make complete removal of water nearly impossible, and therefore, it is important to take steps to prevent water entrance. If you believe that your storage systems fall into this category contact a mechanical engineering company to determine a strategy that will optimize your storage tank.

3.6.5 Microbial Contamination

Biocides are recommended for conventional and biodiesel fuels wherever biological growth in the fuel has been a problem. If biological contamination is a problem, water and sediment contamination must be controlled. The preferred approach, however, is simply a good tank cleanliness program—keep the fuel clean and dry.

3.6.6 Low Temperature/Cold Weather Handling Properties

Biodiesel cold weather properties require that careful attention be paid when dealing with the product in cold weather climates. It is extremely important that before handling the fuels, one be familiar with the cold weather properties of both biodiesel and the generic diesel intended for blending.

Diesel Fuel

The cloud point of the material must be known and meet the requirements for the region for which it will be used, based on the 2.5% mean low temperatures for particular months and regions in Canada. These seasonal cloud point specifications may be provided by your petroleum diesel supplier. CAN/CGSB-5.317 Standard for Low Sulphur Diesel Fuel and CAN/CGSB-3.6 for Regular Sulphur Diesel Fuel contain seasonal specifications for cold-flow properties such as cloud point.

Blends of biodiesel will impact cold weather operability in direct relationship to the independent base analysis of the fuels being blended to create B2, B5, and B20. Therefore, the cloud point and the pour point of both generic fuels require the attention of the blender, and the blended cloud point information should be provided to the customer. It is imperative that selection of the absolutely lowest operating temperature of your diesel fuel be adhered to prior to accepting blends of biodiesel.

Biodiesel

The same precautions taken with petroleum diesel can be used to insure trouble-free operations with biodiesel. Traditional cold weather solutions for diesel work well with biodiesel with the exception of commercial cold-flow additives. Although some additive suppliers claim to have products that work with biodiesel, it is more likely that these products impact the generic diesel or heating oil cold-flow characteristics and not the neat biodiesel.

A key issue for cold weather performance in Canada is that B1-B5 biodiesel blends sold for on-road use within Canada must meet all of the specifications for CAN/CGSB-5.310 Specification for Diesel Fuel, including cloud point.

B100 solidifies/freezes at higher temperatures than conventional diesel fuels. Operators must take this into account if they are handling or using B100. Most B100 begins to cloud between 3°C and 15°C. This clouding will lead to sedimentation that could plug lines and filters. Heated, insulated tanks, lines, and pumps may be needed even in moderate climates. The viscosity of B100 begins to rise dramatically as it begins to gel. Viscosity rises to levels much higher than most diesel fuel. This can cause increased stress on pumping equipment.

Cloud point is the temperature, during cooling, at which wax crystals first form in the fuel. Wax crystals create a visible haze. These crystals can plug fuel filters in diesel engines. Without heating aids on the fuel filter and fuel lines, the cloud point limits the low temperature operability of a diesel fuel.

In general, it has been found that cloud point or LTFT (Low Temperature Flow Test) are better indicators of operability limits. The LTFT is a test which takes 24 hours, and is therefore impractical. In many cases, the CFPP (Cold Filter Plugging Point) tends to overestimate the operability of B100 and B20 blends. The cloud point is therefore the most widely accepted measure of cold weather operability limits. On average, a B2 blend will warm the cloud point by 2°C to 3°C. In general, a B20 blend will impact the finished fuel's cold weather operational temperatures by 7°C to 12°C. The actual warming of the cloud point is dependent upon the cloud point of the biodiesel fuel and that of the petroleum diesel fuel. Keep that compromise in mind when sourcing your base diesel fuel.

B20 has enjoyed a successful track record when these basic instructions are adhered to.

Pour Point is the lowest temperature at which a diesel fuel will flow, and is usually a few degrees below the cloud point. This can be relevant to the minimum delivery temperature for a diesel fuel, especially a biodiesel fuel blend.

Low Temperature Operability Properties

Table 3:[ix]

	Cloud Point		Pour Point		Cold Filter Plug Point	
B100 Fuel	°F	°C	°F	°C	°F	°C
Soy Methyl Ester	36	2	30	-1	28	-2
Canola Methyl Ester	27	-3	25	-4	25	-4
Lard Methyl Ester	57	14	52	11	52	11
Edible Tallow Methyl Ester	68	20	55	13	57	14
Inedible Tallow Methyl Ester	73	23	46	8	50	10
Yellow Grease 1 Methyl Ester	108	42	54	12	52	11
Yellow Grease 2 Methyl Ester	46	8	46	8	34	1

These values are examples only, as taken from the NREL report referenced below.

More typical cloud point ranges are found in the following table. Typical cloud points for biodiesel will vary based on the feedstock from which they were derived:

Table 4:

B100 Biodiesel Fuel	Cloud Point (°C)
Soy Methyl Ester	3 to -7
Canola Methyl Ester	-2 to -12
Tallow Methyl Ester	10 to 20
Yellow Grease Methyl Ester	5 to 15

B100 should be stored at temperatures at least 6°C higher than the cloud point. Generally, storage temperatures of 10°C to 13°C are acceptable for most B100 fuels, although some B100 fuels may require higher storage temperatures.

These temperature requirements make most underground storage facilities adequate, but above ground fuel systems, depending on the climate, should be protected with insulation, agitation, heating systems or other methods. These precautions should also be taken with piping, tanks, pumping equipment, vehicles or any other equipment used for the transport or storage of the fuel.

Cold-flow additives have had limited effectiveness on biodiesel produced in the United States. The same would be true of all North American produced biodiesel fuels. The effectiveness of the additives varies greatly depending on the type of biodiesel and the processing that it has undergone. Cold-flow additives have been used much more successfully with biodiesel blends. For further information contact the major additive manufacturers.

Maintaining Fuel Quality

- **Specify fuels meeting CGSB standards only, (see Appendix C) and ASTM D6751 for B100 biodiesel blend stock (see Appendix D)**
- **Reference cold weather performance and other special needs prior to ordering**
- **Be proactive with general housekeeping practices**
- **Execute a monthly or quarterly fuel-analysis program to ensure the safe keeping of fuels**

3.6.7 Blending B100

As the market has grown for biodiesel and biodiesel blends, much of the blending has become available further upstream in the distribution system. However, depending on the volume, blend level, tankage, space availability, equipment, and other considerations, self-blending may be a better option for some distributors.

Preparing to Blend Biodiesel

- Establish storage and injection points suitable for larger terminals, smaller jobbers, and some retail outlets
- Evaluate each terminal individually because different requirements will be necessary to ensure seamless operation at each terminal

- Coordinate with biodiesel suppliers for best delivery methods and scheduling when sizing tank capacity

- Address on-site storage challenges for biodiesel

Blending options[x]

Biodiesel is designed for full compatibility with petroleum diesel, and therefore blending it is not difficult.

Biodiesel is typically blended via four means:

1. Splash-Blending
2. In-Tank Blending
3. In-Line Blending
4. Rack Injection

1. Splash Blending

Biodiesel and diesel fuel are loaded into a vessel separately. Mixing of the products occurs as the fuel is agitated through the blending of each fuel and during the transportation and delivery of the fuel to the end user. Because biodiesel is slightly heavier than conventional distillates **it is recommended that biodiesel be loaded second on top to eliminate the biodiesel from settling at the bottom of the blending tank**. When bottom loading is utilized the fuel flow may be adequate to load either fuel being blended first with no negative consequences of these minor viscosity differentials. When splash blending, complete compartment loads should be delivered to a single tank, rather than to a partial compartment or more than one tank.

2. **In-Tank Blending**

Biodiesel and petroleum diesel are loaded separately, or in some cases simultaneously, through different incoming sources, but at a high enough fill rate that the fuels sufficiently mix and require no further agitation. Sampling is recommended to ensure that the tank blends are homogeneous. If uncertain about the homogeneity of the samples, density checks on the samples will confirm.

3. In-Line Blending

Biodiesel is added to a stream of diesel fuel as it travels through a pipe or hose. The blending occurs as the two products move through the pipe, or once the fuel is loaded, into its receiving vessel.

4. **Rack Blending**

   Inject directly at the rack into the tank truck, similar to current performance fuel additives and red dye.

Infrastructure Considerations[xi]

At the loading rack, there will not be a good, single method to select for blending the complete range from B2 to B100. You must utilize your current assets the best way possible. To begin, select the storage and blending option that meets your needs and is supported by your existing equipment.

To accommodate B2 to B5 with product flow rates of 2182 litres per minute (LPM)/600 gallons per minute (GPM) you must ensure that the pump and supply line will handle the demand of the total volume for all load arms with sufficient pressure. Blend ratios in this range will require a larger injection point typically a 2-inch opening. Consideration must also be given to the power requirements for the larger motors needed for this blending ratio.

If you are choosing to distribute B2 to B5 with a product flow of 2182 LPM/600 GPM, you will require a meter and valve rated for 44 LPM/12 GPM minimum, while B5 will require a 109 LPM/30 GPM system. These ranges are achievable with the current high capacity meter based injectors found in many terminals nationwide. High capacity meter based injectors will allow accurate control and metering of up to 5% blending.

As you approach blending biodiesel in ratios of 10% and above, you will require a higher level of infrastructure. B10 and above will be more invasive as it pertains to the physical space required by this equipment, but this blend percentage will be achieved by using *sequential blending,* with or without automation, or *preset ratio blending* using automation only.

In sequential blending, you are basically loading one product at a time and can use the same meter for both products—biodiesel and conventional diesel. Both products can also use one common control valve but a block valve for each product will be necessary.

Sequential blending is usually the least intrusive and least expensive to add to an existing terminal infrastructure. It is basically a matter of adding a new product to a loading lane at the truck terminal facility. The ultimate result enables a terminal operator to load multiple products at one loading position or at different rack positions through different loading arms.

Preset true ratio blending enables terminal operators to load both products—biodiesel and diesel fuel—at the same time. One meter and control valve per

product is required and the blend stays proportional and blends throughout the complete load.

Present batch ratio blending activates both products simultaneously and is loaded at the same time. Like the preset true ratio concept one meter and control valve per product is required but flow ratios are not controlled proportionally, meaning that the product with the lesser volume may finish substantially earlier than the larger product volume.

Blending systems like a four-arm blender, engineered to work with rack, can be built to work within your specific space requirements. They are normally designed in a horizontal configuration, but often are designed in vertical configurations to fit into tighter space requirements.

V-Port ball valves allow for more accurate controls of the product stream at different rates and are enabled with hydraulic actuators. Again, if space restrictions at terminals are an issue, multiple arms per bay blenders can be designed and installed at the end of each respective truck bay.

Before you develop a plan to upgrade your existing infrastructure, you must first determine what it is you are trying to accomplish regarding biodiesel distribution. To help you accomplish each of your intended goals and successfully blend multiple blend rates of biodiesel into your generic fuel stream, there are many mechanical engineering companies that are qualified to tour your facility and make specific recommendations.

Comparisons of Infrastructure Options

Each method of blending and its required infrastructure has many positives and negatives. The blending method must fit into your current and future needs while remaining cost effective. Following are the positive and negative aspect of each of the blending options.

Each terminal operator dictates the selected strategy. The strategy must be based on the needs of the operator, the goals of the operation, and the constraints of their budget. Future flexibility must also be considered.

Sizing storage tanks and controlling the cold weather handling characteristics of biodiesel are the majority of the installation costs.

Recommendations for Tank Farm Blending Sequential/Splash Batch: Blending Option 1

Positives
• Cost effective and operationally sound • Allows biodiesel to be transferred into distillate tankage when all distillate is to be blended with biodiesel • Biodiesel can be loaded directly into the storage tank prior to, during, or after delivery. • For optimum blending, the biodiesel can be injected proportionally into the distillate pipeline upstream of tankage. • Minimal capital investment allows accurate accountability with the ability to perform lab analysis on, and make corrections to, the actual blend before loading transports.

Negatives
• All distillate in selected storage tanks has been blended and cannot be sold as unblended to locations not desiring biodiesel blended distillate, i.e. exporting. • The tank may need to be circulated to maintain suspension of biodiesel depending on turnover duration and temperature of fuel.

Recommendations for Truck Loading Terminals Sequential Blending at the Rack: Blending Option 2

Positives
• Cost effective/operationally sound strategy to blending individual loads • Allows biodiesel to be loaded and metered at a flexible proportionate rate, with the fuel loading afterward • Allows use of existing automation systems to perform the blending, monitoring, and reconciling of the fuel mixture • Allows rate changes to be easily performed in programming without future equipment upgrades specific for this product • Allows for independent storage for the unadditized fuel to be loaded either with or without biodiesel • If biodiesel is desired, fuel volume will be selected as normal by the driver with a selection of grade for biodiesel. • The biodiesel will be loaded into the truck first by volume entered in the presets, and the distillate will be added at the end of the load proportionately. This will be done by the existing automation system, using the same loading arm. • Similar to the method commonly used for ethanol and mid-grade • Operates by installing a biodiesel line connection into the fuel loading line • Flow will be controlled by a control valve and meter pulses to the automation system or accuload

Negatives
• B100 requires heat and insulation to all injection points and may slow loading time at some locations by small amounts.

Recommendations for Truck Loading Terminals Blending into Distillates: Blending Option 3

- Splash blending and wild stream blending to the rack
- Goal accomplished by adding the same equipment as for sequential blending
- Splash blending allows the biodiesel to be loaded concurrently with the distillate through a common load arm.

Positives
• Minimal interference with normal operations using equipment common in all terminals • Fuel is mixed throughout load while loading into transport

Negatives
• Installation and maintenance costs are increased versus sequential blending • B100 requires heat and insulation to all blend connections.

Recommendations for Truck Loading Terminals Injecting at the Rack: Blending Option 4

- Biodiesel is blended, as normal fuel additives, proportionately as the fuel is loaded.

Positives
• All terminal operators will be familiar with this type of system operation and maintenance • Typically this is most affordable

Negatives
• Blend rates up to 5% proportional maximum optional • Higher rates desired must slow loading of product

Recommendations for Jobber Locations: Blending Option 5

- Injecting into distillates at jobber locations without automation systems and other limitations

Positives
• Economical

Negatives
• Requires human involvement during blending process • Potential for inaccurate loads • Minimal documentation of loads

Recommendations for Jobber Locations: Blending Option 6

- Injecting into distillate at retail locations without automation systems and other limitations
- This system is currently used at many retail outlets to inject cold-flow improver into fuel.
- Allows for accurate reconciling of blended fuel
- This system adds the biodiesel automatically and proportionately as the fuel is dropped into the storage tanks at the retail outlet from the transport.
- Can be accessed remotely by modem

Positives
• Most economical for small-scale operations

Negatives
• Numerous moving parts, one system per location • Minimal documentation • More hands on involvement • No method to test and make corrections to blend

Cold Weather Blending Tips

Biodiesel has a pour point of from 0°C to 18°C— depending on the biodiesel fuel—and it therefore may require heating to ensure flow prior to being introduced into the generic distillate portion of your biodiesel blend. Once the biodiesel is blended into the generic distillate, the cold-flow performance of the finished product may be impacted between 2°C – 3°C for a B2 blend, and 3°C – 5°C for a B5 blend. This cloud-point warming is dependent upon the petroleum diesel fuel's characteristics and its cloud point, and the cloud point of the biodiesel fuel. The warming of the cloud point will be more pronounced with a B20 blend, and again will be dependent upon the cloud points of the petroleum diesel and the biodiesel. It is highly recommended that you know the fuel specifications related to the generic percentage of your biodiesel blend. This information is provided by your fuel supplier. The lower your winter operability temperatures for the generic distillate that you intend to blend the biodiesel with, the more reliable the blended fuel will be for winter operability in your region.

Blended fuels can be stored below ground in most climates. Above ground storage—for both generic distillates and biodiesel—should be protected with insulation, agitation, kerosene blends, heating systems or other measures if freezing temperatures are common. These precautions include protecting tank piping and the pumping equipment. These cold weather preparatory recommendations are equally important when storing conventional distillates as well as biodiesel and biodiesel blends.

Regularly, throughout Canada, generic distillates are loaded onto fuel trucks at oil terminals with temperatures as low as -7°C. Recognizing that biodiesel requires heat protection to at least 10°C above the pour point of the fuel, it is apparent that fuel handlers will be blending cold diesel fuel with warm biodiesel.

Many fuel handlers have been solicited for independent blending strategies to determine a final recommendation that will provide new fuel handlers with the *best practices needed* to achieve the successful blending and distribution of biodiesel and biodiesel blends. Some maintain that the fuel temperature differentials haven't been a problem. Others, meanwhile, confirmed that they have witnessed the saturated compounds in the biodiesel crystallize and plug fuel filters and fuel lines similar to generic distillate fuels that see temperatures equal to, or lower than, its cloud point.

To circumvent this potentially negative result, it is highly recommended that when blending your biodiesel with generic distillates, adhere to the following principals to eliminate fuels that separate in storage post-blending and fail to meet your winter operability expectations.

Summary of Key points for Blending

1. **Biodiesel is heavier than diesel fuel.** Biodiesel has a density of 0.88 compared to seasonal diesel at 0.85 and No. 1 diesel at 0.82. Therefore, it is recommended that **the generic distillate fuel—diesel fuel, kerosene or heating oil—be in the tank prior to introducing the biodiesel portion. When splash blending, biodiesel should be blended on top of petroleum diesel.**

2. **Biodiesel has a higher pour point—relative to petroleum diesels.** Depending on the outside temperature, to ensure flow, it may be necessary **to heat the biodiesel,** and possibly petroleum diesel, prior to the introduction to the generic distillate portion of the blend.

3. **Blends will not separate in the presence of water.** However, execute proactive tank management to prevent other problems caused by free water.

4. **Only use fuels that meet CGSB specifications,** CAN/CGSB-3.520 Biodiesel B1-B5 Standard for Biodiesel and CAN/CGSB 3.517 for Automotive Low Sulphur Diesel Fuel for generic diesel. Absolutely do not blend fuels that do not meet these specifications.

5. **Blend the biodiesel with 50% No.1 or Type A diesel fuel prior to introducing it into your final fuel mixture.** Make sure that your No. 1 or Type A diesel fuel is above 10°C.

6. **Absolutely know the cloud point and the pour point of your generic diesel fuel product prior to blending** it into the biodiesel. This will tell you what the inclusion of your specified blend of biodiesel will do to these key winter operability characteristics post-blending. If you start with the wrong fuel for the seasonal low temperature operability weather specifications, you will end up with an inferior biodiesel blended fuel.

7. **Seek blending speeds either through gravity distribution or mechanical agitation at least 273 LPM/75 GPM to full rack velocity, which can be as high as 2364 LPM/650 GPM.** Hand mixing—basic pouring of one fuel into another—is not suggested in cold climates. An alternative approach to blending would be product mixing during delivery. Once the truck has been loaded at a bulk terminal, your products are mixed en route to its final destination. Once at the destination, pumps or gravity, drop the mixed products into the end user's fuel storage tanks. Success has been achieved using this blend strategy.

8. **Neat biodiesel should not be kept on a truck overnight prior to delivery.**

9. **Many fuel users and distributors currently use cold winter diesel fuel additives to improve winter handling characteristics of diesel fuel.** To date, no commercial diesel fuel additive has been found to be effective in modifying the cold weather specifications of neat biodiesel. However, commercial additives are available to treat the generic distillate portion of the blend. These commercial additives can aid in reducing the cold weather characteristics of the fuels cloud point and pour point, which in turn, will benefit the biodiesel blend by working solely on the distillate fuel characteristics. As a general rule of thumb, the lower the cloud point of your distillate fuels the better the biodiesel blend will be.

10. When using cold weather distillate additives, **it is imperative that they be added to your fuel before the fuel reaches its cloud point**. Also, make sure that the additive gets into the fuel when agitation is available through your chosen blending strategy. Similar to biodiesel blending, an additive requires equal blending attention so that it gets distributed evenly throughout your entire tank and ensures optimum winter performance characteristics.

11. Become acquainted with a **local fuel testing laboratory in your region** before you have a problem.

12. **Test for water in all tanks storing biodiesel, conventional diesel fuel, and blends of both fuels** by using the tried and true method of a gauge stick and water-finding paste, (available at petroleum supply houses).

13. Whenever possible, **industry recommendations suggest that 30-micron filters be used on filters utilized for fuel pumping islands.** Winter conditions frequently cause fuel to haze when fuels reach posted cloud points because well-entrained moisture tends to freeze causing premature filter plugging.

14. **Water-fuel separators need to be checked** at the same time vehicles are being fueled and must be serviced as often as necessary.

4.0 Warranties, Original Equipment Manufacturers (OEM) and Biodiesel

Original Equipment Manufacturers will not and cannot void warranties based solely on the use of biodiesel. In fact, many OEM's have explicitly stated that the use of biodiesel blends will not void warranties. Any biodiesel used in neat form or as a blending agent must meet ASTM D6751 standards.

Warranties are only violated if the biodiesel is the cause of the equipment malfunction. This is the same practice as with traditional diesel; warranty covers defects caused by material or workmanship. Engine warranty, workmanship and material are not affected simply by the use of biodiesel regardless of the product's origin. Therefore, if the machine's parts breakdown, the manufacturer is bound to honour their warranty, regardless of the fuel used. If the biodiesel, or other fuel, is the cause of the problem then the warranty may be void. However, in such a case, the fuel most likely does not meet specification and, therefore, the fuel supplier is accountable.

As manufacturers become more familiar with biodiesel, updated information on warranties is becoming available. Please check for updates and specific OEM statements on the BAC Web site, www.biodiesel-canada.org or the NBB Web site, www.biodiesel.org.

Information Resource Web sites

Biodiesel Association of Canada
www.biodiesel-canada.org

National Biodiesel Board
www.biodiesel.org

Petroleum Marketers Association of America
www.pmaa.org

BQ-9000 Quality Management Program
www.bq-9000.org

APPENDIX A

Transport Unloading Guidelines[xii]

PURPOSE:
To establish guidelines for the unloading of product from tankers

SCOPE:
Applies to all tank trucks unloading material (of one product type only) at the fueling terminal. Conformance to work instruction is the responsibility of receiving personnel.

INSTRUCTIONS:

1. Verify product name on tanker and obtain weights from paperwork supplied by the driver.

2. Position tanker properly (get approval from supervisor).

3. Obtain sample of material and certificate of analysis. Retain sample for the lab. If COA cannot be obtained, notify QA Department or terminal Manager to obtain one. Approve or reject material according to in-house criteria.

4. Select proper hoses and pumps necessary to unload product. Ask driver for rates to use his equipment and determine the cost difference. If it is cheaper to use their equipment, do so.

5. Determine the pathway of the product to be unloaded.

6. Hook up equipment and tie down/off all connections and inspect vessels.

7. Perform tanker inspection using the form found in this Appendix. If the tank wagon is *spotted* for unloading at a later time, a tanker inspection form must accompany the tank wagon at all times for identification purposes.

8. If product is not approved, or rejected according to procedure, it must be unloaded into clean tank (as determined by management, shipping/receiving personnel or production personnel) and held pending approval.

9. Begin unloading tanker. (When using a vacuum, properly vent the tanker.) If rejecting material, notify the driver that the material is off-specification and will not be accepted. Unhook hoses and clean up.

10. Load product into a clean tank. Label non-dedicated tanks as to contents (Name or code number, lot number, and indicate the test status of vessel).

11. Check hoses and pumps for any leaks. Make sure product is flowing properly. Monitor the pumps, hoses, and connections throughout the unloading process.

12. When product is flowing, inspect the tanker for residual product.

13. If there is product still in the tanker, elevate the tanker so the product can be extracted as completely as possible. Inspect a second time for residual product left in tanker. Repeat step if necessary to rid tanker of excess product.

14. When unloading is completed, blow out the lines and drain them into a clean bucket.

15. Empty the bucket of recovered material into its proper location.

16. Review and sign all paperwork. Detail discrepancies in paperwork and give to Purchasing/Scheduling Manager or Supervisor.

17. Wash out the hoses and pumps and return them to their proper location (as designated by Supervisor).

Transport Inspections Checklists

Tank Car Checklist

	Yes	No	N/A
COA Required for Unloading (if COA not received then do not unload until COA is received)			
Storage Tank Gauged and Tank/Car Capacity Checked Initial:			
Blue Flag and/or Derailers in Place?			
Ground Cable Connected?			
Car Brakes Set?			
2 Chocks in Place?			
Car and Safety Valve Test Due Date?			
Rail Car Tank Test Due Date?			
Year Built?			
Rail Car Coupler is Type F, If not, Do Not Load			
Rupture Disk Inspected?			
Safety Equipment Being Utilized?			
If Inbound Car, is it properly sealed?			
Top			
Bottom			
If Loading, Car Clean, Dry or Odor Free?			
Internal and External Valves Clean, Dry, Odor Free and Functional?			
All Caps Removed if Loading?			
Tank Car Properly Vented for Pumping?			
Spill Buckets in Place?			
Ears Locked and Wired?			
Verify Proper Tank Hook-Up? Tank No. Initial:			
Proper Hose Used? Visual Hose Inspection, Replace Defective or Unsafe Hoses.			
Special Instructions Reviewed?			
Vessel Gauges and Temperature Recorded?			
Samples Have Typical Appearance? Initial:			
Samples Taken, Tagged and Distributed or Stored?			

Complete if Vessel to be Pressured Off			
Record Max. Vessel Pressure			
Regulator Set and Functional			
If Unloading, Are All Compartments Empty?			
Empty Car Seal Numbers			
Top			
Bottom			
Proper Placards, Tags and ID Cards Applied? Initial:			
Nitrogen Pressure or Air Pressure Tags Applied?			
R/C Dome Secured with 24-Inch Pipe Wrench All Bolts Verified Tight?			
Bolts Tightened using *Every Other Bolt* Pattern?			
R/C Pressure Inlet Valve and Top U/L Valve Closed and Plugged?			
R/C Top U/L Housing Cover Closed and Lock Pin Secured?			
R/C Belly Cap (or Plug) Intact and Secured with 36-Inch Pipe Wrench?			

Tank Car Checklist (con't)

If Hazardous Material (Poison, Odorous or Flammable), Do not Release in Plant. If Non-Hazardous Material, was it Pressure Released?			
Equipment Cleaned and Stored? Area Cleaned?			
Blue Flag/Derailers Removed, Chocks Removed, Ground Cable Removed?			

THIS PRODUCT HAS BEEN PROPERLY UNLOADED BY:

TANK CAR #_____ **W/O#**_____

SIGNED:_____DATE:_____

REMARKS:

Tank Truck Checklist

Carrier's Documents: Bill of Lading and COA, if required by customer	Yes	No	N/A
Note: If customer requires COA and carrier has none, then do not unload until COA is received.			
Is the Product Name on the Bill of Lading the Same as that Listed on the Work Order?			
Initial:			
If NO, Notify Supervisor or Operations Manager for Confirmation Before Proceeding.			
Strapping Sheets			
Weight Tickets			
Tank Truck			
Driver in Attendance			
Trailer Grounded			
Brakes Set and Engine Off			
Wheels Checked			
Safety Equipment Being Utilized			
Proper D.O.T. Specification			
Inspection Date:			
Inspection Due Date:			
If Out of Date, Do Not Load and Report to Supervisor/Operations Manager/Facility Manager			
Tank Truck Max. Load Temp.			
If lower than Prod. Loading Temp., Report to Supervisor/Operations Manager/Facility Manager			

For BHMT Tank Trucks, Open the Gauging Hatch……..			
Trailer Clean, Dry and Odor Free, and has Clean-Out Sheet?			
All Trailer Gaskets Inspected?			
Seals Intact and Recorded?			
Proper Samples Taken and Have Typical Appearance COA Verified-Mat'l Acceptable?			
Samples Tagged and Stored or Distributed?			
Vessels Gauged and Temperature Recorded?			
Internal and External Valves Functional?			
Storage Tank Capacity and Volume Checked?			
Tank Truck Capacity Checked?			

Complete *if* Vessel to be Pressured Off:			
Record Max Vessel Pressure Max Pressure psi			
Regulator Set and Functional			
Trailer Properly Vented for Pumping?			
Pump and Hose, Visual Inspection, Hoses must be clean and in good condition			
Replace Defective or Unsafe Hoses			
Spill Buckets in Place?			
Ears Locked and Wired?			
Special Instructions Reviewed and Proper Equipment on Board?			
Verify Proper Tank Hook-Up Tank No. Initial:			
If Unloading, Are All Compartments Empty?			
If Pressured Out With Nitrogen, Is Inert Atmosphere and Pressure Tag Applied?			

If Hazardous Material (Poison, Odorous or Flammable) DO NOT Release Pressure in the Plant.			
- **If Non-Hazardous, Was Pressure Released?**			
Trailer Secure, Domes, Valves, Caps and Plugs?			
Manifold Clean and Empty?			
Equipment Cleaned and Stored?			
Ground Cable and Chocks Removed?			
Area Cleaned?			

Placard #_____ **Applied to Tank Truck Initial:**_____
Number of Placards Applied to Truck_____ **Driver Initials**_____

THIS PRODUCT HAS BEEN PROPERLY LOADED/UNLOADED BY:

TRAC/TRAILER #_____ W/O#_____
SIGNED_____DATE:_____

APPENDIX B

Material Safety Data Sheet (MSDS) for Biodiesel[xiii]

Sample MSDS Form from National Biodiesel Board (www.biodiesel.org)

SAMPLE MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT

General Product Name: **Biodiesel**
Synonyms: Methyl Soyate, Rapeseed Methyl Ester (RME), Methyl Tallowate
Product Description: Methyl esters from lipid sources
CAS Number: Methyl Soyate: 67784-80-9; RME: 73891-99-3; Methyl Tallowate: 61788-71-2

2. COMPOSITION/INFORMATION ON INGREDIENTS

This product contains no hazardous materials.

3. HAZARDS IDENTIFICATION

Potential Health Effects:

INHALATION:
Negligible, unless heated to produce vapors. Vapors or finely misted materials may irritate the mucous membranes and cause irritation, dizziness, and nausea. Remove to fresh air.

EYE CONTACT:
May cause irritation. Irrigate eye with water for at least 15 to 20 minutes. Seek medical attention if symptoms persist.

SKIN CONTACT:
Prolonged or repeated contact is not likely to cause significant skin irritation. Material is sometimes encountered at elevated temperatures. Thermal burns are possible.

INGESTION:
No hazards anticipated from ingestion incidental to industrial exposure.

4. FIRST AID MEASURES

EYES:
Irrigate eyes with a heavy stream of water for at least 15 to 20 minutes.

SKIN:
Wash exposed areas of the body with soap and water.

INHALATION:
Remove from area of exposure; seek medical attention if symptoms persist.

INGESTION:
Give one or two glasses of water to drink. If gastro-intestinal symptoms develop, consult medical personnel. (Never give anything by mouth to an unconscious person.)

5. FIRE FIGHTING MEASURES

Flash Point (Method Used): 130.0° C min (ASTM 93)

Flammability Limits: None known

EXTINGUISHING MEDIA:
Dry chemical, foam, halon, CO_2, water spray (fog). Water stream may splash the burning liquid and spread fire.

SPECIAL FIRE FIGHTING PROCEDURES:
Use water spray to cool drums exposed to fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS:
Oil soaked rags can cause spontaneous combustion if not handled properly. Before disposal, wash rags with soap and water and dry in well ventilated area. Firefighters should use a self-contained breathing apparatus to avoid exposure to smoke and vapor.

6. ACCIDENTAL RELEASE MEASURES SPILL CLEAN-UP PROCEDURES

Remove sources of ignition, contain spill to smallest area possible. Stop leak if possible. Pick up small spills with absorbent materials such as paper towels, *Oil Dry*, sand or dirt. Recover large spills for salvage or disposal. Wash hard surfaces with safety solvent or detergent to remove remaining oil film. Greasy nature will result in a slippery surface.

7. HANDLING AND STORAGE

Store in closed containers between 50°F and 120°F.
Keep away from oxidizing agents, excessive heat, and ignition sources.
Store and use in well-ventilated areas.
Do not store or use near heat, spark, or flame, store out of sun.
Do not puncture, drag, or slide this container.
Drum is not a pressure vessel; never use pressure to empty.

8. EXPOSURE CONTROL/PERSONAL PROTECTION

RESPIRATORY PROTECTION:
If vapors or mists are generated, wear a NIOSH approved organic vapor/mist respirator.

PROTECTIVE CLOTHING:
Safety glasses, goggles, or face shield are recommended to protect eyes from mists or splashing. PVC coated gloves are recommended to prevent skin contact.

OTHER PROTECTIVE MEASURES:
Employees must practice good personal hygiene, washing exposed areas of skin several times daily and laundering contaminated clothing before re-use.

9. PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point, 760 mm Hg:>200°C Volatiles, % by Volume: <2
Specific Gravity (H_2O=1): 0.88 Solubility in H_2O, % by Volume: Insoluble
Vapor Pressure, mm Hg: <2 Evaporation Rate, Butyl Acetate=1: <1
Vapor Density, Air=1:>1
Appearance and Odor: pale yellow liquid, mild odor

10. STABILITY AND REACTIVITY

GENERAL:
This product is stable and hazardous polymerization will not occur.

INCOMPATIBLE MATERIALS AND CONDITIONS TO AVOID:
Strong oxidizing agents

HAZARDOUS DECOMPOSITION PRODUCTS:
Combustion produces carbon monoxide, carbon dioxide along with thick smoke.

11. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL:
Waste may be disposed of by a licensed waste disposal company. Contaminated absorbent material may be disposed of in an approved landfill. Follow local, state and federal disposal regulations.

12. TRANSPORT INFORMATION

UN HAZARD CLASS: N/A
NMFC (National Motor Freight Classification):
PROPER SHIPPING NAME: Fatty acid ester
IDENTIFICATION NUMBER: 144920
SHIPPING CLASSIFICATION: 65

13. REGULATORY INFORMATION:

OSHA STATUS:
This product is not hazardous under the criteria of the Federal OSHA Hazard Communication Standard 29 CFR 1910.1200. However, thermal processing and decomposition fumes from this product may be hazardous as noted in Sections 2 and 3.

TSCA STATUS (*Toxic Substance Control Act)*:
This product is listed on TSCA.

CERCLA (*Comprehensive Response Compensation and Liability Act*):
NOT reportable.

SARA TITLE III (*Superfund Amendments and Reauthorization Act*):

Section 312 Extremely Hazardous Substances:
None

Section 311/312 Hazard Categories:

Non-hazardous under Section 311/312

Section 313 Toxic Chemicals:
None

RCRA STATUS *(Resource Conservation and Recovery Act)*
If discarded in its purchased form, this product would not be a hazardous waste either by listing or by characteristic. However, under RCRA, it is the responsibility of the product user to determine at the time of disposal, whether a material containing the product or derived from the product should be classified as a hazardous waste,
(40 CFR 261.20-24)

CALIFORNIA PROPOSITION 65:
The following statement is made in order to comply with the *California Safe Drinking Water and Toxic Enforcement Act of 1986*. This product contains no chemicals known to the State of California to cause cancer.

14. OTHER INFORMATION:

This information relates only to the specific material designated, and may not be valid for such material used in combination with any other materials or in any other process. Such information is to the best of the company's knowledge and believed accurate and reliable as of the date indicated. However, no representation, warranty or guarantee of any kind, expressed or implied, is made as to its accuracy, reliability or completeness, and we assume no responsibility for any loss, damage or expense, direct or consequential, arising out of its use. It is the user's responsibility to satisfy himself as to the suitableness and completeness of such information for his own particular use.

APPENDIX C

Extracts from CGSB Standards: Biodiesel, Diesel Fuel

CAN/CGSB-3.517–Automotive Low Sulphur Diesel Fuel Standard

Property	ASTM Method	Type A-LS Limits	Type B-LS Limits	Units
Flash Point	D93	40 min.	40 min.	°C
Kinematic Viscosity,40°C	D445	1.30 – 3.60	1.70 – 4.10	mm^2/sec.
Distillation Temp. 90% Recovered	D86	290.0 max	360.0 max	°C
Water and Sediment	D2709 (or D1796)	0.05 max	0.05 max	% volume
Acid Number	D974	0.10 max	0.10 max	mg KOH/g
Sulphur	D5453 (or CAN /CGSB-3.0 No.16.0)	0.05 max	0.05 max	% mass
Copper Strip	D130	No. 1 max	No. 1 max	
Carbon Residue	D4530 D524	0.10 max 0.15 max	0.16 max 0.20 max	
Ash	D482	0.010 max	0.010 max	% mass
Cetane Number	D613	40.0 min	40.0 min	
Conductivity	D2624	25	25	pS/m

Type A-LS is intended for use in urban transit buses and passenger automobiles or when ambient temperatures require better low temperature properties than Type B-LS.

Type B-LS is intended for use in engines in service involving relatively high loads as those found in industrial and heavy mobile equipment, such as intercity trucks and construction equipment, and when ambient temperatures and storage conditions allow for the use of such fuel.

Low Temperature Flow Properties

Low temperature flow properties of the fuel shall be designed to give satisfactory performance at the temperatures indicated by the 2.5% low-end design temperature data for the month and location of intended use. The following shall be reported: the 2.5% low-end temperature for which the fuel is designed, Cloud Point (ASTM D2500 or D5773).

CAN/CGSB-3.6-2000–Regular Sulphur Diesel Fuel Standard

Property	ASTM Method	Type A Limits	Type B Limits	Units
Flash Point	D93	40 min.	40 min.	°C
Kinematic Viscosity,40˚C	D445	1.30 – 3.60	1.70 – 4.10	mm^2/sec.
Distillation Temp. 90% Recovered	D86	290.0 max	360.0 max	°C
Water and Sediment	D2709 (or D1796)	0.05 max	0.05 max	% volume
Acid Number	D974	0.10 max	0.10 max	mg KOH/g
Sulphur	D5453 (or CAN/CGSB-3.0 No. 16.0)	0.30 max	0.50 max	% mass
Copper Strip	D130	No. 1 max	No. 1 max	
Carbon Residue	D4530 D524	0.10 max 0.15 max	0.16 max 0.20 max	
Ash	D482	0.010 max	0.010 max	% mass
Cetane Number	D613	40.0 min	40.0 min	

Type A—applicable for high-speed engines involving frequent and wide variations in loads and speeds, and also in cases where low temperatures are encountered.

Type B—applicable for high-speed engines involving high loads and uniform speeds, or in engines not requiring fuels having the high volatility or other properties in Type A.

Low Temperature Flow Properties

Low temperature flow properties of the fuel shall be designed to give satisfactory performance at the temperatures indicated by the 2.5% low-end design temperature data for the month and location of intended use. The following shall be reported: the 2.5% low-end temperature for which the fuel is designed, Cloud Point (ASTM D2500 or D5773)

CAN/CGSB-3.520 Biodiesel B1-B5 Standard

This standard is awaiting final approval before going into official publication by CGSB. It is expected to be published in 2005.

The technical detailed requirements for B1-B5 Biodiesel Fuel Blends are the same as the requirements for CAN/CGSB-5.517, the Low Sulphur Diesel Fuel standard, with the added requirement that the biodiesel ester component must comply with ASTM D6751 or EN 14214.

If it is not possible to provide this at the time of the first version, it will be included in the printing of the second version of this document.

To obtain a copy of the B1-B5 standard or any other CGSB standard referred to in this document contact:

CGSB Sales Centre
Gatineau, Quebec Canada K1A 1G6
Phone: 800-665-2472 or 819-956-0425
Fax: 819-956-5644

Web site: www.ongc-cgsb.gc.ca

Online standards store for petroleum and related products:
www.techstreet.com/cgi-bin/browsePublisher?publisher_id=58&subgroup_id=13684

E-mail: ncr.cgsb-ongc@pwgsc.gc.ca

APPENDIX D

Extracts from ASTM (American Society for Testing and Materials) Standards: Biodiesel, Diesel and Heating Oil

ASTM D 6751-Biodiesel Blend Stock Specification (B100)

Property	ASTM Method	Limits	Units
Flash Point	D93	130.0 min.	°C
Water and Sediment	D2709	0.050 max	% vol.
Kinematic Viscosity 40˚C	D445 D874	1.9 - 6.0	mm^2/sec.
Sulfated Ash	D5453	0.020 max.	% mass
Sulfur (S 15 Grade)	D5453	0.0015 max.	ppm
Sulfur (S 500 Grade)	D130	0.05 max.	ppm
Copper Strip Corrosion	D613	No. 3 max.	
Cetane	D2500	47 min.	°C
Cloud Point	D4530*	Report Customer	% mass
Carbon Residue	D664	0.050 max.	mg KOH/gm
Acid Number	D6584	0.80 max.	% mass
Free Glycerin	D6584	0.020 max.	% mass
Total Glycerin	D4951	0.240 max.	% mass
Phosphorus Content		0.001 max.	
Distillation Temperature, Atmospheric Equivalent Temperature, 90% Recovered	D1160	360 max.	°C

*Carbon Residue should be run on a 100% sample

ASTM D975-Diesel Fuel Specification

Property	ASTM Method	Limits	Units
Flash Point	D93	52 min.	°C
Water and Sediment	D2709	0.050 max	% vol.
KinematicViscosity,40C	D445	1.9 - 4.1	$mm^2/sec.$
Ash	D482	0.01 max.	% mass
Sulfur (Grade No.2)	D129	0.50 max.	% mass
Sulfur (Grade No. 2-Low Sulfur)	D2622	0.05 max.	% mass
Copper Strip Corrosion	D130	No. 3 max.	
Cetane	D613	40 min.	°C
Pour Point	D97	----------	°C
Cloud Point or LTFT/CFPP	D2500 D4539/D6371	Depends on location Depends on location	% mass
Density, 15˚C	D1298	----------	kg/m^3
Ramsbottom Carbon Residue	D524	0.35 max.	mg KOH/gm
Cetane Index or Aromaticity	D976 D1319	40 min. 35 max.	 % vol.
Distillation Temperature, 90% Recovered	D86	282-338	°C
Lubricity, HFRR @60˚C	D6079	520 max	microns

There is no requirement for low temperature operability in ASTM D975, only guidance.

ASTM D396-Heating Oil Specification

Property	ASTM Method	Limits	Units
Flash Point	D93	38 min.	°C
Water and Sediment	D2709	0.050 max	% vol.
KinematicViscosity,40˚C	D445	1.9 - 3.4	$mm^2/sec.$
Ash	D482	----------	% mass
Sulfur (Grade No.2)	D129	0.50 max.	% mass
Sulfur (Grade No. 2 Low Sulfur)	D2622	0.05 max.	% mass
Copper Strip Corrosion	D130	No. 3 max.	
Cetane	D613	----------	°C
Pour Point	D97	-6	°C
Cloud Point or LTFT/CFPP	D2500 / D4539/D6371	---------- / ----------	% mass
Density, 15˚C	D1298	876	kg/m^3
Ramsbottom Carbon Residue	D524	0.35 max.	mg KOH/gm
Cetane Index or Aromaticity	D976 / D1319	---------- / ----------	% vol.
Distillation Temperature, 90% Recovered	D86	282-338	°C

To obtain a copy of the ASTM D 6751 standard or any other ASTM standard referred to in this document:

Web site: www.astm.org

E-mail: service@astm.org

Phone: 610-832-9585

APPENDIX E

Environmental & Safety Information[xiv]

Acute Oral Toxicity/Rates—Biodiesel is nontoxic. The acute oral LD 50 (lethal dose) is greater than 17.4 g/Kg body weight. By comparison table salt (NaCl) is nearly 10 times more toxic.

Skin Irritation–Humans—A 24-hour-human-patch test indicated that undiluted biodiesel produced very mild irritation. The irritation was less than the result produced by a 4% soap and water solution.

Aquatic Toxicity—A 96-hour lethal concentration for bluegill of biodiesel grade methyl esters was greater than 1000 mg/L. Lethal concentrations at these levels are generally deemed *insignificant* according to NIOSH (National Institute for Occupational Safety and Health) guidelines in its *Registry of the Toxic Effects of Chemical Substances*.

Biodegradability—Biodiesel degrades about four times faster than petroleum diesel. 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 Number 2 diesel alone.

Flash Point—The flash point of a fuel is defined as the lowest temperature at which the vapor above a combustible liquid can be made to ignite in air. Biodiesel's flash point is over 260° Fahrenheit, well above petroleum based diesel fuel's flash point of around 125° Fahrenheit. Testing has shown the flash point of biodiesel blends increases as the percentage of biodiesel increases. Therefore, biodiesel blends of biodiesel with petroleum diesel are safer to store, handle, and use than conventional diesel fuel.

APPENDIX F

Technical Statement on the Use of Biodiesel Fuel in Compression Ignition Engines[xv]

Introduction

The Engine Manufacturers Association (EMA) is an international membership organization representing the interests of manufacturers of internal combustion engines.

In 1995, EMA published a *Statement on the Use of Biodiesel Fuels for Mobile Applications.* Since that time, increased worldwide interest in reducing reliance on petroleum-based fuels and improving air quality has led many stakeholders, including engine manufacturers, to continue to investigate the use of alternative, renewable fuels, including biodiesel fuels, as a substitute for conventional diesel fuel. In addition, recent government proposals in the United States and Europe have called for incentives or mandates to increase the production and use of such renewable fuels.

This *Statement*, which takes into consideration additional laboratory and field research, conducted since its publication, sets forth EMA's position on the use of biodiesel fuels with current engine technologies. It should be noted, however, that only limited data is available regarding the use of biodiesel with those technologies that have been, or are about to be, introduced to meet the (US) Environmental Protection Agency's (EPA) 2004 heavy-duty on-highway emission standards. Moreover, because of the absence of available data, the *Statement* does not address the potential use of biodiesel fuels with advanced emission control technologies, including after-treatment systems designed for future ultra low emission engines.

Biodiesel

Biodiesel fuels are methyl or ethyl esters derived from a broad variety of renewable sources such as vegetable oil, animal fat and cooking oil. Esters are oxygenated organic compounds that can be used in compression ignition engines because some of their key properties are comparable to those of diesel fuel. *Soy Methyl Ester* diesel (*SME* or SOME), derived from soybean oil, is the most common biodiesel in the United States. *Rape Methyl Ester* diesel (*RME*), derived from rapeseed oil, is the most common biodiesel fuel available in Europe. Collectively, these fuels are sometimes referred to as *Fatty Acid Methyl Esters* (*FAME*). Biodiesel fuels are produced by a process called transesterification, in which various oils (triglycerides) are converted into methyl esters through a

chemical reaction with methanol in the presence of a catalyst, such as sodium or potassium hydroxide. The by-products of this chemical reaction are glycerols and water, both of which are undesirable and need to be removed from the fuel along with traces of the methanol, unreacted triglycerides and catalyst. Biodiesel fuels naturally contain oxygen, which must be stabilized to avoid storage problems. Although biodiesel feedstock does not inherently contain sulfur, sulfur may be present in biodiesel fuel because of contamination during the transesterification process and in storage.

Biodiesel Specifications

Biodiesel is produced in a pure form (100% biodiesel fuel referred to as *B100* or *neat biodiesel*) and may be blended with petroleum-based diesel fuel. Such biodiesel blends are designated as BXX, where XX represents the percentage of pure biodiesel contained in the blend (e.g., *B5*, *B20*).

Recently, several standard-setting organizations worldwide have adopted biodiesel specifications. Specifically, ASTM International recently approved a specification for biodiesel referenced as D6751. In addition, German authorities have issued a provisional specification for FAME under DIN51606. And, Europe's Committee for Standardization (CEN) is in the final stages of setting a technical standard for biofuels to be referred to as EN14214. The European specifications include more stringent limits for viscosity and acid number and water, as well as a test for oxidation stability, which is absent from the current ASTM specification. Depending on the biomass feedstock and the process used to produce the fuel, B100 fuels should meet the requirements of either ASTM D6751 or an approved European specification, such as DIN51606 or EN14214 (once adopted). In addition, it should be noted that the National Biodiesel Board has created the National Biodiesel Accreditation Commission to develop and implement a voluntary program for the accreditation of producers and marketers of biodiesel. The Commission has developed a standard for use in the accreditation process entitled, *BQ-9000, Quality Management System Requirements for the Biodiesel Industry.*.

Biodiesel Blends

Public and private bodies recently have taken positions regarding the use of biodiesel blends. For example, the (United States) *Energy Policy Act of 1992* (EPAct) was amended in 1998 to allow covered fleets to use biodiesel to fulfill up to fifty percent (50%) of their annual alternative fuel vehicle (AFV) acquisition requirements. Under EPAct's Biodiesel Fuel Use Credits provisions, covered fleets are allocated one biodiesel fuel use credit (the equivalent of a full vehicle credit) for each 450 gallons of B100 purchased and consumed. Such credits are awarded only if the blended fuel contains at least twenty percent biodiesel (B20) and is used in new or existing vehicles weighing at least 8500 pounds. No credits are awarded for biodiesel used in a vehicle already counted as an AFV. During

the same time period, however, a consortium of diesel fuel injection equipment manufacturers (*FIE Manufacturers*) issued a position statement concluding that blends greater than B5 can cause reduced product service life and injection equipment failures. According to the *FIE Manufacturers' Position Statement*, even if the B100 used in a blend meets one or more specifications, "the enhanced care and attention required to maintain the fuels in vehicle tanks may make for a high risk of noncompliance to the standard during use." As a result, the FIE Manufacturers disclaim responsibility for any failures attributable to operating their products with fuels for which the products were not designed. Based on current understanding of biodiesel fuels and blending with petroleum based diesel fuel, EMA members expect that blends up to a maximum of B5 should not cause engine or fuel system problems, provided the B100 used in the blend meets the requirements of ASTM D6751, DIN51606, or EN14214. If blends exceeding B5 are desired, vehicle owners and operators should consult their engine manufacturer regarding the implications of using such fuel.

Engine Operation, Performance and Durability

The energy content of neat biodiesel fuel is about eleven percent (11%), eight percent (8%) lower than that of petroleum-based diesel fuel (on a per gallon basis), which results in a power loss in engine operation. The viscosity range of biodiesel fuel, however, is higher than that of petroleum-based diesel fuel (1.9 – 6.0 centistokes versus 1.3 – 5.8 centistokes), which tends to reduce barrel/plunger leakage and thereby slightly improve injector efficiency. The net effect of using B100 is a loss of approximately five to seven percent (5-7%) in maximum power output. The actual percentage power loss will vary depending on the percentage of biodiesel blended in the fuel. Any adjustment to the engine in service to compensate for such power loss may result in a violation of EPA's anti-tampering provisions. To avoid such illegal tampering, as well as potential engine problems that may occur if the engine is later operated with petroleum-based diesel fuel, EMA recommends that users not make such adjustments. Neat biodiesel and higher percentage biodiesel blends can cause a variety of engine performance problems including filter plugging, injector coking, piston ring sticking and breaking, elastomer seal swelling and hardening/cracking, and severe engine lubricant degradation. At low ambient temperatures, biodiesel is thicker than conventional diesel fuel, which would limit its use in certain geographic areas. In addition, elastomer compatibility with biodiesel remains unclear; therefore, when biodiesel fuels are used, the condition of seals, hoses, gaskets, and wire coatings should be monitored regularly. There is limited information on the effect of neat biodiesel and biodiesel blends on engine durability during various environmental conditions. More information is needed to assess the viability of using these fuels over the mileage and operating periods typical of heavy-duty engines. See, *Diesel Fuel Injection Equipment Manufacturers Common Position Statement on Fatty Acid Methyl Ester Fuels as a Replacement or Extender for Diesel Fuels (May 1, 1998).*

Emission Characteristics

In October 2002, U.S. EPA released a draft report entitled, *A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions*. The draft technical report can be found on the EPA Web site at www.epa.gov/otaq/models/biodsl.htm. Use of neat biodiesel and biodiesel blends in place of petroleum-based diesel fuel may reduce visible smoke and particulate emissions, which are of special concern in older diesel engines in non-attainment areas. In addition, B100 and biodiesel blends can achieve some reduction in reactive hydrocarbons (HC) and carbon monoxide (CO) emissions when used in an unmodified diesel engine. Those reductions are attributed to the presence of oxygen in the fuel. Oxygen and other biodiesel characteristics, however, also increase oxides of nitrogen (NOx) in an unmodified engine. As a result, B100 and biodiesel blends produce higher NOx emissions than petroleum-based diesel fuel. As such, EMA does not recommend the use of either B100 or biodiesel blends as a means to improve air quality in ozone non-attainment areas.

Storage and Handling

Biodiesel fuels have shown poor oxidation stability, which can result in long-term storage problems. When biodiesel fuels are used at low ambient temperatures, filters may plug, and the fuel in the tank may thicken to the point where it will not flow sufficiently for proper engine operation. Therefore, it may be prudent to store biodiesel fuel in a heated building or storage tank, as well as heat the fuel systems' fuel lines, filters, and tanks. Additives also may be needed to improve storage conditions and allow for the use of biodiesel fuel in a wider range of ambient temperatures. To demonstrate their stability under normal storage and use conditions, biodiesel fuels, tested using ASTM D6468, should have a minimum of 80% reflectance after aging for 180 minutes at a temperature of 150°C. The test is intended to predict the resistance of fuel to degradation at normal engine operating temperatures and provide an indication of overall fuel stability. Biodiesel fuel is an excellent medium for microbial growth. Inasmuch as water accelerates microbial growth, and is naturally more prevalent in biodiesel fuels than in petroleum-based diesel fuels, care must be taken to remove water from fuel tanks. The effectiveness of using conventional anti-microbial additives in biodiesel is unknown. The presence of microbes may cause operational problems, fuel system corrosion, premature filter plugging, and sediment build-up in fuel systems.

Health & Safety

Pure biodiesel fuels have been tested and found to be nontoxic in animal studies. Emissions from engines using biodiesel fuel have undergone health-effects testing in accordance with EPA Tier II requirements for fuel and fuel additive registration. Tier II test results indicate no biologically significant short-term effects on the animals studied other than minor effects on lung tissue at high

exposure levels. Biodiesel fuels are biodegradable, which may promote their use in applications where biodegradability is desired (e.g., marine or farm applications). Biodiesel is as safe in handling and storage as petroleum-based diesel fuel.

Warranties

Engine manufacturers are legally required to provide an emissions warranty on their products that are certified to EPA's diesel fuel specification and, typically, also provide commercial warranties. Individual engine manufacturers determine what implications, if any, the use of biodiesel fuel has on the manufacturers' commercial warranties. It is unclear what implications the use of biodiesel fuel has on emissions warranty, in-use liability, anti-tampering provisions, and the like. As noted previously, however, more information is needed on the impacts of the long-term use of biodiesel on engine operations.

Economics

The cost of biodiesel fuels varies depending on the basestock, geographic area, variability in crop production from season to season, and other factors. Although the cost may be reduced if relatively inexpensive feedstock, such as waste oils or rendered animal fat, is used instead of soybean, corn or other plant oil, the average cost of biodiesel fuel nevertheless exceeds that of petroleum-based diesel fuel. That said, users considering conversion to an alternative fuel should recognize that the relative cost of converting an existing fleet to biodiesel blends is much lower than the cost of converting to any other alternative fuel because no major engine, vehicle, or dispensing system changes are required.

Conclusions

- Depending on the biomass feedstock and the process used to produce the fuel, B100 fuels should meet the requirements of either ASTM D6751 or an approved European specification.
- Biodiesel blends up to a maximum of B5 should not cause engine or fuel system problems, provided the B100 used in the blend meets the requirements of ASTM D6751, DIN51606, or EN14214. Engine manufacturers should be consulted if higher percentage blends are desired.
- Biodiesel blends may require additives to improve storage stability and allow use in a wide range of temperatures. In addition, the conditions of seals, hoses, gaskets, and wire coatings should be monitored regularly when biodiesel fuels are used.
- Although the actual loss will vary depending on the percentage of biodiesel blended in the fuel, the net effect of using B100 fuel is a loss of approximately five to seven percent (5-7%) in maximum power output.

- Neat biodiesel and biodiesel blends reduce particulate, HC and CO emissions and increase NOx emissions compared with petroleum-based diesel fuel used in an unmodified diesel engine. Neither B100 nor biodiesel blends should be used as a means to improve air quality in ozone non-attainment areas.
- Biodiesel fuels have generally been found to be nontoxic and are biodegradable, which may promote their use in applications where biodegradability is desired.
- Individual engine manufacturers determine what implications, if any, the use of biodiesel fuel has on the manufacturers' commercial warranties.
- Although several factors affect the cost of biodiesel fuel, its average cost exceeds that of petroleum-based diesel fuel. The relative cost of converting an existing fleet to biodiesel blends, however, is much lower than the cost of converting to other alternative fuel.

APPENDIX G

Canadian Environmental Protection Act[xvi]

On-Road Vehicle and Engine Emission Regulations

The purpose of these Regulations is to

a) reduce emissions of hydrocarbons, carbon monoxide, oxides of nitrogen, formaldehyde and particulate matter from on-road vehicles and engines by establishing emission limits for those substances;
b) reduce emissions of the toxic substances 1-3 butadiene, acetaldehyde, acrolein and benzene through the establishment of emission limits for hydrocarbons from on-road vehicles and engines; and
c) establish emission standards and test procedures for on-road vehicles and engines that are aligned with those of the EPA.

Fleet Average NOx Standards

The average NOx value for a company's fleet that is composed of all of its light-duty vehicles and light light-duty trucks of a model year set out in column 1 of the table to this section shall not exceed the applicable fleet average NOx standard set out in column 2.

TABLE: LIGHT-DUTY VEHICLES AND LIGHT LIGHT-DUTY TRUCKS

Item	Column 1 Model Year	Column 2 Fleet Average NOx Standard in grams/mile
1.	2004	0.25
2.	2005	0.19
3.	2006	0.13
4.	2007	0.07
5.	2008	0.07

The average NOx value for a company's fleet that is composed of all of its heavy light-duty trucks and medium-duty passenger vehicles of a model year set out in

column 1 of the table to this section shall not exceed the applicable fleet average NOx standard set out in column 2.

TABLE: HEAVY LIGHT-DUTY TRUCKS AND MEDIUM-DUTY PASSENGER VEHICLES

Item	Column 1 Model Year	Column 2 Fleet Average NOx Standard in grams/mile
1.	2004	0.53
2.	2005	0.43
3.	2006	0.33
4.	2007	0.20
5.	2008	0.14

The average NOx value for a company's fleet that is composed of all of its light-duty vehicles, light-duty trucks and medium-duty passenger vehicles of the 2009 and later model years shall not exceed 0.07 grams per mile.

Calculation of Fleet Average NOx Values

For each of its fleets a company shall calculate the average NOx value in accordance with the following formula:

$[\Sigma (A \times B)]/C$

where

A is the NOx emission standard for each full useful life emission bin;

B is the number of vehicles in the fleet that conform to that NOx emission standard; and

C is the total number of vehicles in the fleet.

(2) The average NOx value for the fleet shall be rounded to the same number of significant figures that are contained in the total number of vehicles in the fleet in the denominator in subsection (1), but to at least three decimal places.

(3) If a company's fleet includes any hybrid electric vehicle that is covered by an EPA certificate, the average NOx value calculated under subsection (1) may be lowered by applying one or more hybrid electric vehicle NOx contribution factors as long as

a) each factor has been approved by the EPA in accordance with the provisions of the CFR;
b) each factor is applied in the same manner as it is applied by the EPA; and
c) evidence of the EPA approval is provided to the Minister in the end of model year report referred to in section 32.

(4) Subject to subsection (5), in respect of any of its vehicles that conform to a NOx emission standard for an extended useful life of 15 years or 240,000 km (150,000 miles), a company may, in the equation in subsection (1), replace that standard, for each of those vehicles, with that standard multiplied by 0.85, rounded to at least three decimal places.

(5) A company may only replace a NOx emission standard as described in subsection (4) if the vehicle complies with any standards that may be applicable at the intermediate useful life.

(6) In respect of the 2004 and 2005 model years, a company may multiply by 2 the number of vehicles that conform to full useful life emission bin 1, and multiply by 1.5 the number of vehicles that conform to full useful life emission bin 2, when calculating one of the following:

(*a*) the denominator in subsection (1); or
(*b*) *total number of vehicles in the fleet* in the equation for calculating credits in subsection 26(2).

(7) When calculating the average NOx value under subsection (1) for a fleet of the 2004 model year, a company may include all vehicles of that model year, including those manufactured before January 1, 2004.

A company may elect not to calculate an average NOx value for a fleet of a specific model year if every vehicle in that fleet conforms to a full useful life emission bin that has a NOx standard equal to, or less than, the applicable fleet average NOx standard for that model year that is set out in section 21, 22 or 23.

(2) For the purposes of section 26 and paragraphs 32(2)(*b*) and 37(1)(*c*), the average NOx emission value in respect of a fleet in a model year when a company makes an election under subsection (1) shall be deemed to be the fleet average NOx standard applicable to the fleet for which the election was made.

NOx Emission Credits

For the purposes of subparagraph 162(1)(*b*)(i) of the Act, a company shall obtain NOx emission credits if the average NOx value in respect of a fleet of a specific model year is lower than the fleet average NOx standard for that model year and the company reports the credits under paragraph 32(2)(*e*).

(2) NOx emission credits, expressed in units of vehicle-grams per mile, shall be calculated using the following formula, rounding the result to the nearest whole number:

(A - B) x C

where

A is the fleet average NOx standard;

B is the average NOx value in respect of the fleet, and

C is the total number of vehicles in the fleet.

(3) The NOx emission credits for a specific model year are credited on the last day of that model year.

NOx emission credits obtained in a specific model year shall be used by the company to offset any outstanding NOx emission deficit described in section 28, and any remaining credits may be used to offset a future deficit or may be transferred to another company.

NOx Emission Deficits

Subject to subsection 31(2), if a company's average NOx value in respect of a fleet of a specific model year is higher than the fleet average NOx standard for that model year, the company shall calculate the negative number that is the value of a NOx emission deficit incurred in that model year using the formula set out in subsection 26(2).

(1) A company shall offset a NOx emission deficit no later than the date on which the company submits the end of model year report under section 32 for the third model year after the model year in which the deficit was incurred.

(2) Subject to subsection (3), a company may offset a NOx emission deficit with an equivalent number of NOx emission credits obtained in accordance with section 26 or obtained from another company.

(3) If any part of a NOx emission deficit for a specific model year is outstanding following the submission of the end of model year report for the second model year after the model year in which the deficit was incurred, the number of NOx emission credits required to offset that outstanding deficit in the next model year is 120% of the deficit.

(1) A company that purchases another company or that results from the merger of companies is responsible for offsetting, in accordance with section 29, any outstanding NOx emission deficits of the purchased or merged companies.

Fleet Average NOx Records

(1) A company shall maintain records containing the following information for each of its fleets described in sections 21 to 23:

(*a*) the model year;
(*b*) the applicable fleet average NOx standard;
(*c*) the average NOx value achieved under section 24 or 25; and
(*d*) all values used in calculating the average NOx value achieved.

The *On-Road Vehicle and Engine Emission Regulations* (hereinafter referred to as *the Regulations*) introduce more stringent national emission standards for on-road vehicles and engines and a new regulatory framework under the *Canadian Environmental Protection Act, 1999* (CEPA 1999). The Regulations will come into effect on January 1, 2004, with the exception that provisions addressing the authorization to use the national emissions mark come into force on the date of registration of the Regulations.

Fleet Average NOx Emission Standards

The Regulations establish fleet average NOx emission standards for the 2004 and later model years. The objective of the fleet averaging provisions is to create a regulatory framework that will achieve a Canadian vehicle fleet emission performance comparable with the U.S.

When the standards are fully phased in (i.e., in 2009), a company's combined fleet of light-duty vehicles, light-duty trucks and medium-duty passenger vehicles will be subject to a single fleet average NOx emission standard of 0.07 g/mile, corresponding to the NOx standard in bin 5. A company can, in any model year, generate NOx emission credits by achieving a fleet average NOx value that is lower than the standard. These credits can be used in a subsequent model year to offset a NOx emissions deficit (the fleet average NOx value exceeds the standard). A deficit must be offset no later than the third model year following the year in which it is incurred. NOx emission credits may also be transferred to another company. There are provisions identical with the United States, to promote the early introduction of cleaner vehicles or more durable emission

control systems. Additional NOx emission credits can be earned by, for example, certifying vehicles to bins 1 or 2 during the model years 2004 through 2005 or by certifying vehicles to an extended useful life of 15 years/ 240 000 km.

During the phase-in period leading up to the final fleet average NOx standard in the 2009 model year, the Regulations specify:

(a) for light-duty vehicles and light light-duty trucks, a progressively tightening fleet average NOx standard based on the U.S. phase-in for model years 2004 to 2006 culminating in 2007 in the final fleet average standard specified above for 2009 (i.e., 0.07 g/mile); and

(b) for heavy light-duty trucks and medium-duty passenger vehicles, a progressively tightening fleet average NOx standard based on the U.S. phase-in for model years 2004 to 2008 culminating in the final fleet average standard in 2009 (i.e., 0.07 g/mile).

_____

To view the Canadian Environmental Protection Act, 1999 On-Road Vehicle and Engine Emissions Regulations information online visit:

http://canadagazette.gc.ca/partII/2003/20030101/html/sor2-e.html

APPENDIX H

BQ-9000 Accreditation Program

The BQ-9000 Accreditation Program is a cooperative and voluntary program for the accreditation of producers and marketers of biodiesel fuel. The National Biodiesel Accreditation Commission (NBAC or the Commission) is an autonomous committee that functions independently in all matters directly relating to the Program and administers this Program. Accreditation under the Program is open to all companies actively producing, distributing or marketing, or planning to produce, distribute or market, biodiesel fuel either in its pure form or for use in blending with a petroleum diesel fuel (or similar fuel).

The Program was developed by an objective industry task force that included representation from biodiesel producers, biodiesel distributors, biodiesel marketers, petrodiesel refiners, marketers and distributors, diesel fuel users, and the National Biodiesel Board. Accreditation is awarded following a successful formal review and audit of the capacity and commitment of the applicant to produce or market biodiesel fuel that meets the ASTM D6751 Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels. The accreditation process is comprehensive and includes a detailed review of the applicant's Quality Program documentation, followed by a formal audit of the applicant's conformance to its Program.

This quality assurance program is complimentary to the technical requirements in ASTM D6751. The program requirements determine what elements quality system have to encompass but it is not the purpose of these requirements to enforce uniformity of quality systems. These requirements are generic and independent of any specific organization.

Accreditation is available to two groups within the biodiesel industry: Producers and Marketers (producers being business units that commercially produce biodiesel and marketers being business units that undertake to commercially sell or resell biodiesel or biodiesel blends). A biodiesel producer that successfully meets the accreditation criteria is awarded the status of **Accredited Producer**. A biodiesel marketer that successfully meets the accreditation criteria is awarded the status of **Certified Marketer**.

There is no such thing as "BQ-9000 Biodiesel". BQ-9000 does, however, help insure that biodiesel produced and sold will meet D6751. There is no logo for an accredited producer, however, there is a logo for the certified marketer.

The objective of the Program is to promote the commercial success and public acceptance of biodiesel by recognizing biodiesel producers and marketers who demonstrate compliance with acceptable quality standards. The Program is designed to help assure that biodiesel fuel is produced to and maintained at the industry standard, ASTM D6751.

The Program is designed to avoid redundant testing throughout the production and distribution system. It allows parties to leverage other accredited organizations' quality assurance efforts in a systematic manner, which in turn reduces coordination efforts. It provides a mechanism to track biodiesel in the distribution system, identify biodiesel which meets industry standard, and it provides a means to reduce the probability of product reaching the marketplace which does not meet standards.

The accredited producer process requirements focus:

- Sampling
- Testing
- Storage
- Retain Samples
- Shipping

The accredited marketer process requirements focus:

- Sampling
- Testing
- Storage
- Retain Samples
- Blending
- Shipping

The Biodiesel Association of Canada's Board of Directors adopted the BQ-9000 program to support the NBB and NBAC's efforts and to ensure an accreditation program in Canada is consistent with the US.

The Program has many benefits:

- ✓ Implements the North American accepted standard, ASTM D6751
- ✓ Saves biodiesel producers and marketers time and money by minimizing problems with "out of specification" fuel
- ✓ Saves marketer and users money by taking advantage of the producer quality assurances
- ✓ Provides the biodiesel users (individuals, companies, fleets, government agencies, etc.) with a feeling of confidence

- ✓ Provides the engine and vehicle companies with a feeling of confidence which is critical in the developing stages of this new and exciting industry.

In the US, the first BQ-9000 accredited producer was Peter Cremer North America. Because of this, DaimlerChrysler chose Peter Cremer to supply their fuel for the B5 factory fill of the Jeep Liberty. Many other producers as well as marketers are expected to become accredited as the Program gains momentum, in the US and Canada.

In Canada, the British Columbia Petroleum Products Buying Group (BCPPBG) cited BQ-9000 in their Request for Proposal in March 2005. This trend is expected to continue in Canada as users recognize the importance of the Program.

To obtain complete information about the BQ-9000 Program contact the BAC, NBB or visit: www.bq-9000.org

APPENDIX I

ACRONYMS

ASTM …… American Society for Testing and Materials
B100 ……100 % biodiesel
B20 …….. 20% biodiesel, 80% petroleum diesel
B5 …….. 5% biodiesel, 95% petroleum diesel
B2 …… 2% biodiesel, 98% petroleum diesel
BAC …….. Biodiesel Association of Canada
BOL …….. Bill of Lading
BTU …… British Thermal Unit
C of A …….. Certificate of Analysis
CEPA …….. Canadian Environmental Protection Act
CFPP …… Cold Filter Plugging Point
CRF …….. Code of the Federal Regulations of the U.S.
CGSB …… Canadian General Standards Board
CO …… Carbon Monoxide
CO_2 …… Carbon Dioxide
DOC …….. Diesel Oxidation Catalyst
DOE …… U.S. Department of Energy
EMA …….. Engine Manufacturers Association
EPA ……U.S. Environmental Protection Agency
FAME …….. Fatty Acid Methyl Ester
GPM …… Gallons Per Minute
HC …….. Hydrocarbon
LTFT …… Low Temperature Flow Test
LDS …….. Low Sulphur Diesel
LPM …… Litres Per Minute
MSDS …… Material Safety Data Sheet
NBAC …….. National Biodiesel Accreditation Commission
N2O …… Nitrous Oxide
NOx …… Oxides of Nitrogen
NBB …….. National Biodiesel Board
NRCan …… Natural Resources Canada
NREL …… National Renewable Energy Laboratory
OEM …… Original Equipment Manufacturer
PM …… Particulate Matter
ppm …… parts per million
TMC …….. Technology Maintenance Council
ULSD …….. Ultra Low Sulphur Diesel
USDA …… United States Department of Agriculture
VOC …….. Volatile Organic Compound

Endnotes

[i] Tyson, Shaine, Department of Energy/NREL. 2004 Biodiesel Handling and Use Guidelines, DOE/GOV – 102004 – 1999 – September 2004 (www.osti.gov/bridge)
[ii] A Biodiesel and Liquid Fuels Guide for Petroleum Organizations, 2005, USDA 3161
[iii] Tyson, Shaine, Department of Energy/NREL. 2004 Biodiesel Handling and Use Guidelines, DOE/GOV – 102004 – 1999 – September 2004 (www.osti.gov/bridge)
[iv] Tyson, Shaine, Department of Energy/NREL. 2004 Biodiesel Handling and Use Guidelines, DOE/GOV – 102004 – 1999 – September 2004 (www.osti.gov/bridge)
[v] A Biodiesel and Liquid Fuels Guide for Petroleum Organizations, 2005, USDA 3161
[vi] A Biodiesel and Liquid Fuels Guide for Petroleum Organizations, 2005, USDA 3161
[vii] A Biodiesel and Liquid Fuels Guide for Petroleum Organizations, 2005, USDA 3161
[viii] Tyson, Shaine, Department of Energy/NREL. 2004 Biodiesel Handling and Use Guidelines, DOE/GOV – 102004 – 1999 – September 2004 (www.osti.gov/bridge)
[ix] Tyson, Shaine, Department of Energy/NREL. 2004 Biodiesel Handling and Use Guidelines, DOE/GOV – 102004 – 1999 – September 2004 (www.osti.gov/bridge)
[x] A Biodiesel and Liquid Fuels Guide for Petroleum Organizations, 2005, USDA 3161

[xi] A Biodiesel and Liquid Fuels Guide for Petroleum Organizations, 2005, USDA 3161

[xii] Receipt, Storage and Handling Guidelines for Neat Blend Stock, 2004, Project MBC-02
[xiii] National Biodiesel Board Environment and Safety Information Sheet (http://www.nbb.org/pdf_files/Environment_Safety.pdf)
[xiv] National Biodiesel Board Environment and Safety Information Sheet (http://www.nbb.org/pdf_files/Environment_Safety.pdf)
[xv] A Biodiesel and Liquid Fuels Guide for Petroleum Organizations, 2005, USDA 3161
[xvi] Canada Gazette, Registration SOR/2003-2 12 December, 2002