Task 12: Assessing the Feasibility of Utilizing Recycled Vegetable Oil as Vehicle Fuel

Report – Used Vegetable Oil Reuse: Opportunities and Recommendations

Prepared for: **Broward County Aviation Department**

Fort Lauderdale, Florida

October 2006

Task 12: Assessing the Feasibility of Utilizing Recycled Vegetable Oil as Vehicle Fuel

Prepared for

Broward County Aviation Department
Ft. Lauderdale, Florida

Prepared by

Clean Airport Partnership, Inc.
Westhorp & Associates, Inc.

October 2006

Final Report

ACKNOWLEDGEMENTS

Westhorp & Associates, Inc. would like to thank Mark Howards for all his valuable knowledge and assistance on this project. Mr. Howards was extremely helpful in providing insight and information on the fast growing alternative fuel industry.

We would also like to thank Ray Holan for reviewing the final draft of our report and providing comments.

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ACRONYMS

ADPD – Airport Development Plan Definition

ANAC – Airport Noise Abatement Committee

ANOMS – Airport Noise and Operation Monitoring System

APU – Auxiliary Power Unit

ASCE – Annual Comprehensive Site Evaluation

AST – Above Ground Storage Tank

ATCT – Air Traffic Control Tower

BCAD – Broward County Aviation Department

BCC – Broward County Board of County Commissioners

BOD – Biological Oxygen Demand

BTU – British Thermal Units

CAP – Clean Airport Partnership, Inc.

CO – Carbon Monoxide

CO_2 – Carbon Dioxide

COD – Chemical Oxygen Demand

CWA – Clean Water Act

CUP – Consumptive Use Permit

dB(A) – "A" weighted Decibel

DEA – Draft Environmental Assessment

DEIS – Draft Environmental Impact Statement

DOE – Department of Energy

DOT – US Department of Transportation

EPA – US Environmental Protection Agency

EDMS – Emissions and Dispersion Modeling System

FAA – US Federal Aviation Administration

FAR – Federal Aviation Regulations

FBO – Fixed Base Operator

FDEP – Florida Department of Environmental Protection

FDOT – Florida Department of Transportation

FLL – Ft. Lauderdale-Hollywood International Airport

FLLS – Ft. Lauderdale South

FLLS2 – Ft. Lauderdale South – facility 2

GCTL – Groundwater Cleanup Target Levels

GSE – Ground Support Equipment

GSLD – General Service Large Demand

HID – High Intensity Discharge

IM – Impact Metric

INM – Integrated Noise Model

LTO – Landing and Take Off

KWH – Kilowatt Hour

Ldn – Day/Night Average Sound Level

MS4 – Municipal Separate Storm Sewer System

MSGP – Multi-Sector Group Permit

MSW – Municipal Solid Waste

NADC – Natural Attenuation Default Criteria

NADP – Noise Abatement Departure Profile

NEPA – National Environmental Policy Act

NO_x – Nitrogen Oxides

NPDES – National Pollution Discharge Elimination System

OES – Broward County Office of Environmental Services

PAC – Pre-Approved Advance Cleanup

PCPP – Petroleum Cleanup Participation Program

RCC – Rental Car Center

RMT – Remote Monitoring Terminals

SFWMD – South Florida Water Management District

SO_x – Sulfur Oxides

SPCC – Spill Prevention Control and Countermeasure

SVO – Straight Vegetable Oil

SWPPP – Storm Water Pollution Prevention Plan

TMDL – Total Maximum Daily Load

TOU – Time of Use

TSA – Transportation Security Administration

TSS – Total Suspended Solids

UST – Underground Storage Tank

VFD – Variable Frequency Drive

VOC – Volatile Organic Compounds

1. Executive Summary / Project Overview

1.1. Introduction

Rising fuel prices are encouraging the public to look for cheaper fuel sources such as using recycled vegetable oil. This feasibility report provides detailed information on using processed cooking oil from airport concessions to fuel one or more diesel vehicle at FLL. The quantities of available used oil are identified along with an analysis of BCAD vehicles that are best suited for utilizing the recycled oil, information on vehicle conversion, and associated costs.

1.2. Purpose

FLL is seeking innovative methods for improving energy efficiency and environmental quality associated with airport operations. FLL's tenants include a variety of food concessionaires that generate used vegetable oil in food preparation, which must then be disposed of through waste collection services. Through the centralized collection and treatment of used vegetable oil it can be used to power airport vehicles, reducing both air pollution and the fuel costs associated with their operation.

1.2. Scope

The project team conducted the following steps:

- Identified the quantity and quality of used vegetable oil currently being generated by airport concessionaires. This included an assessment of how this waste is currently collected, disposal costs; and whether these agreements between concessionaires and waste collection companies can be adjusted to enable collection and centralized storage by an entity that would be responsible for treating this product for reuse as a vehicle fuel.

- The costs and process associated with treating this product as a vehicle fuel, and standards that exist for regulating the quality of the fuel product, air emissions, and engine performance.

- Fuel use and storage requirements and any health or safety issues that may exist.

- Those vehicles in FLL's current diesel fleet that would be best candidates for conversion to this fuel. Factors assessed were: air quality benefits compared to diesel fuel, ability to be centrally fueled, required fuel quantity versus projected supplies, and vehicle warranties.

- Additional reliability, cost, mechanic expertise, and safety issues associated with vehicle maintenance and storage including the treatment of accidental fuel spills.

- The projected total cost of the project compared to the fuel savings benefits. Costs include: oil collection, refinement, storage, vehicle retrofit, and any additional costs associated with operation and maintenance.

2. Recycled Vegetable Oil as a Vehicle Fuel

2.1. Introduction

Food concessionaires at FLL are currently paying for their used vegetable oil to be hauled offsite by a rendering company that transforms it into material for pet food, soaps, and cosmetics. Rising fuel prices however are encouraging the public to look for cheaper fuel sources such as using recycled vegetable oil. The concept of using vegetable oil as a fuel dates back to 1895 when Dr. Rudolf Diesel developed the first diesel engine to run on vegetable oil by using peanut oil[1].

Atmospheric greenhouse gases include carbon dioxide and are increasing largely due to the increase in fossil fuel combustion. Vegetable oil is renewable; it is not a fossil fuel so it does not contribute to global warming. Because the carbon dioxide produced by burning vegetable oil is the same or less than the amount absorbed by the plants from which the oil is obtained, vehicles running on vegetable oil produce no net increase in atmospheric carbon dioxide. Also, vegetable oil is indefinitely renewable.

[1] http://www.wnbiodiesel.com/technology.html

Straight vegetable oil (SVO) is not the same as 100 percent biodiesel (B100) which can be used in any stock engine. In order for SVO to be used in a diesel engine, a two-tank system was evaluated which will run approximately 90 percent of the time on vegetable oil, and requires the use of diesel at startup and shutdown. Diesel is required at startup since the vegetable oil needs to be warmed to a specific temperature (approximately 160°F) in order for it to have a similar viscosity as diesel. At shutdown, the fuel system is automatically purged of vegetable oil and refilled with diesel so that the engine can be started on diesel the next time. Figure A-1 in Appendix A depicts the two-tank fuel system.

2.2. Quality and Quantity of Used Vegetable Oil at FLL

FLL's terminal area consists of four separate sections. Each terminal houses several food concessionaires, consisting of fast food establishments, sit down restaurants, and a variety of franchises, many of which use vegetable oil in their daily business. The collection system is centralized and consists of various size vats (approximately 150 gallons each) that are placed just outside the terminal buildings. There is one vat each at Terminals 2 and 4, and two vats each at Terminals 1 and 3. These vats are owned by Tallowmasters, Inc. (Tallowmasters), a rendering company who empties them on an as-needed basis (approximately once a month when notified) at a cost of $100 per pickup. In 2005, Tallowmasters collected approximately 8,000 gallons of used vegetable oil from FLL.[2] Assuming a monthly collection, this works out to about $0.15 per gallon for disposal.

The best oil to use as SVO would be a virgin oil. The quality of the used oil is difficult to determine since many different restaurants dispose of their used vegetable oil in the same vats. Thus, there is most likely a mixture of hydrogenated and non-hydrogenated oils. Based on visual observations during our site visit, if we assume that 20 percent of the product is of poor quality, that would still leave 80 percent or about 6,400 gallons available for use as a fuel, as shown in Figure A-2 in Appendix A. If the vehicle conversion should move forward, further segregation of used oil based on the quality will be explored to optimize the quality of the fuel. Poor quality oil requires more

[2] Personal telephone conversation with Mr. Tom Letcher of Tallowmasters on August 23, 2006.

filtering, may be unpleasant to handle due to objectionable odors, and can cause carbon deposits to form on the engine. This poor quality oil may be better handled through conventional disposal or through rendering companies as is the current practice.

2.3. Storage, Used Oil Processing, and Associated Costs

Because used vegetable oil is treated as a food waste, storage requirements are minimal. The same system could be used for vegetable oil fuel storage that is being used today for disposal. There are no health and safety issues; however, any spilled product should be cleaned up with an absorbent material and disposed of at a licensed solid waste facility as with any other food waste. Poor quality, extremely dirty and/or old vegetable oil can be unpleasant for the workers handling the material.

According to Mr. Jim Caldwell of the EPA[3], cooking oil is not subject to fuel registration requirements at the federal level. Alternative fuels are allowed by Florida law for use in vehicles as stated in the Florida statutes (Title XIV, Chapter 206, Part II Diesel Fuels). It is regulated by the Department of Agriculture and Consumer Services, Bureau of Petroleum Inspection[4]. If this vegetable oil was to be distributed or sold to the public, then quality control standards in accordance with the ASTM D6751-06a Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels would apply. However, as an alternative fuel for use within the FLL property, these standards do not apply. Nevertheless, in order to use this alternative fuel in a vehicle at FLL, an Alternative Fuel Use Permit must be obtained through the Florida Department of Revenue annually (permit application form included in Appendix A). The cost of this permit is between $200 and $300 annually, depending on the type of vehicle used.

The collection containers can either be pumped out or exchanged every one to two weeks to maintain freshness and to avoid having to handle oil that

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[3] Personal communication with Mr. Jim Caldwell of the EPA on October 23, 2006, Telephone Number (202) 343-9303

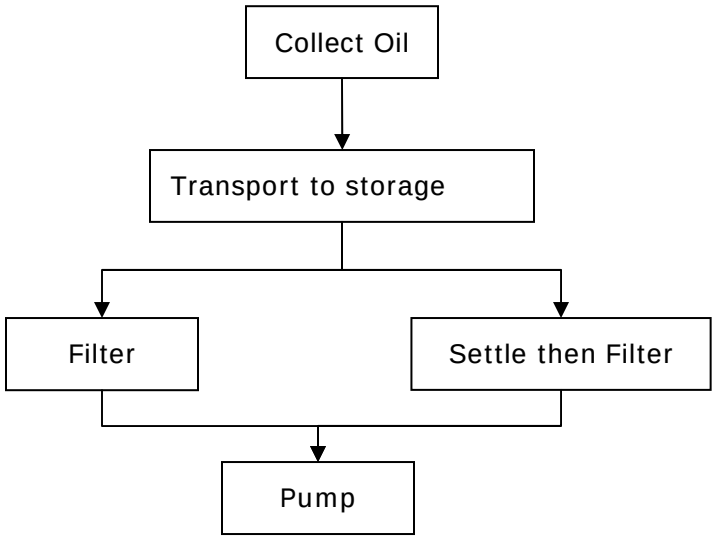
[4] Personal telephone conversations with Ms. Nancy Fischer of the Department of Agriculture and Consumer Services, Bureau of Petroleum Inspection on October 4, 2006.

may have become rancid. The oil can either be pumped out from the collection containers into drums for transportation to the designated filtering area, or the used oil containers picked up and replaced with empty ones. The disadvantage to a collection container exchange program is that equipment is required to lift and move the filled drums on and off the collection vehicle. Upon collection of the oil, it must be filtered preferably at a temperature above 70°F as the oil is less viscous at these temperatures and therefore easier to handle. An alternative to filtering the used oil immediately upon collection is to allow the oil to settle naturally for a few days prior to pumping and filtering. Natural settling will allow most of the debris and water to settle to the bottom of the container, and the remaining cleaner oil can then be pumped out from the upper portion of the container. Upon pumping, the oil will then be filtered. By allowing the oil to settle in this manner, the life of the filters can be maximized.

The most convenient approach for FLL is for the oil to be stored in a drum(s) at a fixed location (a central fueling area, preferably the same area where the filtering will take place). The oil can then be either pumped directly into the vehicle or into a storage container through the use of a metered electric powered pump. Figure A-3 in Appendix A shows a typical stationary filtration and pumping kit.

A schematic of the entire process is shown below.

Figure 1: Schematic of Used Oil Processing



The costs for all the materials and components to convert any type of diesel vehicle are approximately $2,500 with the components typically sold in packaged kits. Labor for installation can take 2-3 days and cost from $2,500 to $3,000 dollars. Ongoing costs for oil collection are approximately $20 per week[5] and include filters and disposal of undesirable material which may be disposed of in any Class I disposal facility (a disposal facility that is permitted to accept all types of solid, non-hazardous wastes from households, commercial businesses and industry.) The ongoing costs include approximately four hours of labor per week for collection and filtering. Approximately $2,800 should be budgeted for the one-time purchase of filtering equipment, drums, pumping equipment, and spill containment. The total projects costs are included in Section 2.4.2.

2.4. Analysis of Candidate Vehicles – Fuel Requirements, Emissions Quality, Maintenance

An evaluation of BCAD's current diesel fleet identified the possibility of two different vehicles for conversion to a two-tank SVO system at FLL: a dump truck and a scrubber (see Table A-1 in Appendix A for a complete list of vehicles considered.) Since the scrubbers are used on a daily basis, they would most likely be the better choice, since they would enable more extensive use of the SVO fuel. The dump trucks are used less frequently and may be retired soon.

Based on the estimated fuel use of 1,600 gallons per year for one scrubber at FLL (see Table A-1), and an estimated used oil quantity of 8,000 gallons per year at FLL, there will be more than enough fuel for conversion of at least two scrubbers in the BCAD fleet. If the oil is segregated based on quality, and some of the oil is not acceptable, there will still be an ample supply to run one or two scrubbers, as shown on Figure1. Neither scrubber is under warranty so there will not be any warranty issues.

Information compiled from the U.S. DOE comparing the amount of energy from different types of fuel shows that diesel yields approximately 129,000

[5] Pricing obtained from www.greasecar.com

btu per gallon of fuel, while SVO yields 112,000 btu per gallon.[6] The btu rating is a measure of how much energy is stored in each fuel. This shows that SVO achieves 10-15% less mileage per gallon than diesel

There is little information available on the difference in air emissions from off-road vehicles using SVO. Data collected from limited research has shown that emissions of nitrogen oxides (NO_x), carbon monoxide (CO), and carbon dioxide (CO_2) from vehicles running on primarily SVO are slightly less when compared to diesel only vehicles.[7] However, there are de minimis sulfur emissions. Perhaps the most positive environmental aspect of SVO is the fact that it is carbon neutral, meaning that the amount of carbon dioxide released is equal to the amount absorbed by the plants from which the oil is obtained.

Emissions data[7] is presented in table A-2 in Appendix A from nine different light duty vehicles that were tested when they were run on diesel fuel versus virgin canola oil. Hydrocarbons, carbon monoxide, carbon dioxide, nitrogen oxides, and particulates were tested. Though none of these vehicles are identical to FLL's scrubber, one can still see the carbon monoxide and carbon dioxide emissions from diesel are comparable to engines run on SVO. There is no data available comparing heavy-duty diesel vehicles operating on diesel versus SVO.

2.4.1 Additional Reliability, Cost, Mechanic Expertise, Safety Issues, and Potential Drawbacks

Once converted, there are no significant differences in maintenance costs except for additional fuel filters for the vegetable oil portion of the fuel system. These filters will need to be replaced approximately every 3,000 miles and cost about $25 per filter. The replacement interval will depend on the quality of the oil and how well it is filtered. Better quality oil will extend the time between changes to greater than 5,000 miles.

The lubricating oil should also be changed more frequently, as stretching the time between oil changes increases the risks that the vegetable oil will break down the lubricating oil, potentially causing major problems. This is referred

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[6] www.eere.energy.gov/afdc

[7] *Sliding Home: A Complete Guide to Driving Your Diesel on Straight Vegetable Oil,* Ray Holan, 2006.

to as polymerization of the lubricating oil. The recommended oil change interval may be a normal maintenance interval for the vehicle chosen, so this will not necessarily be an additional expense.

To prevent the formation of residue on the fuel injectors (the valve that supplies the fuel to the engine) the injectors should be checked for potential carbon deposits. Operation and maintenance instructions should be provided to the maintenance facility by the conversion vendor. This should include schematics of the system as well as description of how the system works. By design, two-tank systems isolate the diesel and vegetable oil sides of the system. If the switching valves are in their off positions, the vehicle operates in diesel mode and the vegetable oil system will be inactive.

For housekeeping purposes, drums may be placed on a spill containment pallet; however, this is not required by law. Pallets that hold four drums are less than $350. Two or three of these units may be required. It is also suggested that several bags of loose absorbent be kept wherever the oil is stored and pumped from. A bag that can absorb eight gallons of oil is less than $15. It is important to note that vegetable oil is not considered a hazardous material so spill health and safety issues associated with handling this product are not applicable.

Some published engineering literature indicate that the use of SVO may lead to reduced engine life caused by the buildup of carbon deposits inside the engine, as well as negative impacts of SVO on the engine lubricant. It was also stated that diesel engines using vegetable oils offer acceptable engine performance and emissions for short-term operation; however, long-term operation may result in operational and durability problems.[6] To minimize this risk, maintenance personnel should monitor long-term vehicle operation to ensure peak performance.

In regard to the use of SVO, EPA's position is that converting a certified vehicle to operate on a fuel other than the fuel the manufacturer used to obtain certification is considered tampering and is illegal under the provisions of the Clean Air Act (as amended 1990).[8]

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[8] Written e-mail message to Jim Norman, staff editor of the Business Day Section of the *New York Times*, from Dave Ryan, a spokesperson for the EPA, on June 16, 2006 (see Appendix B).

WA spoke with Marty Reineman of the EPA regarding this issue. According to Mr. Reineman[9], the EPA considers it illegal to do anything to an engine that would result in increased emissions. Therefore, emissions testing would have to be done on any engine that had been modified to use a different fuel other than what the manufacturer had intended[10]. This could cost tens of thousands of dollars.

2.4.2 Cost vs. Benefit Analysis

Analyzing the fuel requirements of one scrubber, and based on the current cost of diesel in south Florida (October 2006) at $2.75 per gallon, we can use the following formula to calculate the fuel costs:

Annual Required fuel x Cost per gallon of fuel = Annual Fuel Cost

Diesel Only

1,600 gallons x $2.75 per gallon = **$13,278 per year for diesel fuel**

SVO + Diesel

After conversion of one scrubber, assuming that 10 percent of the total fuel consumption will be diesel at a cost of $2.75 per gallon, and a cost of $0.75 per gallon of vegetable oil, we get:

160 gallons of diesel x $2.75 per gallon = $440

Total fuel cost per year: **$440 per year using a SVO system**

Annual operating costs would include:

- Maintenance of the filtering and pumping equipment,

  $20 per week x 52 weeks per year = $1,040

- Labor costs for the handling of the SVO, assume $20 per hour and benefits at 50% of salary.

  $20 per hour x 4 hours per week x 52 weeks per year = $4,160

  Employee benefits at 50% of salary = $2,080

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[9] Personal communication on October 23, 2006 with Marty Reineman of EPA, Telephone Number (734) 214-4430.

[10] Personal communication with Mr. Greg Orehowsky, EPA Certification Specialist, on October 23, 2006, Telephone Number (202) 343-9292

Total annual labor costs of $4,160 + $2,080 = $6,240

Table 1 summarizes the capital costs (as mentioned in Section 2.3) and the annual operating costs that would be required when using vegetable oil.

Table 1: Approximate Cost of Vegetable Oil Conversion for One Scrubber

	Costs	
Description	**Capital**	**Annual Operating**
Fuel	N/A	$ 440
Filtering and Pumping Equipment	$2,800	1,040
Conversion Kit	2,500	N/A
Storage Pallets (2)	700	N/A
Labor	2,500	6,240
Disposal	N/A	(240)
Alternative Fuel Permit	250	250
Total Costs	**$8,750**	**$7,730**

Based on the capital costs for implementation of this conversion, the pay-back period for the conversion of one scrubber is approximately one and a half years. After this time, the vegetable oil will provide an ongoing return on the initial investment by saving approximately $5,000 per year. Once the implementation phase is over, the annual operating costs for SVO are 40% less than the fuel costs when using diesel fuel. Public education and awareness would be an additional benefit through the placement of signs at the participating concessionaires.

2.5. Summary of Findings

As fuel prices continue to rise, other renewable sources of fuel such as used vegetable oil will become more feasible alternatives. Reusing the used cooking oil at FLL would increase the use of renewable fuel. The available quantity of used cooking oil at FLL is sufficient to fuel one or more diesel vehicles. There are virtually no special safety or storage requirements for this material, and the cost savings will accrue over the longer life of the vehicle.

The benefits of using SVO as a vehicle fuel are that it is cost effective and there may be environmental benefits such as:

- Minimal sulfur emissions
- Carbon neutral fuel
- Renewable resource

However, a major drawback to using SVO as a fuel for on-road vehicles is that the engine for the scrubber would need to be EPA certified. This is a time consuming and expensive process. Modifying fuel use without this certification is considered tampering and illegal, although EPA is not currently enforcing these violations because of the relatively small number of SVO users. EPA also indicated that the Clean Air Act does **not** address the issue of tampering for off-road vehicles. They consider this a "gray area" for which application is "neither legal or illegal".[11]

Therefore, if FLL chooses to utilize vegetable oil as a vehicle fuel, this application should be limited to off-road vehicles such as tractors. CAP recommends, however, that implementation of the program be delayed pending regulatory clarification from EPA, which is expected by mid-2007.

[11] Conversation between Mr. Steven Howards and Mr. Terry Newell, US EPA, on October 25, 2006

BIBLIOGRAPHY

Caldwell, Jim, EPA, communication on October 23, 2006.

Fischer, Nancy, Florida Department of Agriculture and Consumer Services, Bureau of Petroleum Inspection, telephone conversation on October 4, 2006.

Holan, Ray L., *Sliding Home: A Complete Guide to Driving Your Diesel on Straight Vegetable Oil*, Volume 6, 2006.

Howards, Steven and Terry Newell, US EPA, conversation on October 25, 2006

http://enn.com/today.html?id=11249

http://itotd.com/articles/509/vegetable-oil-as-diesel-fuel

http://ravenfamily.org/andyg/vegoil.htm

http://sovereignty.org.uk/features/eco/biofuel.html

http://www.biodiesel.org/pdf_files/fuelfactsheets/emissions.pdf

http://www.caranddriver.com/article.asp?section_id=4&article_id=7818&page_number=1

http://www.eere.energy.gov/afdc/

http://www.fueleconomy.gov/feg/biodiesel.shtml

http://www.greasecar.com

http://www.msnbc.msn.com/id/12390463/from/ET/

http://www.msnbc.msn.com/id/7601915/from/ET/

http://www1.eere.energy.gov/vehiclesandfuels/epact/state/index.html

http://www.wnbiodiesel.com/technology.html

Letcher, Tom, Tallowmasters, Inc., telephone conversation on August 23, 2006.

Orehowsky, Greg, EPA Certification Specialist, personal communication on October 23, 2006.

Reineman, Marty, EPA, personal communication on October 23, 2003.

Robertson, Jim, Biofuels America, Inc., telephone conversation on August 23, 2006.

Ryan, Dave, spokesperson for the EPA, written e-mail message to Jim Norman, staff editor of the Business Day Section of the *New York Times* on June 16, 2006.

U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Clean Cities Alternative Fuel Information Series, February 2001.

APPENDIX A

RECYCLED VEGETABLE OIL SUPPORTING INFORMATION

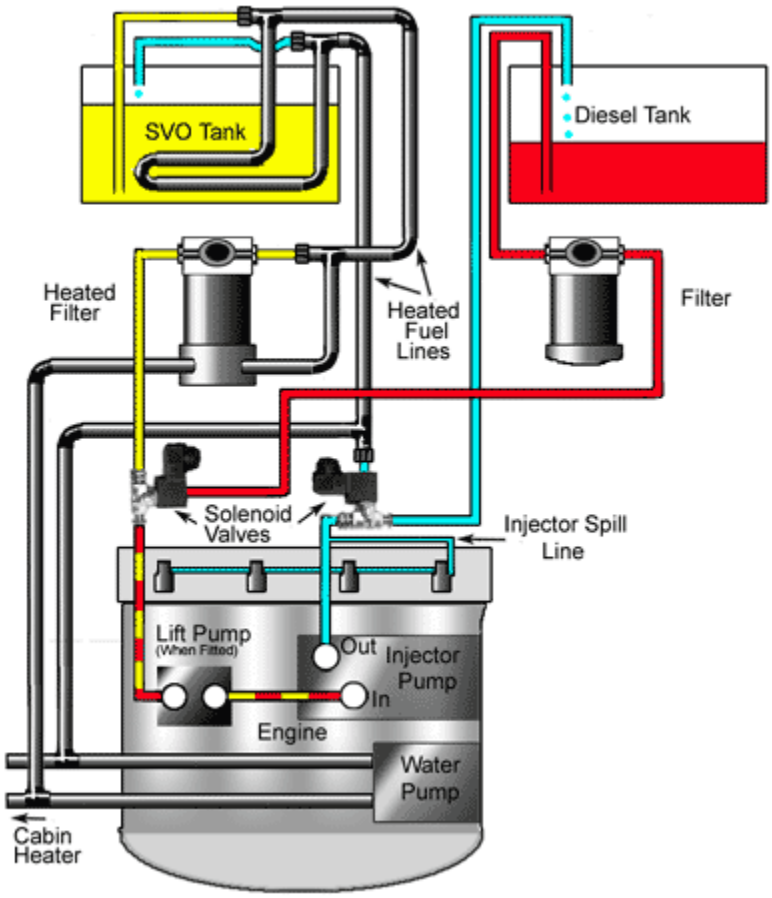

Figure A-1: Two-Tank Fuel System[a]

The engine is started on diesel and the waste heat created by the engine is used to heat the SVO. The fuel supply is switched by a valve. Before shutting down for extended periods, the fuel supply is switched back and the engine is allowed to run for approximately one minute so that the vegetable oil is flushed from the fuel system. The vehicle is then ready to be restarted on diesel fuel. Placing the fuel selection valve as close to the injector pump as possible reduces the flushing time.

[a] http://vegburner.co.uk/heat.htm

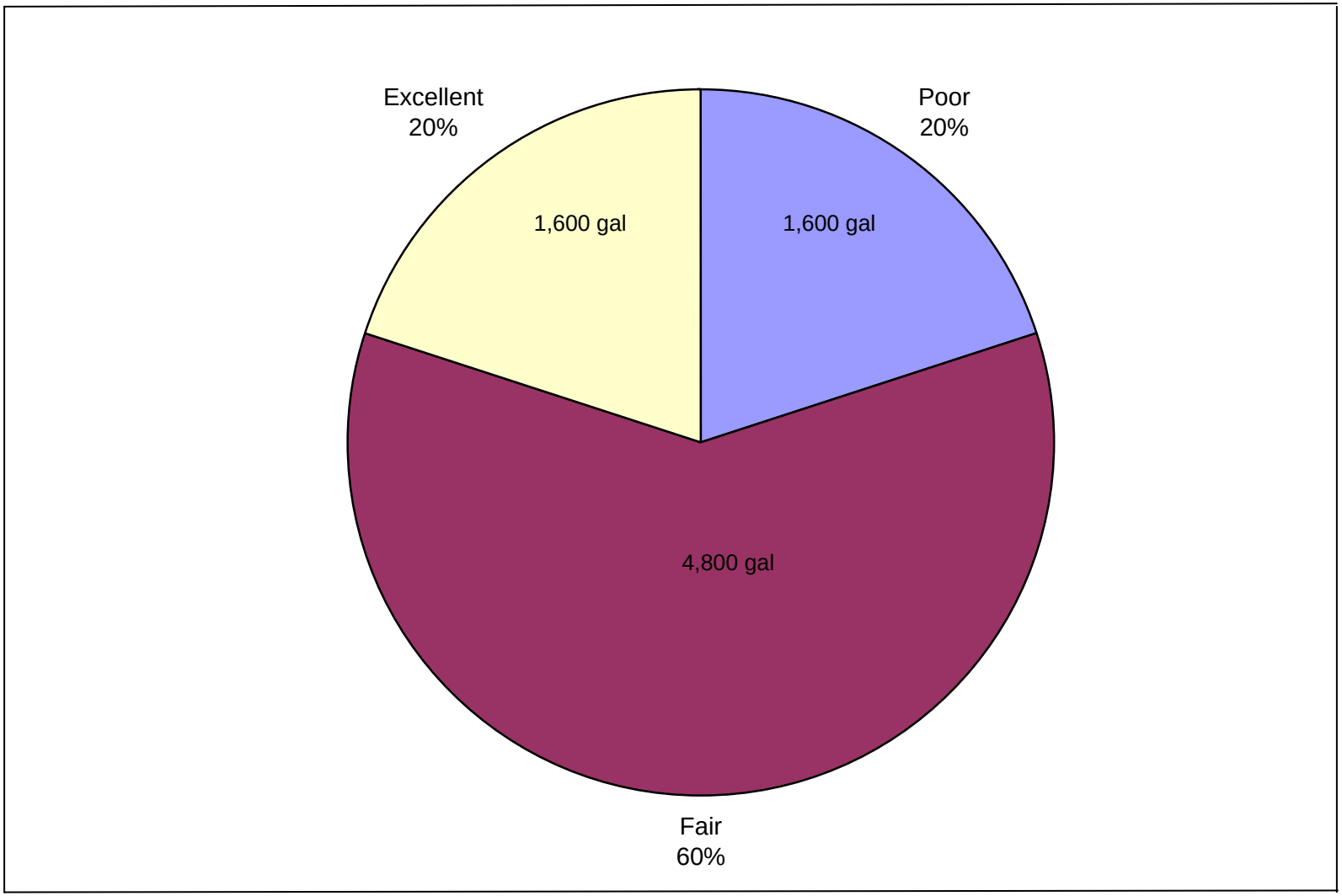

Figure A-2: Quality and Quantity of Used Vegetable Oil at FLL

Figure A-3: Typical Stationary Filtration and Pumping Kit[b]

Used vegetable oil is poured into the 55 gallon barrel (2) and the barrel heater (1) is turned on to warm the oil. Once the oil is warmed to approximately 120°F, the heater is turned off and the pump (3) is turned on to flow the warmed oil right through the bag filter housing (4) to transfer clean oil to your vehicle or storage container (5).

[b] http://greasecar.com/product_detail.cfm?prodID=19

Table A-1: BCAD Vehicles Considered for Vegetable Oil Conversion

Equipment Number	Equipment Description	Make	Model	Year	Engine HP & Displacement (estimated)	Make & model of Injection Pump	Comments	Annual Fuel Usage (gallons)	Fuel Capacity
8433	Bucket truck	Ford Chassis	F700	1996	400+	Bosch		179	30
7430	Scrubber	American Lincoln/New Holland	TN-55	2003	400+	Bosch	Approx. 30 Gal. per week	1560	15
7443	Scrubber	American Lincoln/New Holland	TN-55	2004	400+	Bosch	Approx. 30 Gal. per week	1560	15
8446	Tractors	Ford New Holland	TS-100	1999	400+	Bosch		592	35
8447	Tractors	Ford New Holland	TS-100	1999	400+	Bosch		319	35
8417	Tractors	Ford Chassis	6640	1992	400+	Bosch		?	35
8419	Dump Truck	Ford Chassis	F700	1993	400+	Bosch		305	30
8421	Dump Truck	Ford Chassis	F700	1994	400+	Bosch		256	30
8441	Sweepers	Ford Chassis		1997	400+	Bosch		294	35
8440	Sweepers	Ford Chassis		1997	400+	Bosch	Scheduled to be removed from service in FY 2007.	568	35

Table A-2: Diesel Vehicles Emissions[c]

Emissions of Diesel Vehicles on Petroleum Diesel vs. Heated Straight Vegetable Oil (Canola Oil)

	DSL HC	SVO HC	DSL CO	SVO CO	DSL CO2	SVO CO2	DSL NOx	SVO NOx	DSL Opacity	SVO Opacity	1,000 Miles***
1996 VW Passat	4.0	6.0	0.01	**0.01**	**5.58**	5.62	660.0	580.0	**0.0**	0.4	226
1998 VW Jetta	5.0	12.0	0.01	**0.01**	5.87	6.10	560.0	550.0	**0.0**	**0.0**	130
1998 VW Jetta	4.7	6.1	0.01	**0.01**	5.66	**5.25**	374.9	377.6	0.6	1.0	158
2001 VW Golf	4.0	5.0	0.40	0.30	5.82	6.10	660.0	690.0	0.4	0.3	076
2001 Chevy	1.1	8.0	**0.00**	**0.01**	6.21	6.60	391.0	342.2	**0.0**	1.1	104
2005 Chevy*	—	15.67	—	0.02	—	6.05	—	428.0	—	1.1	035
2003 Dodge 3500	4.7	8.1	0.01	0.02	6.13	6.24	699.2	658,5	0.3	**0.0**	065
1985 BMW 524	**0.1**	**3.1**	**0.00**	**0.01**	8.78	9.11	**243.3**	**191.6**	0.5	0.7	185
1985 BMW 524**	1.6	—	**0.00**	—	9.00	—	261.0	—	1.0	—	199
AVERAGE	**3.03**	8.28	0.06	**0.05**	6.63	**6.38**	481.18	**477.24**	**0.35**	0.57	

All numbers for HC & NOx are in PPM (parts per million). Opacity, CO & CO2 are in %. The equipment and protocol was not suited for the more common "grams/hour" or "grams per brake hp". Best score (i.e. lowest) is **boldface** in each column.

*2005 Chevy had a malfunction in its diesel fuel system while driving to the testing station. This prevented testing on diesel fuel for this vehicle. SVO system was functional, so test was run only on plant oil.

**Unconverted turbodiesel running on B20 biodiesel blend.

***Odometer reading of each vehicle in thousands of miles when tested for emissions.

All vehicles (except one as noted) fueled with premium diesel (i.e. 45+ cetane) from the same station at the same time. All vehicles had their SVO tank filled with virgin canola oil obtained from the same batch. Tests were ASM (Acceleration Simulation Mode) to obtain emission levels for the constituents. This test loads the dynamometer so that the engine is putting out 25% of its maximum at 25 mph. Speed kept at 24-26 mph (27-31 mph for opacity test. Ambient air temperature at time of testing was 34 degrees F.

[c] *Sliding Home: A Complete Guide to Driving Your Diesel on Straight Vegetable Oil*, p. 298. Ray Holan, 2006.

APPENDIX B

EMAIL CORRESPONDENCE

Naila Hosein

From: Newell.Terry@epamail.epa.gov
Sent: Wednesday, October 11, 2006 2:17 PM
To: naila.hosein@westhorp.com
Cc: Reineman.Martin@epamail.epa.gov; Mclaughlin.Jackj@epamail.epa.gov
Subject: Re: Straight Vegetable Oil as Vehicle Fuel & Air Emissions

Dear Naila Hosein:

Converting a certified vehicle to operate on a fuel other than the fuel the manufacturer used to obtain certification is considered tampering and is illegal under the provisions of the Clean Air Act (as amended 1990). The exception is when a conversion has itself been certified.
This is a non-trivial process, and must be done on an engine family specific basis (as original certification is done). That is, the certification of the conversion kit is applicable to the engine family or families that were certified as being in compliance with emission standards after the conversion.

We do not have any emissions data from vehicles converted to and operating on straight vegetable oil (SVO).

If you have additional questions about the certification of alternative fuel conversions, you may contact Mr. Martin Reineman of our Compliance and Innovative Strategies Division. He can be reached at reineman.martin@epa.gov, and I have copied him on this message. You can also visit our web site, at:

http://www.epa.gov/otaq/cert/dearmfr/cisd0602.pdf

http://www.epa.gov/otaq/cert/dearmfr/ccd0516.pdf

http://www.epa.gov/otaq/cert/alt_fuel_convert.pdf

for more information and guidance.

I am sorry that we are not able to provide data in response to your request, but hope that you will find this information helpful. Thank you for contacting EPA's Office of Transportation and Air Quality.

Sincerely,
Terry Newell
OTAQ Public Information Service
US EPA National Vehicle and Fuel Emissions Laboratory 2000 Traverwood Drive Ann Arbor MI 48105
phone: 734.214.4462
email: newell.terry@epa.gov

Naila Hosein <naila.hosein@westhorp.com>
Sent by: Naila Hosein <naila.hosein@westhorp.com>
Received Date: 10/10/2006 09:30 AM
Transmission Date: 10/10/2006 09:30:58 AM

To: Terry Newell/AA/USEPA/US@EPA
cc:
Subject: Straight Vegetable Oil as Vehicle Fuel & Air Emissions

Please respond to

naila.hosein@wes
thorp.com

Good morning,

I have been trying to find information on air emissions when using straight vegetable oil (using a conversion kit) as a vehicle fuel. I know there is a lot of research on biodiesel, but I haven't seen much on SVO. I will appreciate any assistance on this matter.

Thanks!

Naila Hosein, E.I.
Project Engineer
9499 N.E. 2nd Avenue, Suite 207
Miami Shores, FL 33138
Ph: 305-759-4757
Fx: 305-759-4758

Naila Hosein

From: Jim Norman [norman@nytimes.com]
Sent: Wednesday, October 11, 2006 3:22 PM
To: naila.hosein@westhorp.com
Subject: RE: Vegetable Oil as Fuel

Dear Mr. Hosein:

I have located the source of the information you seek. It was in an e-mail message from Dave Ryan, a spokesman for the E.P.A., in Washington. He sent me the following statement in response to questions I had asked him in a telephone interview. The following is his full, verbatim statement, officially comp [osed on behalf of the E.P.A.:

Date: Fri, 16 Jun 2006 14:57:04 -0400
From: Ryan.Dave@epamail.epa.gov
Subject: VEGGIE FUELS STATEMENT
To: norman@nytimes.com
Message-id:
<OF2F476521.632EF8CD-ON8525718F.0067D42D-8525718F.00681A61@epamail.epa.gov>
MIME-version: 1.0
X-Mailer: Lotus Notes Release 6.5.2 June 01, 2004
Content-type: text/plain; charset=US-ASCII
X-MIMETrack: Serialize by Router on EPAHUB11/USEPA/US(653HF66|November 02, 2004) at 06/16/2006 02:56:27 PM
X-NYTOriginatingHost: nat-hq-gate-03.nytimes.com, 199.181.175.223

Vegetable oil has not been registered as a motor vehicle diesel fuel under 40 CFR 79. In addition, no motor vehicle manufacturer has obtained EPA emissions certification for a motor vehicle to operate on vegetable oil. Thus, introduction into commerce of vegetable oil for use as a motor vehicle fuel would violate the Clean Air Act and EPA regulations.

The Clean Air Act prohibits the conversion of a motor vehicle to operate on a fuel other than the fuel used by the manufacturer when the EPA emissions certificate was obtained. No motor vehicles have been certified by EPA to operate on vegetable oil. In addition, no alternative fuel conversion kits to modify motor vehicles to operate on vegetable oil have been certified by EPA.

As a result, the Clean Air Act tampering prohibition would be violated by any person that modifies a motor vehicle to operate on vegetable oil. Maximum penalties for violations of the tampering prohibition are $32,500 per violation if committed by a manufacturer or dealer, or $2,750 per violation if committed by any other person.

Information about the EPA fuel registration program can be found at http://www.epa.gov/otaq/additive.htm

I hope this helps you in your research. If you have any further questions, please do not hesitate to ask.

Jim Norman

Naila Hosein

From: Michael Garjian [michael@greasecar.com]
Sent: Thursday, October 12, 2006 2:20 PM
To: naila.hosein@westhorp.com
Subject: FW: Information on EPA re: vegetable oil fuel

Hello Naila,

The following are technically not yet legal:

1. Vegetable oil conversions and vegetable oil fuel
2. Millions of gallons of biodiesel fuels being made by large rendering companies from waste restaurant grease.
3. Biodiesel blends used for home heating systems due to invalidation of UL listing resulting from use of non-UL listed fuel (biodiesel).

There is a significant amount of activity in the above thre areas. The EPA will eventually catch up on their backlog of work and formalize the viability of these fuels.
Greasecar has been in communication with the EPA and is in the midst of the process of having our kits certified. This will take another 6 months. In the meantime, I attach our corporate position on the Clean Air Act and why we feel we are in compliance. The EPA has accepted this document and has asked us to provide the emissions reports that can validate our claims. We are in that process, as I said.

The article in the Times by Jim Norman points out that although the EPA considers these kits "technically not yet legal", they are not prosecuting any activity in this area as it is so important and widespread.

Michael Garjian

From: Naila Hosein [mailto:naila.hosein@westhorp.com]
Sent: Tuesday, October 10, 2006 12:16 PM
To: michael@greasecar.com
Subject: Information on EPA re: vegetable oil fuel

Good morning Michael,

I just got off the phone with JP Levy who told me to contact you. My firm is working on assessing the feasibility of using recycled vegetable oil as vehicle fuel at the Ft. Lauderdale/Hollywood International Airport in Broward County, FL. As I was finalizing the report, I came across a NY Times article dated July 23, 2006 that stated the EPA has recently stated that vegetable oil as fuel is in violation of the Clean Air Act. To put it mildly, I was mortified to read this. Do you have any documentation/written information on this EPA statement that I can see? I can't just go off of a newspaper article for my report.

Any assistance you can offer would be greatly appreciated. Keep up the great and innovative work you guys are doing!

Naila Hosein, E.I.
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