

Hennepin County's Experience with Heavy-Duty Ethanol Vehicles

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Executive Summary

From November 1993 to October 1996, Hennepin County, which includes Minneapolis, Minnesota, field-tested two heavy-duty snowplow/road maintenance trucks fueled by ethanol. The overall objective of this program was to collect data from original equipment manufacturer (OEM) alternative fuel heavy-duty trucks, along with comparable data from a similarly configured diesel-powered vehicle, to establish economic, emissions, performance, and durability data for the alternative fuel technology. The U.S. Department of Energy (DOE) provided funding for the project through the National Renewable Energy Laboratory (NREL) and the American Trucking Association (ATA) Foundation's Trucking Research Institute (TRI). This is the second of three ethanol demonstrations that NREL has funded. The first demonstration took place in Decatur, Illinois, at Archer Daniels Midland (ADM) Trucking, Incorporated. Applicable data from the ADM report also appear in this report.

The two trucks, International Paystar models F5070, were equipped with a U.S. emissions-certified Detroit Diesel Corporation (DDC) model 6V-92TA ethanol engine. The engine is rated at 300 horsepower and is fueled by E95, a fuel composed of 95% anhydrous ethanol and 5% light hydrocarbon denaturant. These ethanol trucks, along with an identical third truck equipped with a U.S. emissions-certified DDC 6V-92TA diesel engine, were operated year round to maintain the Hennepin county roads. In winter, the trucks were run in 8-hour shifts plowing and hauling snow from urban and suburban roads. For the rest of the year, the three trucks were used to repair and maintain these same roads.

As a result of this project, a considerable amount of data was collected on E95 fuel use, as well as maintenance, repair, emissions, and operational characteristics. Maintenance and repair costs of the E95 trucks were considerably higher primarily due to fuel filter and fuel pump issues. From an emissions standpoint, the E95 trucks emitted less particulate matter and fewer oxides of nitrogen but more carbon monoxide and hydrocarbons. Overall, the E95 trucks operated as well as the diesel, as long as the fuel filters were changed frequently.

This project was a success in that E95, a domestically produced fuel from a renewable energy source, was used in a heavy-duty truck application and performed the same rigorous tasks as the diesel counterparts. The drawbacks to E95 as a heavy-duty fuel take the form of higher operational costs, higher fuel costs, shorter range, and the lack of over-the-road infrastructure.

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Introduction

The American transportation sector uses more than 30% of all the energy consumed annually in this country. Conventional hydrocarbon fuels, primarily gasoline and diesel fuel, represent the current sources of energy for transportation. Naturally occurring hydrocarbon reserves, however, exist in finite quantities and are very limited in geographic extent. Proven worldwide hydrocarbon reserves are being depleted faster than they are being discovered, and more than 50% of the petroleum used for energy in America each year is imported.

Heavy-duty trucks and urban transit buses account for a significant portion of the U.S. transportation sector. For the most part, these vehicles are powered by compression-ignition diesel fuel engines, which typically emit high levels of oxides of nitrogen (NO_x) and black particulate smoke during operation. The black smoke is not only unsightly, but has proven to be carcinogenic.

Ethanol, also known as ethyl alcohol, is a renewable energy resource generated by biologically fermenting simple glucose sugars. At this time, the ethanol industry in the United States has an annual production capacity of approximately 1.6 billion gallons. Although ethanol can be made from a wide variety of feedstocks, corn is generally used to produce ethanol in this country because of its abundance and relatively low price considering the amount of ethanol that it yields.

Ethanol has been successfully used as an additive in gasoline for many years. This fuel formulation, also called "gasohol," is composed of 90% unleaded gasoline and 10% ethanol. In this application, ethanol can be considered a petroleum extender, an octane enhancer, and an oxygenate additive to gasoline.

From an emissions standpoint, numerous studies have shown that gasoline blended with 10% ethanol reduces carbon monoxide (CO) emissions from internal combustion engines by as much as 25%. Ethanol-blended gasolines are being used in many of the nation's cities currently in nonattainment for CO levels. Until recently, very little was known, however, about emissions from vehicles designed to operate on higher percentage blends of ethanol fuel.

Until the 1990s, the use of high-percentage blends of ethanol fuels for transportation was very limited. Henry Ford was the first American automobile manufacturer to see the potential of ethanol as a fuel in the early 1900s. Many of his early Model A automobiles were capable of operating on ethanol fuel rather than gasoline. Since then, only a few isolated testing programs (most performed by vehicle and engine manufacturers and containing proprietary information) have been designed to test, demonstrate, and evaluate the use of ethanol as a viable alternative transportation fuel in light-, medium-, and heavy-duty vehicles.

The overall objective of this project was to demonstrate and collect data on the use of a high-percentage ethanol blend of fuel in a heavy-duty truck application. This project also represents the first public demonstration of the use of ethanol fuels as a viable alternative to conventional diesel fuel in a heavy-duty snowplow/road maintenance application.

Background

It is an impressive sight to see a 60,000-pound snowplow rolling back a layer of snow in a perfect arc to the roadside. Snowplowing is an extremely demanding assignment that can test the limit of a heavy-duty truck design. Snowplow/maintenance trucks work as part bulldozer and part dump truck, often in extreme cold, loaded to their capacity, cutting through ice and snow. Hennepin County in Minneapolis, Minnesota, offers a perfect cold weather environment for testing alternative fuel heavy-duty trucks.

Hennepin County is an urban county of a little more than 1 million people; it makes up about half the Minneapolis/St. Paul metropolitan area. The city of Minneapolis is the county seat. The county has largely typical midwestern topography with a mix of flat farmland, lakeshore, and moderate rolling hills. Much of the county road system comprises multi-lane city streets with curb and gutter, medians, center islands, multiple turn lanes, and traffic control devices. A small portion of the system remains essentially rural with two-way roads, unpaved shoulders, and little in the way of traffic control other than an occasional stop sign.

In 1993, the county began field-testing two ethanol-powered trucks with an identically specified diesel control truck. The county vehicle numbers were 3221, 3228, and 3220, respectively. For the remainder of this report, we will refer to them as ethanol #1, ethanol #2, and diesel control, respectively. The demonstration ran for 3 years from November 1993 through October 1996. The trucks were used by the Department of Public Works Division of Road and Bridge Maintenance Operations. To ensure uniformity and consistency in reporting data from drivers, we asked for volunteer drivers who were willing to stay with the trucks for the full 3 years of the study. We were fortunate that long-term, experienced, and proficient drivers volunteered for the project. Collectively, the three drivers have 62 years of experience driving heavy-duty trucks. They provided weekly data on the performance of the trucks and on the fuel usage. The drivers completed a standard form provided by the ATA, shown in Appendix 1.

All the heavy-duty trucks owned by Hennepin County are used to maintain the county's highway system. This system includes about 600 miles of roads with about 1600 lane-miles.

The Class 8 dump trucks are equipped in the winter with a 12-ft reversible front plow, a 10-ft underbody scraper blade, and a tailgate spreader.

The trucks are International Paystar 5000, model F5070, with the following specifications:

GVWR	49,500	Transmission: Fuller RTX11708LL
Wheelbase	188 in.	8 speed w/double low
Cab-to-Axle	120 in.	14.56:1 max. reduction
Front Axle	18,000 & set back	
Rear Axle	38,000 4.78 ratio	Body: 15-ft Aluminum
Engine	6V-92TA DDEC	Telescopic Hoist
	300 h.p. @ 2,100 rpm	Engine Power Take Off (PTO)
	50 ft. lb. torque @ 1,300 rpm	

This configuration is standard for county dump trucks, and this truck is the workhorse of the county fleet. The three Navistar trucks were purchased with non-U.S. emissions-certified DDC 6V-92TA diesel engines. Navistar, the chassis OEM, did not offer the ethanol or diesel versions of the DDC 6V-92TA with U.S. emissions certification as a commercial option. Consequently all three trucks were repowered with U.S.-emissions-certified 6V-92TA engines by the local DDC dealer; two with the ethanol version and one with the diesel.

All the heavy-duty trucks owned by Hennepin County are purchased primarily for the snowplowing function. The complete snow and ice control operation is essential to maintaining a transportation network in Minnesota. The typical winter duty cycle consists of snowplowing, snow removal, and ice control. For this reason, the county road system is divided into segments so that one truck can plow the full segment in one 8-hour shift. One truck and driver are assigned to each of these segments or routes. The routes for the three trucks in this demonstration project were:

- Diesel control—The most rural route in the project. At least half the route consisted of two-lane roads with no curb and gutter. The remainder of the route was a mix of two-lane roads without curb and gutter, and two-lane or four-lane suburban streets with curb and gutter.
- Ethanol #1—All urban streets, four lanes with both right and left turn lanes, traffic signals, and curb and gutter.
- Ethanol #2—Mostly urban streets, four lanes with turn lanes, traffic signal, curb and gutter. Some sections are two lanes with no curb and gutter.

Appendix 2 contains a map of Hennepin County and these routes.

In a standard duty cycle, the drivers are called to start plowing at 2:45 a.m. The driver loads his truck and begins to plow, clearing the main road lanes first and then spending the rest of the 8-hour shift plowing the shoulders or clearing the roadway full width to the curbs and any turn lanes. The beauty of the dump truck, of course, is that the driver can spread salt/sand mix or salt to control ice while he is plowing. Subsequent shifts will either repeat this cycle, or move into more intensive clean-up plowing, either on an early start or during regular work hours.

Other typical winter work cycles include hauling materials from one location to another. Salt, for example, is frequently moved from the county's main supply, at the department's headquarters, to the outlying truck stations so those facilities have adequate quantities for their snow removal activities. When there is no snow, the drivers may begin by patrolling their assigned routes looking for icy spots and salting them. When the plowing and salting is done, the drivers will often assist with Public Works projects, which generally entail hauling aggregates, street sweepings, dirt, trees and brush, broken and removed concrete, construction refuse, gravel fill, and snow.

Later in the winter, when the snow has narrowed the streets, the trucks help in joint city/county operations to make the streets more passable. A city identifies the street most in need of widening, and provides a grader, an operator, and other laborers. The grader cuts out the snow/ice that has accumulated at the road edge and forms it into a windrow. The county provides a large loader-mounted snow blower and several tandem-axle dump trucks. The blower moves down the windrow and blows the snow into the dump bodies of the trucks. One truck follows another, pulling under the blower shoot as soon as the lead truck is loaded and out of the way. The combined operation efficiently widens the streets. The trucks then haul and dump the snow in a city-designated storage area.

The winter weather during the 3-year project is described below.

1993-94	Total snowfall: 55.7 inches Average temperature: 12.4 degrees F Temperature range: -26 to 34 degrees F
1994-95	Total snowfall: 29.6 inches Average temperature: 22.6 degrees F Temperature range: -5 to 38 degrees F
1995-96	Total snowfall: 55.5 inches Average temperature: 16.7 degrees F Temperature range: -16 to 36 degrees F

In the summer, these trucks become essential tools in the county's paving and pavement maintenance programs. As a rule, the county contracts most major road work except for bituminous overlay and seal coat programs, which are completed by county employees and equipment. In this operation trucks make continuous rounds to haul millings (created during resurfacing process) to a disposal site, deliver hot asphalt to the paver, or take seal coat chips to the seal coating operation.

The summer and winter work cycles described above were consistent throughout the demonstration and were performed by the diesel control and ethanol trucks alike.

Engines

The DDC Model 6V-92TA (with the TA denoting turbocharged and aftercooled) powerplant was selected as the engine for the two ethanol trucks. The 6V-92TA alcohol fuel engine is a vee-configuration, six cylinder, two-cycle motor capable of producing up to 300 horsepower. The methanol version of the engine was first developed in 1986 and emissions certified (by the U.S. Environmental Protection Agency [EPA] and the California Air Resources Board [CARB]) in 1991 for use in urban transit buses in California. DDC's previous experiences with the methanol 6V-92TA engine aided the development and subsequent emissions certification of the ethanol -- 6V-0-92TA in 1992. DDC considered both alcohol engines and standard production engines.

DDC selected the 6V-92TA engine to develop as an alcohol fuel engine for at least two reasons: (1) the 6V-92TA diesel engine was used in about 80% of the urban transit buses currently on the road, and (2) the two-cycle engine was easier to convert to alcohol fuel than a four-cycle engine. A two-cycle engine removes combustion products close to the bottom of the piston stroke by means of a blower that pushes out the exhaust gases (called "scavenging"). Scavenging causes mixing of hot exhaust gases with the new fuel mixture to be combusted. The presence of these hot exhaust gases in the cylinder raises the fuel temperature, making compression ignition of low-cetane-number fuels (such as ethanol) possible. As a result, two-cycle engines have a distinct advantage over four-cycle engines in compression igniting fuel with high auto-ignition temperatures.

DDC also modified some of the components on the ethanol 6V-92TA engines. The first of these major modifications was to the Detroit Diesel Electronic Controls (referred to as DDEC II), which contains the electronic control module (ECM) and the electronic unit (fuel) injectors (EUI). The ECM is the on-board computer for the engine that controls various engine operations under continuously varying conditions to optimize performance, fuel economy, and emissions. The ECM receives electronic signals from the truck's driver in addition to engine-mounted sensors. The electronic hardware in the ECM contains a PROM (Programmable Read Only Memory) encoded with the specific engine performance characteristics (such as horsepower rating, torque curve, and maximum engine speed. To use ethanol fuel, the ECM must be specifically programmed for ethanol fuel at the factory or by a DDC field engineer.

The second part of the DDEC II unit, the EUI, contains an electronically controlled solenoid valve that meters and times fuel input to the cylinders. Because ethanol contains only about 60% of the energy of diesel fuel per unit volume, more ethanol fuel is required to generate the same amount of power in the engine. This is accomplished by using two larger (relative to diesel) ethanol-resistant fuel pumps and by increasing the diameter of the holes in the injector tip. The EUI can then inject the proper amount of ethanol fuel into the cylinder at the right time without reducing the engine performance.

Next, the bypass air system was modified. This system provides the correct metering and mixing of retained hot exhaust gases and fresh air in order to achieve the proper ethanol compression-ignition temperature. The bypass air system is controlled by the DDEC II unit and changes system settings based on changes in engine operating conditions.

The ethanol 6V-92TA engines also use a glow plug system that has been modified for use with the DDEC II system. The glow plugs are electronically heated and are used to help start the engine. The glow plugs remain on (heated) for 1 minute prior to starting the engine and remain on until the engine coolant reaches normal operating temperature.

Another major modification to the ethanol engine is an increased compression ratio compared to the conventional diesel version. The ethanol engine has a compression ratio of 23:1 compared to 18:1 for the diesel. This increase is needed to ensure complete combustion of the ethanol fuel in the cylinder and to maximize engine performance and torque.

Finally, the fuel systems of the two ethanol trucks were modified. Because ethanol is more corrosive to certain metal, plastic, and rubber parts, stainless-steel fuel tanks and fuel lines were added.

E95 Ethanol Fuel

Ethanol (also called ethyl alcohol) is an oxygenated hydrocarbon with the chemical formula of C_2H_5OH . Ethanol is a by-product of the fermentation of simple glucose sugar by yeasts. Anhydrous ethanol contains 76,000 Btu of energy per gallon. Energy contents and other properties of ethanol are compared to other fuels in Table 1.

The "proof" of an alcohol is defined as twice the percentage of alcohol in the solution. For example, a mixture of 90% pure ethanol and 10% water is referred to as "180-proof" ethanol.

For all practical purposes, there are two types of industrial-grade ethanol: anhydrous and hydrated. Anhydrous ethanol is defined as at least 99.5% pure ethanol, with less than 0.5% water by volume. Anhydrous ethanol is also called "200 proof" ethanol or gasoline grade ethanol, as this is the concentration of ethanol blended with gasoline to make "gasohol." Hydrated ethanol is any other ethanol blend containing more than 0.5% water by volume. In either case, fuel-grade ethanol must be denatured with 2% to 5% denaturant to make it unfit for human consumption. Otherwise, it is highly taxed by the U.S. Department of Treasury, Bureau of Alcohol, Tobacco, and Firearms (ATF) as beverage-grade alcohol. Some of the denaturants commonly used include methanol, benzene, toluene, natural gasoline, kerosene, and unleaded gasoline.

The cetane number, also found in Table 1, is a measure of the ease (or difficulty) by which a fuel can be compression ignited. Fuels with high cetane numbers have low autoignition temperatures and short ignition delay times. Ethanol has a low cetane number, less than 5, compared to 40 to 55 for diesel fuel. This indicates that the alcohol fuels have higher autoignition temperatures relative to diesel fuel. This is reflected in the autoignition temperatures of ~600 degrees F for diesel fuel and 793 degrees F for ethanol. Hence, the requirement of glow plugs to autoignite the E95 fuel in the 6V-92TA engines.

Diesel fuel is a complex mixture of hydrocarbons, and the composition can vary from "batch to batch." Because of this variation, the energy content of #2 diesel fuel is assumed to average about 127,000 Btu per gallon (Btu/gal).

The fuel formulation used in the two 6V-92TA truck engines in this project is a blend of 95% anhydrous ethanol and 5% denaturant. This fuel is called E95, but it can also be called E(d)-100, with the "d" standing for denatured. For consistency, the term E95 will be used throughout this report whenever 95% anhydrous ethanol and 5% denaturant fuel is discussed.

DDC supplied an E95 fuel specification for use with its 6V-92TA engines (shown in Appendix 3), which includes an optional lubrication additive called "Lubrizol". One problem encountered with using ethanol fuels is that they do not have the inherent lubricating properties

Table 1. Comparison of Properties of Potential Diesel Fuel Components*

Property	DF-2 Diesel	Fischer-Tropsch	Bio-diesel	Gasoline	CNG	Propane HD-5 ^h	Methanol	Ethanol	Methylal	Dimethyl ether	Diethyl ether
Formula	Hydrocarbons -C ₁₀ -C ₂₁	Principally C ₁₀ H _{2n+2}	Various oils and esters	Hydrocarbons C ₄ -C ₉	Principally CH ₄	Principally C ₃ H ₈	CH ₃ OH	C ₂ H ₅ OH	CH ₃ OCH ₂ OH ₃	CH ₃ OCH ₃	C ₂ H ₅ OCH ₂ CH ₃
Boiling Point, °F	370 - 650	350 - 670	360 - 640	80 - 437	n.a.	n.a.	149	172	107	-13	94
Reid Vapor Pressure, psi @ 100°F	<0.2	n.a.	n.a.	8-15	n.a.	170	4.6	2.3	12.2 ^c	116	16.0
Cetane Number	40 - 55	>74	>48	13 - 17	low	low	low	<5 ^b	49	>55	>125 ^a
Autoignition Temperature, °F	~600	~600	-	495	990	870	867	793	459	662	320
Stoichiometric Air/Fuel Ratio, Wt./Wt.	15.0	15.2	13.8	14.5	16.4	15.7	6.45	9.0	7.1	8.9	11.1
Flammability Limits, Vol. %:	7.6	-	-	6.0	13.9	9.5	36.9	19.0	14.9 ^c	27.0 ^d	9.5 36.0 ^d
Flammability Limits, Vol. %:	1.4	-	-	1.0	5.0	2.4	7.3	4.3	3.3 ^c	3.4 ^d	1.9 ^d
Lower Heating Value, Btu/lb	18,200	18,600	16,500	18,500	20,750	19,940	8,570	11,500	10,200	12,100	14,600
Lower Heating Value, Btu/gal	128,700	121,300	120,910	115,400		83,900	56,800	76,000	73,000	66,600	86,500
Lower Heating Value, Btu/SCF					1,033						
Viscosity, centipoise at (temp)°F	40(68)	2.1(100)	3.5(100)	3.4 (68)	-	-	0.59 (68)	1.19(68)	-	-	0.23(68)
Specific Gravity @ 60°F	0.860	0.783	0.880	0.750	-	0.506	0.796	0.794	0.86	0.66	0.714
Density, lb/gal	7.079	6.520	7.328	6.246	-	4.21	6.629	6.612	7.16	5.50	5.946
Note (See below)	e	h	b	e	f	h	e	e	c	b	b

* Table compiled by N.R. Sefer, Southwest Research Institute.

- Inferred from ignition delay
- Recent measurement at Southwest Research Institute
- Naegeli, D. W., and Weatherford, W. D. Jr. "Practical Ignition Limits for Low Molecular Weight Alcohols," Fuel 68, 45 (1989)
- NFPA 325 M, *Fire Hazard Properties of Flammable Liquids, Gases, Volatile Solids* (1977), Copyright 1977 National Fire Protection Association, Inc., Batterymarch Park, Quincy, MA 02269
- Table on gasoline and gasohol from *Alcohols and Ethers*, API Publication 4261, second edition, (July 1988).
- Liss, W.E., et al., "Variability of Natural Gas Composition in the US", GRI 92/0123, (March 1992).
- Alternative Fuels Special Report, Diesel Progress, Engines and Drives*, (December 1993).
- Composition information from ASTM D 1635 Standard Specification for LPG. Calculations after Perry's *Chemical Engineers' Handbook*, 6th ed., (1984).

of petroleum-based fuels. To ensure upper cylinder lubrication, an additive developed in California for the methanol buses, Lubrizol, is added to fuel in very low concentrations. The recommended amount of Lubrizol is 0.06%, by volume, in the fuel mixture. Hennepin County was able to contract an E95 fuel supplier and confirm the DDC recommended fuel specifications, including the specified amount of Lubrizol.

Data Collection

The overall objective of this program was to collect data from OEM alternative fuel heavy-duty trucks, along with comparable data from a similarly configured diesel-powered vehicle to establish emissions, performance, and durability data for alternative fuel technology. The data were collected from drivers and mechanics on paper forms provided by TRI, and then forwarded to NREL. TRI compiled the data and entered the information into NREL's Alternative Fuels Data Center (AFDC) via modem.

Fuel Economy: E95 versus Diesel

Assuming #2 diesel fuel contains about 127,000 Btu/gal and E95 fuel contains 78,000 Btu/gal, the ethanol trucks should travel about 60% of the distance the diesel trucks travel on a gallon of fuel, if the trucks have the same thermal efficiency. On a volume basis, the average fuel economy over the project was 4.6, 2.6, and 2.2 miles per gallon (mpg) for the diesel control, ethanol #1, and ethanol #2, respectively (shown in Figure 1). The ethanol trucks traveled about 48% to 57% of the distance traveled by the diesel trucks. This indicates that the thermal efficiency of the ethanol trucks was somewhat less than that of the diesel truck. Although plowing snow represents only a fraction of the miles driven in a month, it is not unusual to see the overall fuel economy of a truck drop by one or two miles per gallon in the winter months. Both ethanol trucks dropped to 1 mpg at some time during the project.

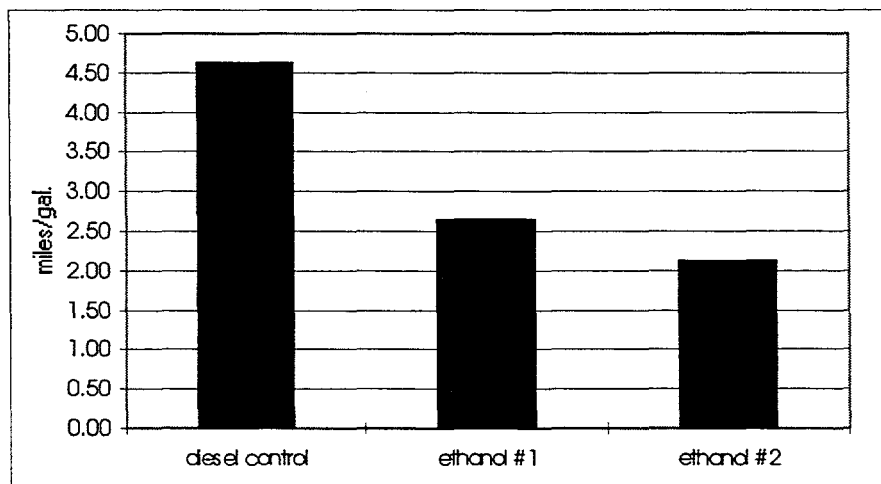


Figure 1. Average Fuel Economy

Fuel Cost: E95 versus Diesel

The cost of ethanol fuel is high, about twice as much as diesel. In the beginning of the project, diesel cost the county \$0.80/gallon and ethanol \$1.40/gallon. At the project end, diesel cost \$0.90/gallon and ethanol cost \$1.80/gallon. The county cost is a delivered price for bulk purchases and includes a state fuel tax of \$0.20/gallon. The county does not pay federal fuel tax. The most comprehensive picture of fuel costs is illustrated in the comparison of fuel cost per mile by year (shown in Figure 2). This graph indicates that, from 1994 on, the E95 fuel cost was three to four times more (per mile) than the diesel fuel cost.

Application of the alcohol tax credit can greatly reduce the cost of ethanol and the operation costs of a fleet of ethanol vehicles. Congress developed the alcohol fuel credit in response to the energy crisis of the late 1970s and early 1980s. The intent was to foster growth of the alcohol industry by subsidizing non-petroleum-based alcohol used as fuel so the cost for the end user would be comparable to traditional hydrocarbon fuels. The tax credit is accomplished in two ways: (1) by granting a \$0.054 per gallon partial excise tax exemption for 10% alcohol blended fuels (gasohol) and (2) by allowing a \$0.54 per gallon income tax credit for ethanol used as a fuel. The income tax credit is available to taxpayers who: (1) "produce" or blend an alcohol mixture, or (2) sell or use for business 100% straight alcohol placed in the vehicle's fuel supply tank by the taxpayer. Because E95 fuel is composed of 95% ethanol and 5% denaturant, 95% of the \$0.54 (or \$0.513 per gallon E95) per gallon tax credit can be taken. However, because Hennepin County is a state agency and exempt from federal taxes, it cannot file for the alcohol tax credit.

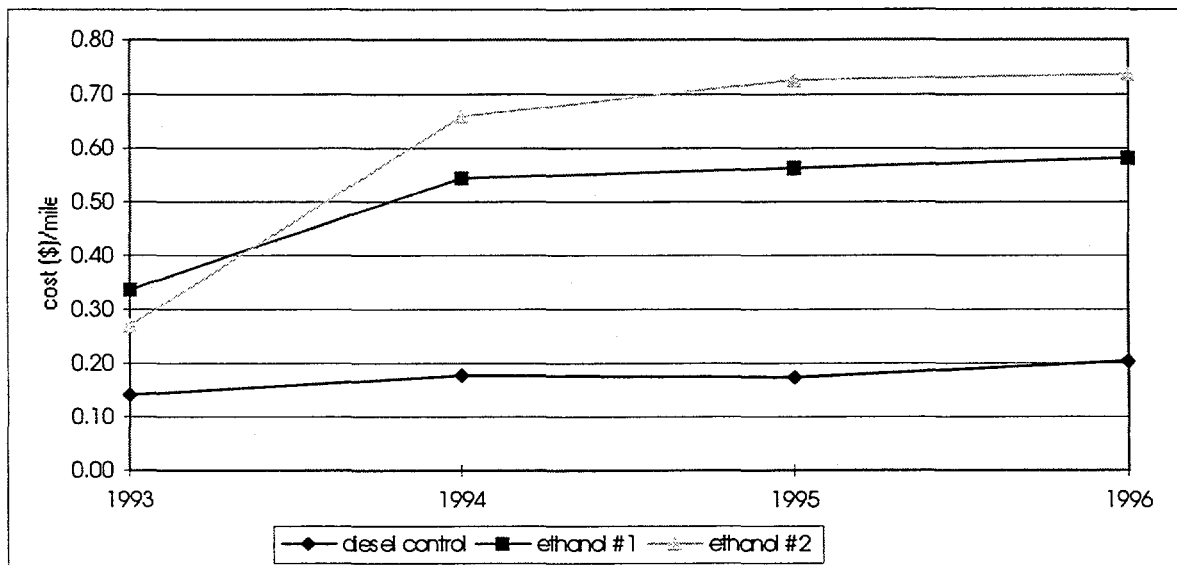


Figure 2. Fuel Cost per Mile by Year

E95 Availability

Minneapolis-St. Paul is a major metropolitan center in the agricultural Midwest. The area has a history of supporting ethanol production and its use as an automotive fuel. There has been a long-standing promotion of gasohol, a 10% blend of ethanol and unleaded gasoline. The county has used gasohol in its automotive fleet since 1983. In addition, the cities are also a moderate nonattainment area for carbon monoxide and the Clean Air Act requires that this area use an oxygenated fuel during winter months. For this application, ethanol has been the oxygenate of choice. These factors have combined to produce plentiful supplies of ethanol in the metropolitan area.

The county bid this fuel the same as all other bulk fuel purchases and never experienced any delays in delivery. The supplier was able to provide E95 that met the manufacturer's specification, as shown in Appendix 3, with the recommended additive "Lubrizol" (part no. 23509970). The Lubrizol is added to the fuel as a detergent, to eliminate lube oil contamination of injectors, and to increase fuel lubricity. The county is convinced it did not have any maintenance problems that resulted from poor fuel quality.

Maintenance and Repair Data

The total maintenance and repair cost for the diesel control truck was \$21,549 as opposed to \$26,101 and \$22,512 for ethanol #1 and ethanol #2, respectively (shown in Figure 3). The higher costs for the ethanol trucks were evident in each year throughout the project except in 1996 (shown in Table 2). The higher cost for the diesel control in 1996 was primarily due to component replacement costs, which is directly related to the difference in accumulated mileage.

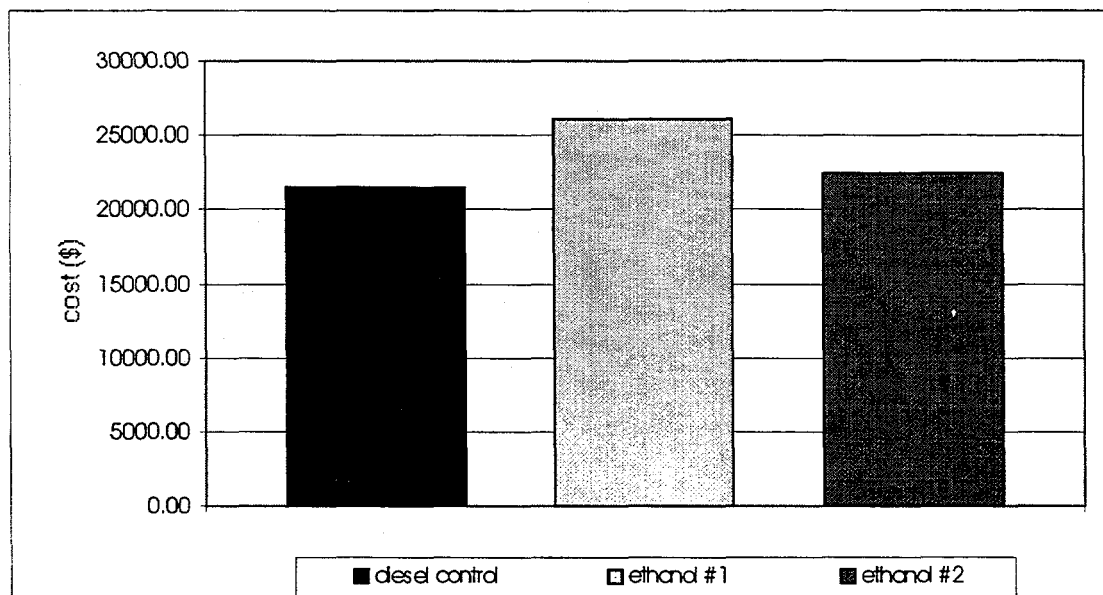


Figure 3. Total Maintenance Cost by Truck

The usage of the three trucks did vary more than intended. The mileage on the three trucks at end of the project was 81,861 for the diesel control, 61,002 for ethanol #1, and 32,526 for ethanol #2. The reason for the unexpected variance was that we had, for consistency, assigned specific drivers to each vehicle for the duration of the test. The lesser availability of one of the drivers during the project caused a difference in truck usage. To factor in the difference in accumulated mileage, the total maintenance cost per mile was charted for the three trucks. Over the life of the project, the costs per mile were \$0.26, \$0.43, and \$0.69 for the diesel control, ethanol #1, and ethanol #2, respectively (shown in Figure 4).

Table 2. Repair Costs by Year and System

	1993 Repair Costs			1994 Repair Costs		
	Diesel control	ethanol #1	ethanol #2	diesel control	ethanol #1	ethanol #2
Cab/Body	0.00	21.50	215.02	47.95	1,431.63	448.42
PM'S	180.51	0.00	0.00	379.26	401.91	329.32
Chassis GRP	553.23	918.30	75.25	198.66	645.41	556.18
Drive Train	0.00	0.00	0.00	258.00	64.50	96.75
Electrical	0.00	0.00	0.00	1,406.97	803.65	1,352.35
Power Plant	62.09	807.94	402.08	488.00	2,157.12	1,905.16
Accessories	187.22	260.66	238.00	1,865.73	2,802.66	2,630.36
Special Appl.	78.81	238.14	143.31	0.00	129.00	0.00
Hydraulics	107.50	0.00	21.50	190.36	374.11	237.95
Misc. Work	4,256.39	4,312.27	4,526.91	1,061.75	778.20	1,055.20
Misc.-New Prep	377.17	0.00	0.00			
Total-Prep	1,546.53	2,246.54	1,095.16			
Total	5,425.75	6,558.81	5,622.07	5,896.68	9,588.19	8,611.69
	1995 Repair Costs			1996 Repair Costs		
	Diesel control	ethanol #1	ethanol #2	diesel control	ethanol #1	ethanol #2
Cab/Body	630.26	383.74	270.95	1,008.75	671.06	577.01
PM'S	401.21	570.29	519.43	187.22	232.50	239.65
Chassis GRP	1,425.38	299.11	451.47	2,102.76	2,165.10	183.88
Drive Train	68.55	64.50	86.00	21.50	296.64	21.50
Electrical	745.04	1,491.89	1,289.03	1,293.96	799.17	912.92
Power Plant	983.16	1,615.15	384.22	1,411.54	1,197.77	1,775.22
Accessories	534.36	781.25	630.67	1,058.95	680.97	601.00
Special Appl.	0.00	179.34	53.75	32.25	64.50	251.18
Hydraulics	343.15	103.24	334.71	654.25	560.87	643.37
Misc. Work	704.99	1,079.91	2,325.26	498.90	1,028.81	1,253.76
Total	5,836.10	6,568.42	6,345.49	8,270.08	7,697.39	6,459.49

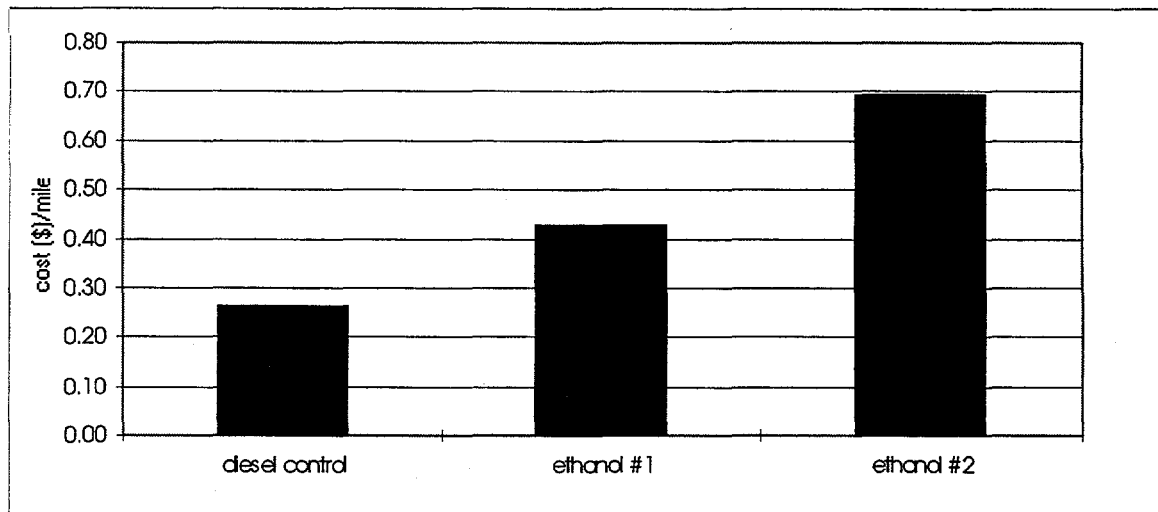


Figure 4. Total Maintenance Cost per Mile

To determine whether these costs resulted from the alternative fuel, the repair costs were broken down by truck systems. Table 3 shows the total maintenance cost by truck system. The detailed components that make up these systems can be seen in Appendix 4, which details repair costs by system and year. The most expensive systems for the 3 vehicles were chassis, for the diesel control, and power plant for both ethanol #1 and ethanol #2. Power plant maintenance and repair ranked number 4 for the diesel control. This can also be seen graphically in Figure 5.

Table 3. Total Maintenance Cost by Systems

	diesel control	ethanol #1	Ethanol #2
Cab /Body	1,686.96	2,507.93	1,511.40
PM'S	1,148.20	1,204.70	948.36
Chassis GRP	4,280.03	4,027.92	1,406.82
Drive Train	348.05	425.64	204.25
Electrical	3,445.97	3,094.71	3,554.30
Power Plant	2,944.79	5,777.98	4,466.68
Accessories	3,646.26	4,525.54	4,100.03
Special Appl.	111.06	610.98	448.24
Hydraulics	1,295.26	1,038.22	1,237.53
Misc.-New Prep	2,642.81	2,886.92	4,634.22
Total	21,549.39	26,100.54	22,511.83

The difference in maintenance and repair costs between the diesel control and the ethanol trucks is mainly attributable to the E95 fuel. Most of the components that are unique to the ethanol trucks are in the power plant system. The few remaining ethanol-specific components are categorized in cab/body or electrical and are insignificant relative to the non-ethanol component costs that make up those systems.

Most of the power plant repairs on the ethanol trucks were fuel system repairs. Both the primary and secondary fuel filters had to be replaced frequently. The fuel filters for the ethanol engines are much less porous than the diesel fuel filters to stop fine dirt from damaging the injectors and cylinders. The DDC 6V-92TA ethanol engine requires a 10- micron primary and a 1-micron secondary filter, where the DDC 6V-92TA diesel engine only requires a 40-micron primary and 5-micron secondary filter. Because of the smaller porosity, ethanol filters tend to clog more frequently from dirt and debris that enter the fuel system in the normal course of operation. The finer filters are required because ethanol does not have the lubricating properties inherent to petroleum-based fuels. Consequently, engines that burn ethanol are far less tolerant of impurities. We replaced the filters once each year on the diesel truck compared to eight or nine times for the ethanol trucks. Although the primary ethanol filter price came down \$72 during the project, the ethanol filters, primary and secondary, were still \$107 more expensive than the diesel filters. In the end, the primary and secondary ethanol filters cost \$73 and \$50, respectively. The diesel primary and secondary cost \$8 each. The total costs for fuel filter replacements were \$48, \$1,843, and \$1,667, for the diesel control, ethanol #1, and ethanol #2, respectively.

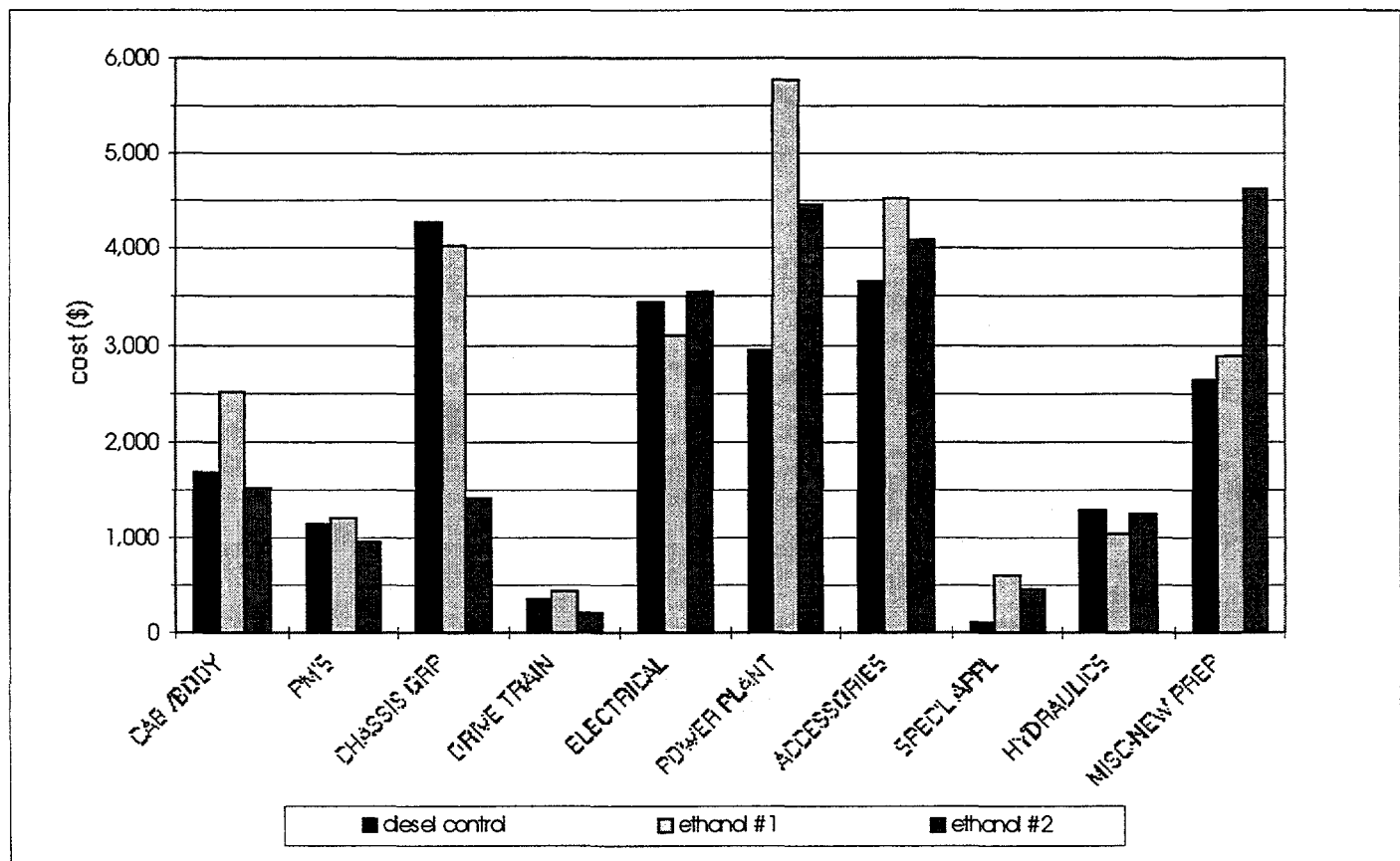


Figure 5. Total Maintenance Cost by Systems

The ethanol trucks also experienced fuel pump and fuel sending unit problems. Ethanol fuel pumps differ from diesel fuel pumps. They need to deliver almost twice as much fuel as a diesel fuel pump as a result of the lower heating value of ethanol. They also require special alcohol-resistant components. Both ethanol trucks required fuel pump replacements during the project. The fuel pump was replaced under warranty on ethanol #1 and the county replaced the fuel pump on ethanol #2. The total bill for this one repair was \$1,229, making it one of the more expensive repairs. Both trucks also had recurring problems with the fuel sending units and other miscellaneous fuel system repairs. In total, fuel system repair costs for the ethanol trucks were \$2,782 and \$2,623, compared to \$205 for the diesel truck. These costs account for most of the difference in repair costs for the three trucks.

Both ethanol trucks also had recurring problems with the electronic engine controls, but the problem was particularly troublesome on ethanol #2. The self-diagnostic codes (instrument panel warning system) repeatedly displayed false alarms for the cooling system and crankcase oil pressure. The county referred these problems to the dealer because they developed while the trucks were under warranty. The initial response from the dealer was that these were indeed false codes and the ECM was reset. When the false codes reoccurred, the dealer thought the problem was caused by bad sensors or a programming glitch with the ECM. Neither of these possibilities developed into a permanent fix and eventually the drivers came to just ignore the warnings.

In 1996, the last year of the project, both ethanol trucks started to require glow plug replacement. Glow plug replacement at this mileage is premature relative to diesel engines. Ethanol #1 had three glow plugs replaced at a total cost of \$324.56 and ethanol #2 had four glow plugs replaced at a total cost of \$332.97.

Although it is not being attributed to E95, it should be noted that ethanol #1 had a catastrophic engine failure at the end of the project. A cylinder head gasket failure allowed antifreeze into the cylinder. According to the engine dealer, the failure of the head gasket could have been caused by a gasket material failure, incorrect cylinder liner height, or incorrect head bolt torque. Although none of these failures can be discounted, the most likely cause is a failure or flaw in the gasket material. We do not believe the failure was fuel related.

Also worth noting, the new vehicle preparation costs are not included in these repair figures. These costs—\$3,879, \$4,312, and, \$4,527 for the diesel control, ethanol #1, and ethanol #2, respectively—are part of the cost of placing a truck in service and are not related to the alternative fuel. Mounting snow control equipment is quite labor intensive and staff time accounts for most of these costs. Because the preparation costs overstate the cost of repairs in the "miscellaneous" category, they were not included in the repair cost analysis.

The complete repair history for all trucks, arranged chronologically and by truck systems, is given in Appendix 5.

Driver Opinion

The fuel delivery system problems were the most troublesome to the drivers. As the fuel filters began to clog, drivers noted hard starting, stalling, hesitation, and cutting in and out. The more clogged the filters became, the more frequently the problems occurred. Sometimes the trucks would stall in traffic, creating a tense situation for the driver.

Fuel range was also a problem for the drivers. The drivers frequently expressed concern about having enough fuel to complete their routes. Although neither of the E95 trucks ever ran out of fuel, the drivers retained a level of nervousness about the short range, especially during the winter months.

The electronic problems were mildly annoying. The recurring false codes weakened the credibility of the diagnostic instrumentation and frequent trips to the engine dealer disrupted the normal work cycle. In the end, the drivers ignored the error messages.

Finally, the drivers reported a lack of power in the ethanol trucks. During the most strenuous assignments, such as hauling sand or aggregate on a grade, the drivers contended that the ethanol trucks had less power than the diesel. However, it should be noted that the county did not quantitatively substantiate these opinions.

Overall, when asked, the drivers stated they would not pick the ethanol trucks if given a choice of which truck to drive.

Oil Sampling

The county has been using oil analysis on its heavy equipment for about 20 years, and has had good luck in extending the oil change interval and in detecting engine problems early. The oil analysis for the ethanol trucks went smoothly with no abnormalities in all instances but one. The last oil sample on ethanol #1 revealed serious problems. However, by the time we received the results, the engine had already failed. As indicated previously, a head gasket failure allowed antifreeze into one of the cylinders causing the failure. Oil analysis results are shown in Appendix 6.

Operational Data

Hennepin County has considerable experience with alcohol fuels including storage and dispensing systems. We have used gasohol since 1983, and experienced all the early system problems inherent with alcohol fuels. In 1986, the county replaced the storage tanks as well as the pumping equipment. Gasohol had been in these tanks exclusively until the E95 demonstration when the county converted one tank solely to E95. This demonstration project lasted 3 years, and we did not have any of the fuel dispensing problems that we had experienced in the early

days of gasohol use. We did not replace any storage or pumping components throughout the project term, nor were there any reports from employees of any problems related to the E95.

Ethanol fuel is as easy to use as any conventional petroleum fuel. For Hennepin County, the conversion could not have been easier. There were no capital costs and no lengthy construction or installation projects. In fact, from the drivers' point of view, the larger fuel tank, fill time, and different fuel smell are the only differences they noticed at the pump.

In terms of cold weather fueling, E95 performed better than diesel. The county has experienced, during extreme cold weather, some gelling problems when fueling with diesel, which was not evident with E95. Hennepin County did not experience any cold starting problems with E95 because all the snow plow units were stored in heated garages.

Safety

The county did not experience any safety incidents with E95. Because it is not extremely toxic even in the denatured state (95% ethyl alcohol, 5% unleaded gasoline), it does not require any precautions beyond those needed for gasoline.

Emissions

West Virginia University (WVU) tested the emissions of the trucks twice during the project. The WVU transportable heavy-duty truck dynamometer was brought on site to test the emissions of the ethanol trucks as well as the diesel control truck.

The data generally show that oxides of nitrogen are slightly lower for the ethanol vehicles than for the diesel vehicle, and that particulate matter levels are significantly lower for ethanol. The diesel emissions levels remained consistent from year to year, and offered lower carbon monoxide emissions than the ethanol trucks, whereas the carbon monoxide emissions from ethanol #2 rose by a factor of three between 1994 and 1995. It is possible that catalytic converter efficiency had degraded on this vehicle, because hydrocarbon emissions also rose. Although the diesel vehicle had lower hydrocarbon emissions than the ethanol vehicles, it was evident that unburned ethanol was present as a significant fraction of the total hydrocarbon emissions of the ethanol vehicles. However, because oxides of nitrogen and particulate matter may be considered the emissions of concern for the heavy-duty fleet, the ethanol-powered vehicles have an advantage over their diesel counterparts relative to emissions. The complete WVU test results and summary are in Appendices 7 and 8.

Conclusions

This project was successful in several ways. First, a heavy-duty engine was developed and emissions certified to run on a high percentage blend of ethanol, a domestically produced and renewable fuel, for use in urban transit buses and over-the-road trucks. To date, the DDC 6V-92TA is the only alcohol fuel engine that can make this claim. Second, the ethanol trucks successfully performed the same rigorous duties as the diesel control trucks in a demanding vocation and harsh winter environment. Third, with some refinement, ethanol engines could prove to be as reliable and durable as their diesel counterparts. From a functional standpoint, the fuel filter clogging issue was the only significant barrier from the fleet administrator and the drivers' viewpoint. Fourth and finally, although E95 trucks emitted more hydrocarbons and carbon monoxide than the diesel trucks, the oxides of nitrogen and particulate matter, the emissions of concern for heavy-duty vehicles, were reduced.

The real hurdles for the widespread use of high percentage blends of ethanol are fuel costs, vehicle range, and infrastructure. Although exact fuel costs will vary by region and tax status, the E95 cost more than three times as much as diesel #2 (on an equivalent energy basis) in this demonstration. The vehicle range was an issue, even in this application where the vehicles covered a relatively small area. With this in mind, over-the-road travel would be impossible without an extensive fueling infrastructure.

Appendix 1
Collection Form to Gather Data: Driver Option

Appendix 1: Data Collection Form to Gather Driver Option

Vehicle Weekly Log Sheet

Operator: _____

Week of _____

Mileage: (_____) _____ - _____

Fuel Cost Per Gallon _____

Organization: _____

Vehicle ID # _____

License # _____

Data Collection for Week

Beginning (Monday): _____ / _____ /1993

SIDE 2

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Starting Odometer Reading:							
Ending Odometer Reading:							

Please evaluate the performance of your vehicle by responding to the performance categories listed in the table below.

Responses are: S = Superior; ✓ = No Problem; A = Mildly Annoying; T = Very Troublesome

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Hard to Start							
Stalled After Starting							
Stalled in Traffic							
Idle Quality							
Acceleration Quality							
Hesitation, Coughing							
Lack of Power							

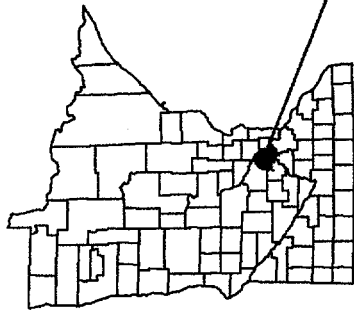
Regardless of severity, if any problem occurred, describe the type of driving (e.g., city, freeway), time of occurrence, and approximate weather condition (temp./moisture) for each problem occurrence.

Fuel Added		Oil Added		Maintenance Performed? Yes _____ No _____ If yes, Date _____ Type of Maintenance: _____
# Gallons	Odometer	# Qts.	Odometer	
Monday				☐ Scheduled ☐ Unscheduled
Tuesday				
Wednesday				
Thursday				
Friday				
Saturday				
Sunday				

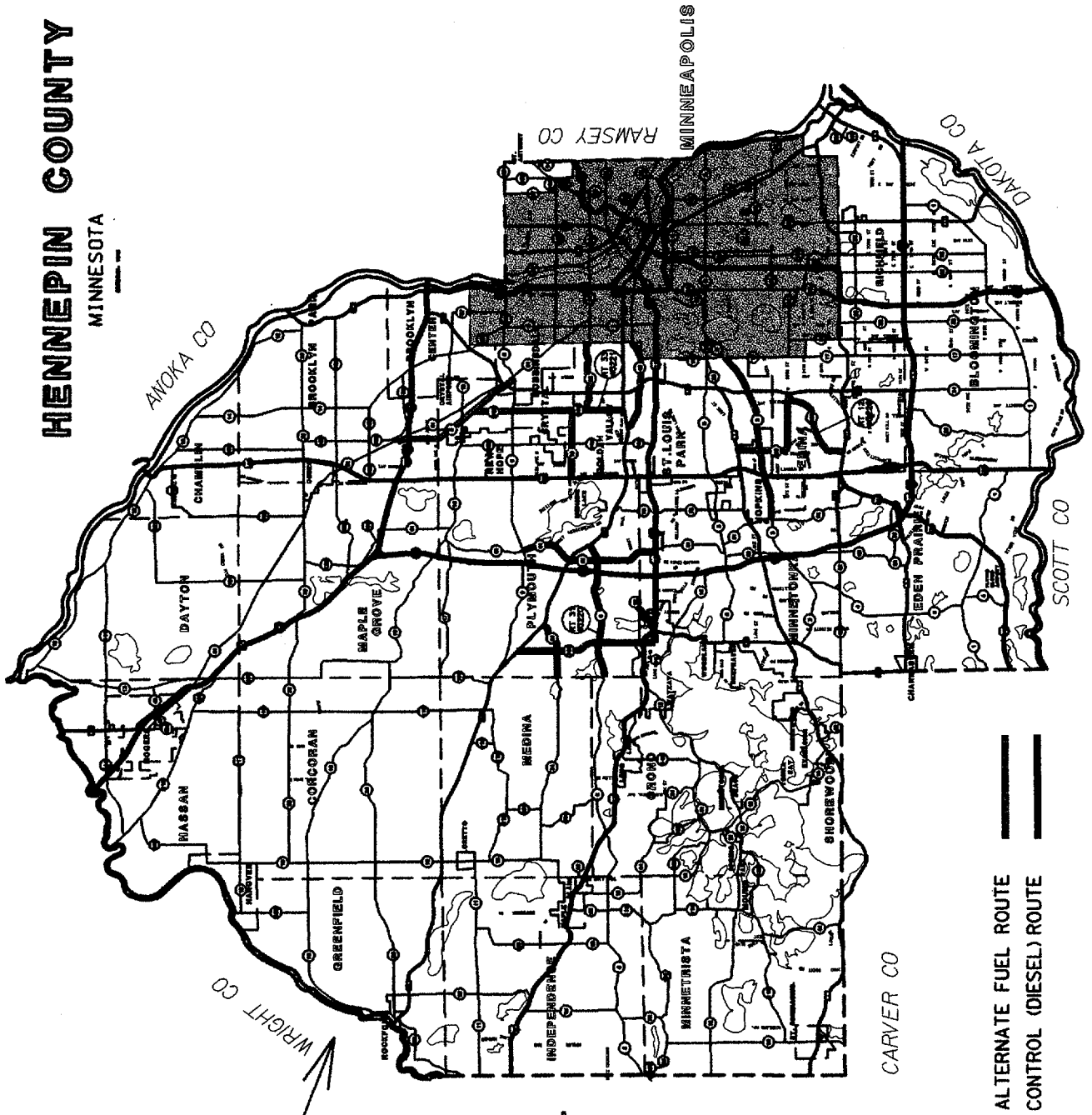
Appendix 2
Map of Demonstration Area

HENNEPIN COUNTY

MINNESOTA



ALTERNATE FUEL DEMONSTRATION



Appendix 3
Specifications for E95 Ethanol Fuel

SPECIFICATIONS FOR E95 ETHANOL FUEL
Interstate Detroit Diesel, Inc.

Specification	Value	Test Method
Ethanol	92 vol. % (min.)	ASTM D 3545-90
Denatured fuel ethanol	98 vol. % (min.)	1
Other alcohols and others	2 mass % (max.)	ASTM D 4815-89
Hydrocarbons gasoline or diesel fuel derived	5 mass % (max.)	ASTM D 4815-89, and then subtract concentration of alcohols, ethers, and water from 100 to obtain percent hydrocarbons.
Acidity as acetic acid	0.007 mass % (max.)	ASTM D 1613-85
Total chlorine as chloride	0.0004 mass % (max.)	ASTM D 3120-87 modified for organic chlorides, and ASTM 2988-86.
Copper	0.07 mg/l (max.)	ASTM D 1688-90 as modified in ASTM D 4806-88.
Lead	2 mg/l (max.)	ASTM D 3237-90
Phosphorus	0.2 mg/l (max.)	ASTM D 3231-89
Sulfur	0.01 mass % (max.)	ASTM D 3120-87
Gum, heptane washed	5 mg/liter (max.)	ASTM D 381-86
Total particulates	5 mg/l (max.)	ASTM D 2276-89
Water content	0.5 mass % (max.)	ASTM E 203-75
Appearance	Free of turbidity suspended matter and sediment	Visually determined at 15 degrees C by Proc. A of ASTM D 4176-86

Option: 0.06% (8 oz. per 100 gal) Lubrizol, Part #23509970

1 Must meet and ASTM D 4806-88 specification for denatured fuel ethanol, except the denaturant must be representative of unleaded gasoline that is commercially available blended at a maximum of 4 to 5 parts gasoline to 100 parts by volume fuel ethanol (including water) to form the denatured fuel ethanol. The final blend specifications for E-100 fuel take precedence over the ASTM D 4806-88 specification.

Appendix 4
Maintenance Costs by Truck System and Year

Repair Detail, Truck Number 3221

	1993	1994	1995	1996	TOTAL
CAB/BODY/MISC					
01 Climate cnt'l		53.75			53.75
02 Cab fixtures	21.50		56.81	150.23	228.54
03 gauges/instru		1,119.88		284.33	1,404.21
04 Glass					0.00
07 body		258.00	326.93	236.50	821.43
Total All Years	21.50	1,431.63	383.74	671.06	2,507.93
CHASSIS GROUP					
11 Axle, front, nondriv					0.00
12 Axle, rear, nondriv					0.00
13 Brake assm	571.09	360.75		649.89	1,581.73
14 Frame assm					0.00
15 Steering System					0.00
16 Suspension system				462.25	462.25
17 Tires		43.00	249.79	1,052.96	1,345.75
18 Wheel/rim	347.21	241.66	49.32		638.19
19 Track system					0.00
Total All Years	918.30	645.41	299.11	2,165.10	4,027.92
DRIVE TRAIN GROUP					
21 Axle, front driven					0.00
22 Axle, rear driven					0.00
23 Clutch assembly		64.50		64.50	129.00
24 Driveshaft assm					0.00
26 Transmiss, manual			64.50	232.14	296.64
Total All Years	0.00	64.50	64.50	296.64	425.64
ELECTRICAL					
31 Charging			107.50	212.39	319.89
32 Cranking		265.43	540.33		805.76
33 Ignition			107.50	217.06	324.56
34 Lighting		538.22	736.56	369.72	1,644.50
Total All Years	0.00	803.65	1,491.89	799.17	3,094.71
POWER PLANT					
41 Intake			413.87	118.25	532.12
42 Cooling		974.71	60.76	94.88	1,130.35
43 Exhaust		91.64	73.72	110.22	275.58
44 Fuel	764.94	951.02	699.65	366.35	2,781.96
45 Engine	43.00	139.75	367.15	277.33	827.23
46 Emissions Control				230.74	230.74
Total All Years	807.94	2,157.12	1,615.15	1,197.77	5,777.98
PMA		358.91	409.04	189.50	957.45
PMB		43.00	161.25	43.00	247.25
Total All Years	0.00	401.91	570.29	232.50	1,204.70

Repair Detail, Truck Number 3228

	1993	1994	1995	1996	TOTAL
CAB/BODY/MISC					
01 Climate cnt'l		118.69			118.69
02 Cab fixtures		77.92	43.00	86.00	206.92
03 gauges/instru		251.81	227.95	134.53	614.29
04 Glass					0.00
07 body	215.02			356.48	571.50
Total All Years	215.02	448.42	270.95	577.01	1,511.40
CHASSIS GROUP					
11 Axle, front, nondriv			140.04	43.00	183.04
12 Axle, rear, nondriv					0.00
13 Brake assm	75.25	389.77	97.85	140.88	703.75
14 Frame assm					0.00
15 Steering System					0.00
16 Suspension system					0.00
17 Tires			353.62		353.62
18 Wheel/rim		166.41			166.41
19 Track system					0.00
Total All Years	75.25	556.18	591.51	183.88	1,406.82
DRIVE TRAIN GROUP					
21 Axle, front driven					0.00
22 Axle, rear driven		96.75			96.75
23 Clutch assembly				21.50	21.50
24 Driveshaft assm					0.00
26 Transmiss, manual			86.00		86.00
Total All Years	0.00	96.75	86.00	21.50	204.25
ELECTRICAL					
31 Charging		391.40	86.00	37.28	514.68
32 Cranking		379.53	303.83	223.77	907.13
33 Ignition				347.88	347.88
34 Lighting		581.42	899.20	303.99	1,784.61
Total All Years	0.00	1,352.35	1,289.03	912.92	3,554.30
POWER PLANT					
41 Intake				121.41	121.41
42 Cooling	21.50	350.39	30.38	248.73	651.00
43 Exhaust		127.47		423.96	551.43
44 Fuel	344.88	943.55	353.84	981.12	2,623.39
45 Engine		483.75			483.75
46 Emissions Control	35.70				35.70
Total All Years	402.08	1,905.16	384.22	1,775.22	4,466.68
PMA		135.82	185.89	153.65	475.36
PMB		193.50	193.50	86.00	473.00
Total All Years	0.00	329.32	379.39	239.65	948.36

	1993	1994	1995	1996	TOTAL
51 Access general	51.83	2,021.77	392.71	86.00	2,552.31
52 Access electric	43.00	565.59	205.71	439.75	1,254.05
54 Snow equip	98.05	21.50	32.25	75.25	227.05
55 Lift systems		21.50			21.50
56 PTO systems					0.00
59 Veh coupling sys	45.12				45.12
Total All Years	238.00	2,630.36	630.67	601.00	4,100.03
SPECIAL APPLICAT					
61 Buckets					0.00
62 Blades					0.00
63 Brooms					0.00
64 Cables					0.00
65 Heating units					0.00
66 Special quip	143.31		53.75	251.18	448.24
Total All Years	143.31	0.00	53.75	251.18	448.24
HYDRAULICS					
71 Hydraulic pump					0.00
72 Hydraulic cylinder					0.00
73 Lines		150.50	220.72	335.88	707.10
74 Valves	21.50			290.25	311.75
75 Motors					0.00
76 Couplings			86.00		86.00
77 Tank assm		87.45	27.99	17.24	132.68
78 Auxiliary					0.00
Total All Years	21.50	237.95	334.71	643.37	1,237.53
MISC EQUIP/WORK					
91 Misc Tank					0.00
92 Misc cutting equip					0.00
98 Misc inside work	4,526.91	1,055.20	876.01	864.40	7,322.52
99 Outside vendor			1,449.25	389.36	1,838.61
9830 New veh Prep	4526.91				
Total All Yrs-Veh Prep	0.00	1,055.20	2,325.26	1,253.76	4,634.22
Total All Years					9,161.13
GRAND TOTAL					22,511.83

	1993	1994	1995	1996	TOTAL
CAB/BODY/MISC					
01 Climate cnt'l	0.00		142.50		142.50
02 Cab fixtures	0.00		23.16	310.00	333.16
03 gauges/instru	0.00		142.91	602.00	744.91
04 Glass					0.00
07 body	0.00	47.95	321.69	96.75	466.39
Total All Years	0.00	47.95	630.26	1,008.75	1,686.96
CHASSIS GROUP					
11 Axle, front, nondriv	0.00			21.50	21.50
12 Axle, rear, nondriv	0.00				0.00
13 Brake assm	206.02		692.79	179.02	1,077.83
14 Frame assm	0.00				0.00
15 Steering System	0.00				0.00
16 Suspension system	0.00			881.40	881.40
17 Tires	0.00	43.00	732.59	1,020.84	1,796.43
18 Wheel/rim	347.21	155.66			502.87
19 Track system	0.00				0.00
Total All Years	553.23	198.66	1,425.38	2,102.76	4,280.03
DRIVE TRAIN GROUP					
21 Axle, front driven					0.00
22 Axle, rear driven		43.00			43.00
23 Clutch assembly		129.00	53.75	21.50	204.25
24 Driveshaft assm					0.00
26 Transmiss, manual		86.00	14.80		100.80
Total All Years	0.00	258.00	68.55	21.50	348.05
ELECTRICAL					
31 Charging				193.31	193.31
32 Cranking		213.44		421.33	634.77
33 Ignition		86.00			86.00
34 Lighting		1,107.53	745.04	679.32	2,531.89
Total All Years	0.00	1,406.97	745.04	1,293.96	3,445.97
POWER PLANT					
41 Intake		161.38			161.38
42 Cooling		250.00	924.72	1,276.85	2,451.57
43 Exhaust	62.09		21.50		83.59
44 Fuel		33.62	36.94	134.69	205.25
45 Engine		43.00			43.00
46 Emissions Control					0.00
Total All Years	62.09	488.00	983.16	1,411.54	2,944.79
PMA	180.51	335.36	368.96	165.72	1,050.55
PMB		43.90	32.25	21.50	97.65
Total All Years	180.51	379.26	401.21	187.22	1,148.20

	1993	1994	1995	1996	TOTAL
ACCESSORIES GRP					
51 Access general	75.25	1,425.74	324.68	627.43	2,453.10
52 Access electric	66.85	375.49	209.68	388.52	1,040.54
54 Snow equip	0.00	64.50		43.00	107.50
55 Lift systems	0.00				0.00
56 PTO systems	0.00				0.00
59 Veh Coupling Sys	45.12				45.12
Total All Years	187.22	1,865.73	534.36	1,058.95	3,646.26
SPECIAL APPLICAT					
61 Buckets	0.00				0.00
62 Blades	0.00				0.00
63 Brooms	0.00				0.00
64 Cables	0.00				0.00
65 Heating units	0.00				0.00
66 Special quip	78.81			32.25	111.06
Total All Years	78.81	0.00	0.00	32.25	111.06
HYDRAULICS					
71 Hydraulic pump					0.00
72 Hydraulic cylinder					0.00
73 Lines			87.42	565.50	652.92
74 Valves	107.50	136.61	139.75		383.86
75 Motors					0.00
76 Couplings			24.74		24.74
77 Tank assm		53.75	91.24	88.75	233.74
78 Auxiliary					0.00
Total All Years	107.50	190.36	343.15	654.25	1,295.26
MISC EQUIP/WORK					
91 Misc Tank				21.50	21.50
92 Misc cutting equip					0.00
98 Misc inside work	4,256.39	1,061.75	704.99	477.40	6,500.53
99 Outside vendor					0.00
9830 New veh prep	3,879.22				
Total All Yrs-Veh Prep	377.17	1,061.75	704.99	498.90	2,642.81
Total All Years					6,522.03
GRAND TOTAL					21,549.39

Appendix 5
Repair History by Truck System

SYNCSORT 3.6ARI TPF2B US PATENTS: 4210961,5117495, OTHER PAT. PEND. (C) SYNCSORT INC. 1993 DATE=96/324 TIME=14.59.13
HENNEPIN COUNTY INFORMATION SERVICES ESA 5.2.2 CPU MODEL 3090

PARMLIST :
SORT SIZE=E0002804, FIELDS=(01,04,CH,A,067,04,CH,A,05,01,CH,A,031,04,CH,A,067,08,
2D,A)
RECORD TYPE=F, LENGTH=00148

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HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

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VEHICLE 3228 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
FINAL TOTALS				195,736.07	32,767.73	61,878.56	290,382.36

2.804 RECORDS TOTALED

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
		VEHICLE 3228	INT'	ETHANOL TANDEM AXLE			
				4,740.75	269.48	1,343.51	6,353.74
				19,136.75	1,655.75	6,246.24	27,038.74
	ENDYR TOTAL						
	UNIT TOTAL						

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HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

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VEHICLE 3228 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
7301R	HYD LINE, PRESSURE	259106	1996/03/20	322.50	13.38	.00	335.88
	REPAIR TYPE TOTAL			322.50	13.38	.00	335.88
	REPAIR SUB GROUP TOTAL			322.50	13.38	.00	335.88
7401O	HYDRAULIC VALVE	257703	1996/01/30	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
7476O	CABLE, CONTL LEVER	257703	1996/01/30	75.25	.00	.00	75.25
7476O	CABLE, CONTL LEVER	256305	1996/07/02	172.00	.00	.00	172.00
	REPAIR TYPE TOTAL			247.25	.00	.00	247.25
	REPAIR SUB GROUP TOTAL			290.25	.00	.00	290.25
7721R	HYD TANK FILTER	262379	1996/08/21	10.75	6.49	.00	17.24
	REPAIR TYPE TOTAL			10.75	6.49	.00	17.24
	REPAIR SUB GROUP TOTAL			10.75	6.49	.00	17.24
	REPAIR GROUP TOTAL			623.50	19.87	.00	643.37
9820O	GENERAL GREASING	M08225	1996/02/08	96.75	.88	.00	97.63
9820O	GENERAL GREASING	M08407	1996/03/14	86.00	.88	.00	86.88
9820O	GENERAL GREASING	M08607	1996/04/26	86.00	.88	.00	86.88
9820O	GENERAL GREASING	M09175	1996/09/19	86.00	.88	.00	86.88
9820O	GENERAL GREASING	M09298	1996/10/29	86.00	.88	.00	86.88
	REPAIR TYPE TOTAL			440.75	4.40	.00	445.15
9860I	TRUCK INSPECTION	262379	1996/08/21	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
9890O	DIAGNOSTIC ELECTRIC	257310	1996/01/23	129.00	.00	.00	129.00
	REPAIR TYPE TOTAL			129.00	.00	.00	129.00
9895O	DIAGNOSTIC MECHANICL	257310	1996/01/23	64.50	.00	.00	64.50
9895I	DIAGNOSTIC MECHANICL	261019	1996/06/14	21.50	.00	.00	21.50
9895I	DIAGNOSTIC MECHANICL	263344	1996/09/17	64.50	.00	.00	64.50
	REPAIR TYPE TOTAL			150.50	.00	.00	150.50
	REPAIR SUB GROUP TOTAL			763.25	4.40	.00	767.65
9940O	POWER PLANT GROUP	259385	1996/04/03	.00	.00	389.36	389.36
	REPAIR TYPE TOTAL			.00	.00	389.36	389.36
	REPAIR SUB GROUP TOTAL			.00	.00	389.36	389.36
	REPAIR GROUP TOTAL			763.25	4.40	389.36	1,157.01
	PM/MINUS PM TOTAL			4,515.00	258.50	1,297.59	6,071.09

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

VEHICLE 3228 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
4411R	FILTER, SECONDARY	259385	1996/04/03	.00	.00	46.92	46.92
4411R	FILTER, SECONDARY	262379	1996/08/21	21.50	.00	145.42	166.92
	REPAIR TYPE TOTAL			21.50	.00	192.34	213.84
4415I	FUEL LINES	257194	1996/02/06	118.25	.00	.00	118.25
	REPAIR TYPE TOTAL			118.25	.00	.00	118.25
44800	ELECTRONIC CONTROLS	257194	1996/02/06	193.50	14.43	.00	207.93
	REPAIR TYPE TOTAL			193.50	14.43	.00	207.93
	REPAIR SUB GROUP TOTAL			580.50	21.89	378.73	981.12
	REPAIR GROUP TOTAL			1,096.50	86.81	591.91	1,775.22
5102R	MUD FLAP(S)	262481	1996/08/15	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
51100	TARPALIN ASSEMBLY	263644	1996/09/26	21.50	.00	.00	21.50
51100	TARPALIN ASSEMBLY	263919	1996/10/21	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			64.50	.00	.00	64.50
	REPAIR SUB GROUP TOTAL			86.00	.00	.00	86.00
52400	BOX SHAKER	257194	1996/02/06	96.75	.63	.00	97.38
	REPAIR TYPE TOTAL			96.75	.63	.00	97.38
52510	MISC WIRING	258020	1996/02/16	225.75	.00	19.87	245.62
52510	MISC WIRING	263344	1996/09/17	96.75	.00	.00	96.75
	REPAIR TYPE TOTAL			322.50	.00	19.87	342.37
	REPAIR SUB GROUP TOTAL			419.25	.63	19.87	439.75
54020	SNOW PLOW BLADE	257310	1996/01/23	75.25	.00	.00	75.25
	REPAIR TYPE TOTAL			75.25	.00	.00	75.25
	REPAIR SUB GROUP TOTAL			75.25	.00	.00	75.25
	REPAIR GROUP TOTAL			580.50	.63	19.87	601.00
66000	SP EQUIP ACCESSORIES	260236	1996/05/07	161.25	5.15	.00	166.40
66000	SP EQUIP ACCESSORIES	252154	1996/07/02	.00	.00	20.28	20.28
6600L	SP EQUIP ACCESSORIES	262523	1996/08/15	21.50	.00	.00	21.50
66000	SP EQUIP ACCESSORIES	264085	1996/10/23	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			225.75	5.15	20.28	251.18
	REPAIR SUB GROUP TOTAL			225.75	5.15	20.28	251.18
	REPAIR GROUP TOTAL			225.75	5.15	20.28	251.18

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

REPAIR CODE	DESCRIPTION	WORK ORDER	NO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
VEHICLE 3228 INT' ETHANOL TANDEM AXLE							
34500	SANDER/WORK LAMP	257860	1996/02/06	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				21.50	.00	.00	21.50
34700	FUSES, LIGHT(S)	258720	1996/03/11	43.00	1.47	.00	44.47
REPAIR TYPE TOTAL				43.00	1.47	.00	44.47
3485R	FLASHER UNIT	260369	1996/05/14	21.50	12.68	.00	34.18
REPAIR TYPE TOTAL				21.50	12.68	.00	34.18
REPAIR SUB GROUP TOTAL				182.75	78.00	43.24	303.99
REPAIR GROUP TOTAL				612.75	119.02	181.15	912.92
41300	SUPERCARGER	257310	1996/01/23	86.00	.00	35.41	121.41
REPAIR TYPE TOTAL				86.00	.00	35.41	121.41
REPAIR SUB GROUP TOTAL				86.00	.00	35.41	121.41
42000	COOLING SYSTEM	260369	1996/05/14	64.50	.00	.00	64.50
42000	COOLING SYSTEM	262379	1996/08/21	.00	.00	7.96	7.96
REPAIR TYPE TOTAL				64.50	.00	7.96	72.46
42010	RADIATOR	262379	1996/08/21	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				43.00	.00	.00	43.00
4212R	COOLANT FILTER	262379	1996/08/21	10.75	8.88	.00	19.63
REPAIR TYPE TOTAL				10.75	8.88	.00	19.63
4231R	WATER PUMP BELT	262379	1996/08/21	64.50	.00	49.14	113.64
REPAIR TYPE TOTAL				64.50	.00	49.14	113.64
REPAIR SUB GROUP TOTAL				182.75	8.88	57.10	248.73
4302R	EXT MANIFOLD GASKET	258766	1996/03/28	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				43.00	.00	.00	43.00
4320R	EXHAUST TUBING	262379	1996/08/21	204.25	56.04	120.67	380.96
REPAIR TYPE TOTAL				204.25	56.04	120.67	380.96
REPAIR SUB GROUP TOTAL				247.25	56.04	120.67	423.96
44000	FUEL SYSTEM	257310	1996/01/23	129.00	7.46	.00	136.46
44000	FUEL SYSTEM	259385	1996/04/03	64.50	.00	.00	64.50
REPAIR TYPE TOTAL				193.50	7.46	.00	200.96
4410R	FILTER, PRIMARY	257194	1996/02/06	32.25	.00	63.97	96.22
4410R	FILTER, PRIMARY	259385	1996/04/03	.00	.00	72.71	72.71
4410R	FILTER, PRIMARY	262379	1996/08/21	21.50	.00	49.71	71.21
REPAIR TYPE TOTAL				53.75	.00	186.39	240.14

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

VEHICLE 3228 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
REPAIR GROUP TOTAL							
2300L	CLUTCH ASSEMBLY	262379	1996/08/21	21.50	.00	.00	21.50
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
3107R	ALTERNATOR BELT	262379	1996/08/21	21.50	.00	15.78	37.28
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
3201R	BATTERY	261019	1996/06/14	43.00	41.02	.00	84.02
3201I	BATTERY	261846	1996/07/26	118.25	.00	.00	118.25
REPAIR TYPE TOTAL							
3240R	STARTER SWITCH	263344	1996/09/17	21.50	.00	.00	21.50
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
3325R	GLOW PLUG(S)	258020	1996/02/16	43.00	.00	25.77	68.77
3325R	GLOW PLUG(S)	258766	1996/03/28	96.75	.00	81.45	178.20
3325O	GLOW PLUG(S)	258766	1996/03/28	86.00	.00	.00	86.00
REPAIR TYPE TOTAL							
3335R	IGNITION SWITCH	263344	1996/09/17	.00	.00	14.91	14.91
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
3401R	HEADLAMP	257860	1996/02/06	21.50	12.36	.00	33.86
REPAIR TYPE TOTAL							
3410O	STOPLAMP	261839	1996/07/19	10.75	.00	.00	10.75
REPAIR TYPE TOTAL							
3420R	TAIL/PARK LAMP	261839	1996/07/19	.00	8.67	.00	8.67
REPAIR TYPE TOTAL							
3430R	CLEARANCE/MARKER LMP	261839	1996/07/19	.00	1.82	.00	1.82
REPAIR TYPE TOTAL							
3433O	MISC. LAMPS	257194	1996/02/06	21.50	.00	.00	21.50
REPAIR TYPE TOTAL							
3440O	STROBE LAMP	258835	1996/03/11	43.00	41.00	43.24	127.24
REPAIR TYPE TOTAL							

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HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
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VEHICLE 3228 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
1115L PMA		258351	1996/02/23	96.75	10.98	45.92	153.65
REPAIR TYPE TOTAL				96.75	10.98	45.92	153.65
1120L PWB		262379	1996/08/21	86.00	.00	.00	86.00
REPAIR TYPE TOTAL				86.00	.00	.00	86.00
REPAIR SUB GROUP TOTAL				225.75	10.98	45.92	282.65
REPAIR GROUP TOTAL				225.75	10.98	45.92	282.65
PM/MINUS PM TOTAL				225.75	10.98	45.92	282.65
02150 MIRROR, EXTERNAL		257310	1996/01/23	64.50	.00	.00	64.50
REPAIR TYPE TOTAL				64.50	.00	.00	64.50
02850 W/SHIELD WASHER ASSM		257194	1996/02/06	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				21.50	.00	.00	21.50
REPAIR SUB GROUP TOTAL				86.00	.00	.00	86.00
03260 FUEL GG SENDER UNIT		257667	1996/01/30	21.50	.00	.00	21.50
0326R FUEL GG SENDER UNIT		258020	1996/02/16	43.00	.00	24.32	67.32
0326R FUEL GG SENDER UNIT		263344	1996/09/17	21.50	.00	24.21	45.71
REPAIR TYPE TOTAL				86.00	.00	48.53	134.53
REPAIR SUB GROUP TOTAL				86.00	.00	48.53	134.53
07450 TAILGATE		262215	1996/08/06	53.75	.00	.00	53.75
REPAIR TYPE TOTAL				53.75	.00	.00	53.75
07960 DUMP BODY CAB SHIELD		263492	1996/09/20	96.75	.00	.00	96.75
REPAIR TYPE TOTAL				96.75	.00	.00	96.75
0797R DMBODY SPILL SHIELD		252154	1996/07/02	161.25	9.06	35.67	205.98
REPAIR TYPE TOTAL				161.25	9.06	35.67	205.98
REPAIR SUB GROUP TOTAL				311.75	9.06	35.67	356.48
REPAIR GROUP TOTAL				483.75	9.06	84.20	577.01
13000 BRAKE SYSTEM		259388	1996/04/03	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				43.00	.00	.00	43.00
13500 AIR COMPRESSOR		262379	1996/08/21	64.50	13.56	.00	78.06
REPAIR TYPE TOTAL				64.50	13.56	.00	78.06
13600 AIR SUPPLY TANKS		259388	1996/04/03	.00	.00	10.82	10.82
REPAIR TYPE TOTAL				.00	.00	10.82	10.82
REPAIR SUB GROUP TOTAL				107.50	13.56	10.82	131.88

VEHICLE 3228 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
76010	QUICK DISCONNECT	252229	1995/06/19	86.00	.00	.00	86.00
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
7721R	HYD TANK FILTER	253218	1995/08/17	21.50	6.49	.00	27.99
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
98200	GENERAL GREASING	M06620	1995/01/27	118.25	.87	.00	119.12
98200	GENERAL GREASING	M06945	1995/03/29	64.50	.87	.00	65.37
98200	GENERAL GREASING	M07397	1995/07/24	64.50	.88	.00	65.38
98200	GENERAL GREASING	M07634	1995/09/18	86.00	.88	.00	86.88
98200	GENERAL GREASING	M07770	1995/10/20	86.00	.88	.00	86.88
98200	GENERAL GREASING	M07964	1995/12/07	86.00	.88	.00	86.88
REPAIR TYPE TOTAL							
98601	TRUCK INSPECTION	253218	1995/08/17	129.00	.00	.00	129.00
REPAIR TYPE TOTAL							
98901	DIAGNOSTIC ELECTRIC	253188	1995/08/07	193.50	.00	.00	193.50
REPAIR TYPE TOTAL							
98951	DIAGNOSTIC MECHANICAL	252311	1995/07/24	43.00	.00	.00	43.00
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
99400	POWER PLANT GROUP	252311	1995/07/24	.00	.00	1,229.05	1,229.05
99400	POWER PLANT GROUP	253462	1995/08/21	.00	.00	.00	.00
99400	POWER PLANT GROUP	253750	1995/08/28	.00	.00	164.30	164.30
REPAIR TYPE TOTAL							
9990L	TOWING	251306	1995/05/19	.00	.00	.00	.00
99900	TOWING	M07160	1995/05/25	.00	.00	55.90	55.90
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
PM/MINUS PM TOTAL				870.75	5.26	1,449.25	2,325.26
ENDYR TOTAL				3,354.00	619.05	1,853.01	5,826.06
11100	WET TYPE HUB ASSEMB.	258020	1996/02/16	43.00	.00	.00	43.00
REPAIR TYPE TOTAL							

Fuel Pump

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HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

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VEHICLE 3228 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
4411R	FILTER, SECONDARY	256349	1995/12/15	.00	.00	49.71	49.71
	REPAIR TYPE TOTAL			.00	.00	49.71	49.71
	REPAIR SUB GROUP TOTAL			86.00	.00	267.84	353.84
45000	ENGINE	251306	1995/05/19	.00	.00	.00	.00
	REPAIR TYPE TOTAL			.00	.00	.00	.00
	REPAIR SUB GROUP TOTAL			.00	.00	.00	.00
	REPAIR GROUP TOTAL			107.50	8.88	267.84	384.22
51000	ACCESSORIES, GENERAL	255142	1995/10/30	.00	.00	58.62	58.62
	REPAIR TYPE TOTAL			.00	.00	58.62	58.62
51100	TARPALIN ASSEMBLY	255142	1995/10/30	247.25	.84	.00	248.09
51100	TARPALIN ASSEMBLY	256244	1995/12/12	86.00	.00	.00	86.00
	REPAIR TYPE TOTAL			333.25	.84	.00	334.09
	REPAIR SUB GROUP TOTAL			333.25	.84	58.62	392.71
52250	2-WAY RADIO	253836	1995/09/01	161.25	.00	.00	161.25
	REPAIR TYPE TOTAL			161.25	.00	.00	161.25
5251R	MISC WIRING	253554	1995/08/21	43.00	1.46	.00	44.46
	REPAIR TYPE TOTAL			43.00	1.46	.00	44.46
	REPAIR SUB GROUP TOTAL			204.25	1.46	.00	205.71
54020	SNOW PLOW BLADE	249305	1995/02/21	32.25	.00	.00	32.25
	REPAIR TYPE TOTAL			32.25	.00	.00	32.25
	REPAIR SUB GROUP TOTAL			32.25	.00	.00	32.25
	REPAIR GROUP TOTAL			569.75	2.30	58.62	630.67
66000	SP EQUIP ACCESSORIES	256662	1995/12/28	53.75	.00	.00	53.75
	REPAIR TYPE TOTAL			53.75	.00	.00	53.75
	REPAIR SUB GROUP TOTAL			53.75	.00	.00	53.75
	REPAIR GROUP TOTAL			53.75	.00	.00	53.75
7301R	HYD LINE, PRESSURE	248113	1995/01/12	129.00	33.65	.00	162.65
	REPAIR TYPE TOTAL			129.00	33.65	.00	162.65
73500	HYD LINE, MISC.	248278	1995/01/23	53.75	4.32	.00	58.07
	REPAIR TYPE TOTAL			53.75	4.32	.00	58.07
	REPAIR SUB GROUP TOTAL			182.75	37.97	.00	220.72

VEHICLE 3228 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
3201R	BATTERY	252960	1995/07/24	139.75	164.08	.00	303.83
REPAIR TYPE TOTAL				139.75	164.08	.00	303.83
REPAIR SUB GROUP TOTAL				139.75	164.08	.00	303.83
3401R	HEADLAMP	253218	1995/08/17	21.50	12.36	.00	33.86
REPAIR TYPE TOTAL				21.50	12.36	.00	33.86
34100	STOPLAMP	253836	1995/09/01	139.75	.00	.00	139.75
REPAIR TYPE TOTAL				139.75	.00	.00	139.75
34150	TURN SIGNAL LAMP	250658	1995/04/18	193.50	7.93	.00	201.43
REPAIR TYPE TOTAL				193.50	7.93	.00	201.43
3420R	TAIL/PARK LAMP	251427	1995/05/12	.00	.00	8.30	8.30
34200	TAIL/PARK LAMP	251427	1995/05/12	32.25	.00	.00	32.25
REPAIR TYPE TOTAL				32.25	.00	8.30	40.55
34300	CLEARANCE/MARKER LMP	248090	1995/01/12	10.75	.00	.00	10.75
34300	CLEARANCE/MARKER LMP	252311	1995/07/24	21.50	.00	.00	21.50
34300	CLEARANCE/MARKER LMP	253280	1995/08/07	43.00	.00	.00	43.00
34300	CLEARANCE/MARKER LMP	256514	1995/12/19	43.00	1.95	.00	44.95
REPAIR TYPE TOTAL				118.25	1.95	.00	120.20
34330	MISC. LAMPS	248404	1995/01/23	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				43.00	.00	.00	43.00
34400	STROBE LAMP	248113	1995/01/12	193.50	.00	.00	193.50
34400	STROBE LAMP	253218	1995/08/17	64.50	.00	.00	64.50
REPAIR TYPE TOTAL				258.00	.00	.00	258.00
34500	SANDER/WORK LAMP	249795	1995/03/10	43.00	6.36	.00	49.36
REPAIR TYPE TOTAL				43.00	6.36	.00	49.36
3455R	LAMP SWITCH(S)	253836	1995/09/01	.00	.00	13.05	13.05
REPAIR TYPE TOTAL				.00	.00	13.05	13.05
REPAIR SUB GROUP TOTAL				849.25	28.60	21.35	899.20
REPAIR GROUP TOTAL				1,075.00	192.68	21.35	1,289.03
4212R	COOLANT FILTER	253218	1995/08/17	21.50	8.88	.00	30.38
REPAIR TYPE TOTAL				21.50	8.88	.00	30.38
REPAIR SUB GROUP TOTAL				21.50	8.88	.00	30.38
4410R	FILTER, PRIMARY	252050	1995/06/12	21.50	.00	145.42	166.92
4410R	FILTER, PRIMARY	256349	1995/12/15	.00	.00	72.71	72.71
44100	FILTER, PRIMARY	256349	1995/12/15	64.50	.00	.00	64.50
REPAIR TYPE TOTAL				86.00	.00	218.13	304.13

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VEHICLE 3228 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
	REPAIR SUB GROUP TOTAL			408.50	10.97	99.96	519.43
	REPAIR GROUP TOTAL			408.50	10.97	99.96	519.43
	PM/MINUS PM TOTAL			408.50	10.97	99.96	519.43
02150	MIRROR, EXTERNAL	252960	1995/07/24	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
	REPAIR SUB GROUP TOTAL			43.00	.00	.00	43.00
03250	FUEL GAUGE	248597	1995/01/30	86.00	.00	.00	86.00
	REPAIR TYPE TOTAL			86.00	.00	.00	86.00
0326R	FUEL GG SENDER UNIT	248597	1995/01/30	.00	.00	28.90	28.90
0326R	FUEL GG SENDER UNIT	253836	1995/09/01	64.50	.00	27.05	91.55
0326I	FUEL GG SENDER UNIT	253836	1995/09/01	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			86.00	.00	55.95	141.95
	REPAIR SUB GROUP TOTAL			172.00	.00	55.95	227.95
	REPAIR GROUP TOTAL			215.00	.00	55.95	270.95
13850	SPRING PARKING BRAKE	256547	1995/12/19	32.25	65.60	.00	97.85
	REPAIR TYPE TOTAL			32.25	65.60	.00	97.85
	REPAIR SUB GROUP TOTAL			32.25	65.60	.00	97.85
1702R	TIRE, WORN	249930	1995/03/14	53.75	299.87	.00	353.62
	REPAIR TYPE TOTAL			53.75	299.87	.00	353.62
	REPAIR SUB GROUP TOTAL			53.75	299.87	.00	353.62
	REPAIR GROUP TOTAL			86.00	365.47	.00	451.47
26000	TRANSMISSION, MANUAL	249305	1995/02/21	86.00	.00	.00	86.00
	REPAIR TYPE TOTAL			86.00	.00	.00	86.00
	REPAIR SUB GROUP TOTAL			86.00	.00	.00	86.00
	REPAIR GROUP TOTAL			86.00	.00	.00	86.00
3100I	CHARGING SYSTEM	253218	1995/08/17	64.50	.00	.00	64.50
	REPAIR TYPE TOTAL			64.50	.00	.00	64.50
31300	ELECTRICAL GROUND	253218	1995/08/17	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
	REPAIR SUB GROUP TOTAL			86.00	.00	.00	86.00

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VEHICLE 3228 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
7720R	HYD TANK FILTER ASSM	244659	1994/08/30	86.00	1.45	.00	87.45
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
98000	MISC INSIDE WORK	M05302	1994/02/25	.00	.00	2.56	2.56
REPAIR TYPE TOTAL							
98020	STEAMING	243887	1994/08/01	86.00	.00	.00	86.00
REPAIR TYPE TOTAL							
98200	GENERAL GREASING	M04995	1994/01/06	124.50	.80	.00	125.30
98200	GENERAL GREASING	M05570	1994/04/14	64.50	.80	.00	65.30
98200	GENERAL GREASING	M05684	1994/05/18	53.75	.80	.00	54.55
98200	GENERAL GREASING	M06071	1994/09/19	86.00	.80	5.12	91.92
98200	GENERAL GREASING	M06247	1994/11/04	107.50	.80	.00	108.30
98200	GENERAL GREASING	M06449	1994/12/14	96.75	.80	4.47	102.02
REPAIR TYPE TOTAL							
98601	TRUCK INSPECTION	244659	1994/08/30	397.75	.00	.00	397.75
REPAIR TYPE TOTAL							
98951	DIAGNOSTIC MECHANIC	244924	1994/09/21	21.50	.00	.00	21.50
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
9940L	POWER PLANT GROUP	245814	1994/09/30	.00	.00	.00	.00
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
PM/MINUS PM TOTAL							
ENDYR TOTAL							
11100	WET TYPE HUB ASSEMB.	253435	1995/08/17	86.00	.00	.00	86.00
1110R	WET TYPE HUB ASSEMB.	253435	1995/08/17	.00	.00	54.04	54.04
REPAIR TYPE TOTAL							
1115L	PMA	249505	1995/03/01	129.00	10.97	45.92	185.89
REPAIR TYPE TOTAL							
1120L	PMB	253218	1995/08/17	193.50	.00	.00	193.50
REPAIR TYPE TOTAL							

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REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
VEHICLE 3228 INT' ETHANOL TANDEM AXLE							
REPAIR SUB GROUP TOTAL							
45000	ENGINE	239488	1994/02/14	526.75	.00	416.80	943.55
REPAIR TYPE TOTAL							
45010	BLOCK & CRANKCASE	244192	1994/08/04	311.75	.00	.00	311.75
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
51000	ACCESSORIES, GENERAL	240995	1994/04/12	892.25	8.06	.00	900.31
51001	ACCESSORIES, GENERAL	240995	1994/04/12	75.25	.00	.00	75.25
REPAIR TYPE TOTAL							
51050	AIR HORN ASSEMBLY	240078	1994/03/01	64.50	.00	.00	64.50
REPAIR TYPE TOTAL							
5110R	TARPALIN ASSEMBLY	240995	1994/04/12	.00	.00	852.72	852.72
51100	TARPALIN ASSEMBLY	242235	1994/05/26	43.00	.00	.00	43.00
REPAIR TYPE TOTAL							
5115R	W/WASHER BLADES	239112	1994/02/04	32.25	.00	53.74	85.99
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
5244R	BOX SPRAY PUMP	243727	1994/08/01	419.25	34.43	111.91	565.59
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
5407R	RUBBING BLOCKS	239112	1994/02/04	21.50	.00	.00	21.50
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
55500	DUMBODY LIFT ASSM	244659	1994/08/30	21.50	.00	.00	21.50
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
73010	HYD LINE, PRESSURE	244611	1994/08/23	75.25	.00	.00	75.25
73010	HYD LINE, PRESSURE	246798	1994/11/10	75.25	.00	.00	75.25
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
REPAIR SUB GROUP TOTAL							

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
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REPAIR CODE	DESCRIPTION	WORK ORDER	NO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
VEHICLE 3228 INT' ETHANOL TANDEM AXLE							
34300	CLEARANCE/MARKER IMP	239303	1994/02/04	43.00	.00	.00	43.00
3430R	CLEARANCE/MARKER IMP	242235	1994/05/26	32.25	10.41	.00	42.66
34300	CLEARANCE/MARKER IMP	247325	1994/12/02	64.50	.00	.00	64.50
REPAIR TYPE TOTAL				139.75	10.41	.00	150.16
34500	SANDER/WORK LAMP	247880	1994/12/21	86.00	.00	.00	86.00
REPAIR TYPE TOTAL				86.00	.00	.00	86.00
REPAIR SUB GROUP TOTAL				537.50	30.77	13.15	581.42
REPAIR GROUP TOTAL				920.00	189.05	243.30	1,352.35
42001	COOLING SYSTEM	246298	1994/10/20	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				43.00	.00	.00	43.00
42040	RAD HOSE, LOWER	240078	1994/03/01	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				43.00	.00	.00	43.00
4212R	COOLANT FILTER	244659	1994/08/30	161.25	62.44	40.70	264.39
REPAIR TYPE TOTAL				161.25	62.44	40.70	264.39
REPAIR SUB GROUP TOTAL				247.25	62.44	40.70	350.39
43001	EXHAUST SYSTEM	243348	1994/06/30	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				21.50	.00	.00	21.50
4320R	EXHAUST TUBING	243348	1994/06/30	75.25	30.72	.00	105.97
REPAIR TYPE TOTAL				75.25	30.72	.00	105.97
REPAIR SUB GROUP TOTAL				96.75	30.72	.00	127.47
44001	FUEL SYSTEM	238856	1994/01/25	118.25	.00	.00	118.25
44000	FUEL SYSTEM	240995	1994/04/12	43.00	.00	.00	43.00
44001	FUEL SYSTEM	245814	1994/09/30	.00	.00	.00	.00
REPAIR TYPE TOTAL				161.25	.00	.00	161.25
4410R	FILTER, PRIMARY	238856	1994/01/25	21.50	.00	76.26	97.76
4410R	FILTER, PRIMARY	239133	1994/02/04	32.25	.00	145.42	177.67
4410R	FILTER, PRIMARY	243091	1994/06/30	64.50	.00	.00	64.50
44100	FILTER, PRIMARY	247793	1994/12/20	.00	.00	145.41	145.41
4410R	FILTER, PRIMARY	247793	1994/12/20	64.50	.00	.00	64.50
REPAIR TYPE TOTAL				182.75	.00	367.09	549.84
4411I	FILTER, SECONDARY	238856	1994/01/25	21.50	.00	.00	21.50
4411R	FILTER, SECONDARY	239133	1994/02/04	43.00	.00	49.71	92.71
REPAIR TYPE TOTAL				64.50	.00	49.71	114.21
44800	ELECTRONIC CONTROLS	243091	1994/06/30	118.25	.00	.00	118.25
REPAIR TYPE TOTAL				118.25	.00	.00	118.25

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VEHICLE 3228 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
13850	SPRING PARKING BRAKE	244659	1994/08/30	236.50	3.24	.00	239.74
	REPAIR TYPE TOTAL			236.50	3.24	.00	239.74
	REPAIR SUB GROUP TOTAL			376.25	13.52	.00	389.77
18010	RIM	246718	1994/11/08	139.75	.00	26.66	166.41
	REPAIR TYPE TOTAL			139.75	.00	26.66	166.41
	REPAIR SUB GROUP TOTAL			139.75	.00	26.66	166.41
	REPAIR GROUP TOTAL			516.00	13.52	26.66	556.18
22010	HOUSING, REAR AXLE	244659	1994/08/30	96.75	.00	.00	96.75
	REPAIR TYPE TOTAL			96.75	.00	.00	96.75
	REPAIR SUB GROUP TOTAL			96.75	.00	.00	96.75
	REPAIR GROUP TOTAL			96.75	.00	.00	96.75
31001	CHARGING SYSTEM	244408	1994/08/18	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
3101R	ALTERNATOR	244408	1994/08/18	118.25	.00	230.15	348.40
	REPAIR TYPE TOTAL			118.25	.00	230.15	348.40
	REPAIR SUB GROUP TOTAL			161.25	.00	230.15	391.40
32010	BATTERY	238880	1994/01/25	62.25	73.98	.00	136.23
3201R	BATTERY	243727	1994/08/01	75.25	82.04	.00	157.29
	REPAIR TYPE TOTAL			137.50	156.02	.00	293.52
32020	BATTERY CABLE	238880	1994/01/25	63.00	1.68	.00	64.68
	REPAIR TYPE TOTAL			63.00	1.68	.00	64.68
32060	BATTERY HOLDOWNS	238880	1994/01/25	20.75	.58	.00	21.33
	REPAIR TYPE TOTAL			20.75	.58	.00	21.33
	REPAIR SUB GROUP TOTAL			221.25	158.28	.00	379.53
34000	LIGHTING SYSTEM	243887	1994/08/01	43.00	.33	.00	43.33
	REPAIR TYPE TOTAL			43.00	.33	.00	43.33
34010	HEADLAMP	247167	1994/11/29	21.50	10.87	.00	32.37
	REPAIR TYPE TOTAL			21.50	10.87	.00	32.37
34100	STOPLAMP	238259	1994/01/11	96.75	.00	13.15	109.90
	REPAIR TYPE TOTAL			96.75	.00	13.15	109.90
34250	BACKUP LAMP	246726	1994/11/10	150.50	9.16	.00	159.66
	REPAIR TYPE TOTAL			150.50	9.16	.00	159.66

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VEHICLE 3228 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
REPAIR GROUP TOTAL							
PM/MINUS PM TOTAL							
ENDYR TOTAL							
1115L PMA		240078	1994/03/01	107.50	28.32	.00	135.82
REPAIR TYPE TOTAL							
1120L PMB		244659	1994/08/30	193.50	.00	.00	193.50
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
PM/MINUS PM TOTAL							
0150L HEATER ASSEMBLY		238635	1994/01/24	118.25	.00	.00	118.25
0150R HEATER ASSEMBLY		238880	1994/01/25	.00	.44	.00	.44
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
PM/MINUS PM TOTAL							
0215R MIRROR, EXTERNAL		243254	1994/06/30	32.25	12.98	.00	45.23
REPAIR TYPE TOTAL							
0217R MIRROR, EXT CONVEX		243722	1994/07/18	21.50	11.19	.00	32.69
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
0326R FUEL GG SENDER UNIT		242924	1994/06/21	.00	.00	26.06	26.06
0326O FUEL GG SENDER UNIT		242924	1994/06/21	150.50	.00	.00	150.50
0326I FUEL GG SENDER UNIT		247167	1994/11/29	43.00	.00	.00	43.00
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
0330O LOW AIR PRESS LIGHT		247093	1994/11/23	32.25	.00	.00	32.25
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
1300O BRAKE SYSTEM		240995	1994/04/12	53.75	.00	.00	53.75
REPAIR TYPE TOTAL							
1361O AIR SUPPLY LINES		243196	1994/06/24	86.00	10.28	.00	96.28
REPAIR TYPE TOTAL							

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VEHICLE 3228 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
46100	CATALYTIC CONVERTER	236516	1993/11/08	32.25	3.45	.00	35.70
	REPAIR TYPE TOTAL			32.25	3.45	.00	35.70
	REPAIR SUB GROUP TOTAL			32.25	3.45	.00	35.70
	REPAIR GROUP TOTAL			215.00	3.45	183.63	402.08
51050	AIR HORN ASSEMBLY	238090	1993/12/24	43.00	.00	8.83	51.83
	REPAIR TYPE TOTAL			43.00	.00	8.83	51.83
	REPAIR SUB GROUP TOTAL			43.00	.00	8.83	51.83
52000	ACCESSORY, ELECTRIC	236707	1993/11/08	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
	REPAIR SUB GROUP TOTAL			43.00	.00	.00	43.00
54340	SANDER HYD LINES	236855	1993/11/17	96.75	1.30	.00	98.05
	REPAIR TYPE TOTAL			96.75	1.30	.00	98.05
	REPAIR SUB GROUP TOTAL			96.75	1.30	.00	98.05
5910R	PINTLE HOOK	231149	1993/09/21	.00	.00	45.12	45.12
	REPAIR TYPE TOTAL			.00	.00	45.12	45.12
	REPAIR SUB GROUP TOTAL			.00	.00	45.12	45.12
	REPAIR GROUP TOTAL			182.75	1.30	53.95	238.00
66000	SP EQUIP ACCESSORIES	237742	1993/12/14	139.75	3.56	.00	143.31
	REPAIR TYPE TOTAL			139.75	3.56	.00	143.31
	REPAIR SUB GROUP TOTAL			139.75	3.56	.00	143.31
	REPAIR GROUP TOTAL			139.75	3.56	.00	143.31
7476L	CABLE, CONTRL LEVER	238122	1993/12/28	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
	REPAIR SUB GROUP TOTAL			21.50	.00	.00	21.50
	REPAIR GROUP TOTAL			21.50	.00	.00	21.50
9830R	NEW VEHICLE PREP.	231149	1993/09/21	.00	.00	212.69	212.69
9830O	NEW VEHICLE PREP.	231149	1993/09/21	3,182.00	350.27	.00	3,532.27
9830I	NEW VEHICLE PREP.	231149	1993/09/21	.00	.00	271.20	271.20
9830O	NEW VEHICLE PREP.	235741	1993/10/01	96.75	.00	414.00	510.75
	REPAIR TYPE TOTAL			3,278.75	350.27	897.89	4,526.91
	REPAIR SUB GROUP TOTAL			3,278.75	350.27	897.89	4,526.91

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VEHICLE 3228 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	MO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
13500	AIR COMPRESSOR	262421	0000/00/00	.00	.00	9.00	9.00
	REPAIR TYPE TOTAL			.00	.00	9.00	9.00
	REPAIR SUB GROUP TOTAL			.00	.00	9.00	9.00
	REPAIR GROUP TOTAL			.00	.00	9.00	9.00
98951	DIAGNOSTIC MECHANICL	262421	0000/00/00	96.75	.00	.00	96.75
	REPAIR TYPE TOTAL			96.75	.00	.00	96.75
	REPAIR SUB GROUP TOTAL			96.75	.00	.00	96.75
	REPAIR GROUP TOTAL			96.75	.00	.00	96.75
	PM/MINUS PM TOTAL			96.75	.00	9.00	105.75
	ENDYR TOTAL			96.75	.00	9.00	105.75
07380	ENGINE COVER(S)	238122	1993/12/28	118.25	.27	21.25	139.77
	REPAIR TYPE TOTAL			118.25	.27	21.25	139.77
07470	TAILGATE LATCH ASSM	231149	1993/09/21	75.25	.00	.00	75.25
	REPAIR TYPE TOTAL			75.25	.00	.00	75.25
	REPAIR SUB GROUP TOTAL			193.50	.27	21.25	215.02
	REPAIR GROUP TOTAL			193.50	.27	21.25	215.02
13610	AIR SUPPLY LINES	236516	1993/11/08	75.25	.00	.00	75.25
	REPAIR TYPE TOTAL			75.25	.00	.00	75.25
	REPAIR SUB GROUP TOTAL			75.25	.00	.00	75.25
	REPAIR GROUP TOTAL			75.25	.00	.00	75.25
42040	RAD HOSE, LOWER	238122	1993/12/28	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
	REPAIR SUB GROUP TOTAL			21.50	.00	.00	21.50
4410R	FILTER, PRIMARY	237390	1993/12/03	10.75	.00	183.63	194.38
	REPAIR TYPE TOTAL			10.75	.00	183.63	194.38
4411R	FILTER, SECONDARY	237390	1993/12/03	10.75	.00	.00	10.75
	REPAIR TYPE TOTAL			10.75	.00	.00	10.75
44200	FUEL PUMP	236855	1993/11/17	139.75	.00	.00	139.75
	REPAIR TYPE TOTAL			139.75	.00	.00	139.75
	REPAIR SUB GROUP TOTAL			161.25	.00	183.63	344.88

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

VEHICLE 3221 INT'' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
98901	DIAGNOSTIC ELECTRIC	256804	1996/02/23	64.50	.00	.00	64.50
98901	DIAGNOSTIC ELECTRIC	263390	1996/09/17	32.25	.00	.00	32.25
	REPAIR TYPE TOTAL			96.75	.00	.00	96.75
98951	DIAGNOSTIC MECHANICL	260537	1996/05/17	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
	REPAIR SUB GROUP TOTAL			677.25	5.28	19.68	702.21
99100	CHASSIS GROUP	263556	1996/09/26	.00	.00	197.60	197.60
	REPAIR TYPE TOTAL			.00	.00	197.60	197.60
	REPAIR SUB GROUP TOTAL			.00	.00	197.60	197.60
	REPAIR GROUP TOTAL			677.25	5.28	217.28	899.81
	PM/MINUS PM TOTAL			5,031.00	1,222.70	1,082.19	7,335.89
	ENDYR TOTAL			5,203.00	1,237.28	1,128.11	7,568.39
	UNIT TOTAL			22,631.78	2,316.70	5,464.33	30,412.81

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
VEHICLE 3221 INT' ETHANOL TANDEM AXLE							
51100	TARPALIN ASSEMBLY	259063	1996/03/20	43.00	.00	.00	43.00
51100	TARPALIN ASSEMBLY	263390	1996/09/17	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				268.75	.98	.00	269.73
REPAIR SUB GROUP TOTAL				419.25	.98	153.24	573.47
52250	2-WAY RADIO	262270	1996/08/08	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				21.50	.00	.00	21.50
52400	BOX SHAKER	261425	1996/07/02	86.00	.00	.00	86.00
REPAIR TYPE TOTAL				86.00	.00	.00	86.00
REPAIR SUB GROUP TOTAL				107.50	.00	.00	107.50
REPAIR GROUP TOTAL				526.75	.98	153.24	680.97
66000	SP EQUIP ACCESSORIES	261972	1996/07/26	43.00	.00	.00	43.00
66000	SP EQUIP ACCESSORIES	263556	1996/09/26	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				64.50	.00	.00	64.50
REPAIR SUB GROUP TOTAL				64.50	.00	.00	64.50
REPAIR GROUP TOTAL				64.50	.00	.00	64.50
71100	HYD PUMP	259528	1996/05/02	.00	.00	274.88	274.88
7110R	HYD PUMP	259528	1996/05/02	236.50	.00	.00	236.50
7110I	HYD PUMP	259528	1996/05/02	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				258.00	.00	274.88	532.88
REPAIR SUB GROUP TOTAL				258.00	.00	274.88	532.88
7721R	HYD TANK FILTER	262381	1996/09/03	21.50	6.49	.00	27.99
REPAIR TYPE TOTAL				21.50	6.49	.00	27.99
REPAIR SUB GROUP TOTAL				21.50	6.49	.00	27.99
REPAIR GROUP TOTAL				279.50	6.49	274.88	560.87
98200	GENERAL GREASING	M08136	1996/01/25	86.00	.88	.00	86.88
98200	GENERAL GREASING	M08222	1996/02/07	86.00	.88	.00	86.88
98200	GENERAL GREASING	M08432	1996/03/15	86.00	.88	9.84	96.72
98200	GENERAL GREASING	M08484	1996/04/03	86.00	.88	.00	86.88
98200	GENERAL GREASING	M08720	1996/05/23	86.00	.88	9.84	96.72
98200	GENERAL GREASING	M09046	1996/08/15	86.00	.88	.00	86.88
REPAIR TYPE TOTAL				516.00	5.28	19.68	540.96
9860I	TRUCK INSPECTION	262381	1996/09/03	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				21.50	.00	.00	21.50

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
 WORK ORDER COST HISTORY

REPAIR CODE	DESCRIPTION	WORK ORDER	NO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
VEHICLE 3221 INT' ETHANOL TANDEM AXLE							
4320R	EXHAUST TUBING	262164	1996/07/31	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				21.50	.00	.00	21.50
4350R	CLAMPS	262164	1996/07/31	10.75	15.36	.00	26.11
REPAIR TYPE TOTAL				10.75	15.36	.00	26.11
REPAIR SUB GROUP TOTAL				86.00	15.36	8.86	110.22
4410R	FILTER, PRIMARY	257539	1996/01/26	64.50	.00	63.97	128.47
4410R	FILTER, PRIMARY	259063	1996/03/20	53.75	.00	72.71	126.46
4410R	FILTER, PRIMARY	261897	1996/07/23	32.25	.00	.00	32.25
REPAIR TYPE TOTAL				150.50	.00	136.68	287.18
4411R	FILTER, SECONDARY	259063	1996/03/20	.00	.00	46.92	46.92
4411R	FILTER, SECONDARY	261897	1996/07/23	32.25	.00	.00	32.25
REPAIR TYPE TOTAL				32.25	.00	46.92	79.17
REPAIR SUB GROUP TOTAL				182.75	.00	183.60	366.35
4500I	ENGINE	259085	1996/03/20	43.00	.00	.00	43.00
4500I	ENGINE	259528	1996/05/02	75.25	.00	.00	75.25
4500I	ENGINE	263316	1996/09/12	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				161.25	.00	.00	161.25
45700	VENTILATING SYSTEM	263316	1996/09/12	43.00	3.37	.00	46.37
REPAIR TYPE TOTAL				43.00	3.37	.00	46.37
45750	VALVE COVER GASKET	262270	1996/08/08	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				43.00	.00	.00	43.00
4584R	SEALS, MISC.	257664	1996/02/29	.00	.00	26.71	26.71
REPAIR TYPE TOTAL				.00	.00	26.71	26.71
REPAIR SUB GROUP TOTAL				247.25	3.37	26.71	277.33
4632R	PCV VALVE	257539	1996/01/26	204.25	2.12	24.37	230.74
REPAIR TYPE TOTAL				204.25	2.12	24.37	230.74
REPAIR SUB GROUP TOTAL				204.25	2.12	24.37	230.74
REPAIR GROUP TOTAL				924.50	29.73	243.54	1,197.77
51000	ACCESSORIES, GENERAL	258435	1996/02/28	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				21.50	.00	.00	21.50
5102R	MUD FLAP(S)	261972	1996/07/26	129.00	.00	153.24	282.24
REPAIR TYPE TOTAL				129.00	.00	153.24	282.24
51100	TARPALIN ASSEMBLY	259045	1996/03/18	182.75	.98	.00	183.73

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

REPAIR CODE	DESCRIPTION	WORK ORDER	NO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
VEHICLE 3221 INT' ETHANOL TANDEM AXLE							
REPAIR SUB GROUP TOTAL							
3325R	GLOW PLUG(S)	257664	1996/02/29	75.25	.00	25.77	101.02
3325R	GLOW PLUG(S)	258677	1996/03/28	43.00	.00	.00	43.00
3325R	GLOW PLUG(S)	262381	1996/09/03	.00	.00	25.77	25.77
3325R	GLOW PLUG(S)	263390	1996/09/17	21.50	.00	25.77	47.27
REPAIR TYPE TOTAL							
139.75							
REPAIR SUB GROUP TOTAL							
139.75							
3415R	TURN SIGNAL LAMP	259528	1996/05/02	.00	.00	22.55	22.55
REPAIR TYPE TOTAL							
.00							
3420O	TAIL/PARK LAMP	257446	1996/01/23	75.25	.00	.00	75.25
3420O	TAIL/PARK LAMP	259528	1996/05/02	53.75	1.34	.00	55.09
REPAIR TYPE TOTAL							
129.00							
3430O	CLEARANCE/MARKER LMP	257664	1996/02/29	43.00	.00	.00	43.00
3430O	CLEARANCE/MARKER LMP	258695	1996/03/05	21.50	1.83	.00	23.33
3430R	CLEARANCE/MARKER LMP	259528	1996/05/02	86.00	.00	.00	86.00
REPAIR TYPE TOTAL							
150.50							
3432R	SPOTLIGHT LAMP	257539	1996/01/26	64.50	.00	.00	64.50
REPAIR TYPE TOTAL							
64.50							
REPAIR SUB GROUP TOTAL							
344.00							
REPAIR GROUP TOTAL							
677.25							
4130O	SUPERCARGER	257664	1996/02/29	75.25	.00	.00	75.25
4130I	SUPERCARGER	258677	1996/03/28	43.00	.00	.00	43.00
REPAIR TYPE TOTAL							
118.25							
REPAIR SUB GROUP TOTAL							
118.25							
4204L	RAD HOSE, LOWER	257342	1996/01/23	43.00	.00	.00	43.00
REPAIR TYPE TOTAL							
43.00							
4211O	ANTIFREEZE	263316	1996/09/12	21.50	.00	.00	21.50
REPAIR TYPE TOTAL							
21.50							
4212R	COOLANT FILTER	262381	1996/09/03	21.50	8.88	.00	30.38
REPAIR TYPE TOTAL							
21.50							
REPAIR SUB GROUP TOTAL							
86.00							
4302R	EXT MANIFOLD GASKET	258677	1996/03/28	53.75	.00	8.86	62.61
REPAIR TYPE TOTAL							
53.75							
REPAIR SUB GROUP TOTAL							
8.88							
REPAIR GROUP TOTAL							
94.88							
REPAIR SUB GROUP TOTAL							
8.86							
REPAIR TYPE TOTAL							
8.86							

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
 WORK ORDER COST HISTORY

VEHICLE 3221 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
13000	BRAKE SYSTEM	259231	1996/04/03	86.00	.00	.00	86.00
	REPAIR TYPE TOTAL			86.00	.00	.00	86.00
13500	AIR COMPRESSOR	257664	1996/02/29	75.25	13.56	9.00	97.81
	REPAIR TYPE TOTAL			75.25	13.56	9.00	97.81
13550	AIR DRYER ASSEMBLY	257664	1996/02/29	43.00	.00	11.28	54.28
	REPAIR TYPE TOTAL			43.00	.00	11.28	54.28
13850	SPRING PARKING BRAKE	258435	1996/02/28	43.00	.00	.00	43.00
1385R	SPRING PARKING BRAKE	260785	1996/05/31	107.50	65.60	.00	173.10
1385R	SPRING PARKING BRAKE	262381	1996/09/03	64.50	131.20	.00	195.70
	REPAIR TYPE TOTAL			215.00	196.80	.00	411.80
	REPAIR SUB GROUP TOTAL			419.25	210.36	20.28	649.89
1670R	REAR SPRING ASSEMBLY	263556	1996/09/26	462.25	.00	.00	462.25
	REPAIR TYPE TOTAL			462.25	.00	.00	462.25
	REPAIR SUB GROUP TOTAL			462.25	.00	.00	462.25
1702R	TIRE, WORN	263556	1996/09/26	129.00	923.96	.00	1,052.96
	REPAIR TYPE TOTAL			129.00	923.96	.00	1,052.96
	REPAIR SUB GROUP TOTAL			129.00	923.96	.00	1,052.96
	REPAIR GROUP TOTAL			1,010.50	1,134.32	20.28	2,165.10
2300L	CLUTCH ASSEMBLY	262381	1996/09/03	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
2301L	PRESSURE PLATE	257664	1996/02/29	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
	REPAIR SUB GROUP TOTAL			64.50	.00	.00	64.50
26000	TRANSMISSION, MANUAL	257664	1996/02/29	64.50	.00	6.39	70.89
	REPAIR TYPE TOTAL			64.50	.00	6.39	70.89
26020	TRANS REAR HOUSING	257664	1996/02/29	161.25	.00	.00	161.25
	REPAIR TYPE TOTAL			161.25	.00	.00	161.25
	REPAIR SUB GROUP TOTAL			225.75	.00	6.39	232.14
	REPAIR GROUP TOTAL			290.25	.00	6.39	296.64
3107R	ALTERNATOR BELT	259085	1996/03/20	129.00	.00	18.89	147.89
3107L	ALTERNATOR BELT	258677	1996/03/28	64.50	.00	.00	64.50
	REPAIR TYPE TOTAL			193.50	.00	18.89	212.39

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
VEHICLE 3221 INT' ETHANOL TANDEN AXLE							
ENDYR TOTAL							
1115L PMA		258695	1996/03/05	.00	3.60	.00	3.60
1115L PMA		263556	1996/09/26	129.00	10.98	45.92	185.90
REPAIR TYPE TOTAL				129.00	14.58	45.92	189.50
1120L PMB		262381	1996/09/03	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				43.00	.00	.00	43.00
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
PM/MINUS PM TOTAL							
0215R MIRROR, EXTERNAL		256804	1996/02/23	21.50	.00	.00	21.50
0215O MIRROR, EXTERNAL		256804	1996/02/23	.00	13.81	.00	13.81
0215R MIRROR, EXTERNAL		257664	1996/02/29	43.00	13.81	.00	56.81
0215R MIRROR, EXTERNAL		262501	1996/08/15	43.00	15.11	.00	58.11
REPAIR TYPE TOTAL				107.50	42.73	.00	150.23
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
0300O GAUGES/INSTRUMENTS		259989	1996/04/29	107.50	.00	.00	107.50
REPAIR TYPE TOTAL				107.50	.00	.00	107.50
0326R FUEL GG SENDER UNIT		261109	1996/06/14	21.50	.00	26.82	48.32
0326I FUEL GG SENDER UNIT		261109	1996/06/14	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				43.00	.00	26.82	69.82
0340I SPEEDOMETER		261109	1996/06/14	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				43.00	.00	.00	43.00
0344R SPEDOMETR SENDER UNIT		261109	1996/06/14	43.00	.00	21.01	64.01
REPAIR TYPE TOTAL				43.00	.00	21.01	64.01
REPAIR SUB GROUP TOTAL							
0795O DUMP BODY		258950	1996/03/14	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				43.00	.00	.00	43.00
0797O DMPBODY SPILL SHIELD		262569	1996/08/21	129.00	.00	.00	129.00
REPAIR TYPE TOTAL				129.00	.00	.00	129.00
0798O DUMP BODY TAILGATE		259063	1996/03/20	64.50	.00	.00	64.50
REPAIR TYPE TOTAL				64.50	.00	.00	64.50
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
REPAIR TYPE TOTAL				236.50	.00	.00	236.50
REPAIR TYPE TOTAL				580.50	42.73	47.83	671.06

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

VEHICLE 3221 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	NO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
REPAIR SUB GROUP TOTAL				118.25	.00	61.09	179.34
REPAIR GROUP TOTAL				118.25	.00	61.09	179.34
7301L HYD LINE, PRESSURE		256395	1995/12/15	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				43.00	.00	.00	43.00
REPAIR SUB GROUP TOTAL				43.00	.00	.00	43.00
7601R QUICK DISCONNECT		252342	1995/06/22	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				21.50	.00	.00	21.50
REPAIR SUB GROUP TOTAL				21.50	.00	.00	21.50
7721R HYD TANK FILTER		253217	1995/08/17	32.25	6.49	.00	38.74
REPAIR TYPE TOTAL				32.25	6.49	.00	38.74
REPAIR SUB GROUP TOTAL				32.25	6.49	.00	38.74
REPAIR GROUP TOTAL				96.75	6.49	.00	103.24
98200 GENERAL GREASING		M06595	1995/01/18	107.50	1.74	6.56	115.80
98200 GENERAL GREASING		M06919	1995/03/15	86.00	.87	4.92	91.79
98200 GENERAL GREASING		M07392	1995/07/21	86.00	.88	.00	86.88
98200 GENERAL GREASING		M07632	1995/09/18	86.00	.88	.00	86.88
98200 GENERAL GREASING		M07773	1995/10/24	86.00	21.60	.00	107.60
98200 GENERAL GREASING		M07962	1995/12/07	86.00	.88	.00	86.88
REPAIR TYPE TOTAL				537.50	26.85	11.48	575.83
9860I TRUCK INSPECTION		253217	1995/08/17	86.00	.00	.00	86.00
REPAIR TYPE TOTAL				86.00	.00	.00	86.00
9890I DIAGNOSTIC ELECTRIC		254670	1995/10/16	193.50	.00	.00	193.50
REPAIR TYPE TOTAL				193.50	.00	.00	193.50
9895I DIAGNOSTIC MECHANICAL		248654	1995/01/25	64.50	.00	.00	64.50
REPAIR TYPE TOTAL				64.50	.00	.00	64.50
REPAIR SUB GROUP TOTAL				881.50	26.85	11.48	919.83
99400 POWER PLANT GROUP		253475	1995/08/21	.00	.00	.00	.00
99400 POWER PLANT GROUP		254670	1995/10/16	.00	.00	160.08	160.08
REPAIR TYPE TOTAL				.00	.00	160.08	160.08
REPAIR SUB GROUP TOTAL				.00	.00	160.08	160.08
REPAIR GROUP TOTAL				881.50	26.85	171.56	1,079.91
PM/MINUS PM TOTAL				4,894.69	420.24	683.20	5,998.13

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

VEHICLE 3221 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
4566R	OIL FILLER/DIPSTICK	251777	1995/06/02	10.75	.00	12.88	23.63
4566R	OIL FILLER/DIPSTICK	254670	1995/10/16	10.75	.00	13.29	24.04
	REPAIR TYPE TOTAL			21.50	.00	26.17	47.67
45700	VENTILATING SYSTEM	250538	1995/04/14	107.50	1.21	5.02	113.73
	REPAIR TYPE TOTAL			107.50	1.21	5.02	113.73
4575R	VALVE COVER GASKET	251777	1995/06/02	10.75	.00	6.48	17.23
4575R	VALVE COVER GASKET	254670	1995/10/16	.00	.00	13.36	13.36
	REPAIR TYPE TOTAL			10.75	.00	19.84	30.59
	REPAIR SUB GROUP TOTAL			279.50	1.21	86.44	367.15
	REPAIR GROUP TOTAL			1,247.00	63.58	304.57	1,615.15
51100	TARPALIN ASSEMBLY	248761	1995/02/03	172.00	.00	.00	172.00
51100	TARPALIN ASSEMBLY	250173	1995/03/24	21.50	.00	.00	21.50
51100	TARPALIN ASSEMBLY	252049	1995/06/12	21.50	.00	.00	21.50
51100	TARPALIN ASSEMBLY	253458	1995/08/21	43.00	.00	.00	43.00
51100	TARPALIN ASSEMBLY	254378	1995/09/22	10.75	.00	.00	10.75
	REPAIR TYPE TOTAL			268.75	.00	.00	268.75
5115R	W/WASHER BLADES	256054	1995/11/30	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
	REPAIR SUB GROUP TOTAL			290.25	.00	.00	290.25
5221R	RADIO, AM/FM	252440	1995/08/07	.00	.00	104.00	104.00
52210	RADIO, AM/FM	252440	1995/08/07	161.25	.00	.00	161.25
	REPAIR TYPE TOTAL			161.25	.00	104.00	265.25
52400	BOX SHAKER	253458	1995/08/21	75.25	.00	.00	75.25
52400	BOX SHAKER	253526	1995/08/21	86.00	.00	.00	86.00
	REPAIR TYPE TOTAL			161.25	.00	.00	161.25
52440	BOX SPRAY PUMP	252113	1995/06/15	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
	REPAIR SUB GROUP TOTAL			344.00	.00	104.00	448.00
54100	SNOW FLOW FRAME	256704	1995/12/28	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
	REPAIR SUB GROUP TOTAL			43.00	.00	.00	43.00
	REPAIR GROUP TOTAL			677.25	.00	104.00	781.25
66000	SP EQUIP ACCESSORIES	252153	1995/06/19	.00	.00	20.28	20.28
66000	SP EQUIP ACCESSORIES	252440	1995/08/07	118.25	.00	40.81	159.06
	REPAIR TYPE TOTAL			118.25	.00	61.09	179.34

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

VEHICLE 3221 INT'' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
4101R	FILTER, PRIMARY	250538	1995/04/14	21.50	.00	.00	21.50
REPAIR TYPE TOTAL							
4130O	SUPERCARGER	250538	1995/04/14	96.75	.00	.00	96.75
4130I	SUPERCARGER	254670	1995/10/16	86.00	.00	.00	86.00
4130O	SUPERCARGER	254670	1995/10/16	139.75	.00	.00	139.75
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
4200I	COOLING SYSTEM	252964	1995/07/24	10.75	.00	.00	10.75
REPAIR TYPE TOTAL							
4212R	COOLANT FILTER	253217	1995/08/17	32.25	8.88	.00	41.13
4212R	COOLANT FILTER	253475	1995/08/21	.00	8.88	.00	8.88
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
4300I	EXHAUST SYSTEM	254378	1995/09/22	10.75	.00	.00	10.75
REPAIR TYPE TOTAL							
4311O	TAIL PIPE	254378	1995/09/22	32.25	30.72	.00	62.97
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
4410R	FILTER, PRIMARY	249418	1995/02/27	86.00	.00	.00	86.00
4410R	FILTER, PRIMARY	252144	1995/06/15	53.75	.00	.00	53.75
4410R	FILTER, PRIMARY	254552	1995/10/03	43.00	.00	72.71	115.71
4410R	FILTER, PRIMARY	256288	1995/12/15	64.50	.00	72.71	137.21
REPAIR TYPE TOTAL							
4411R	FILTER, SECONDARY	256288	1995/12/15	.00	.00	72.71	72.71
REPAIR TYPE TOTAL							
4415R	FUEL LINES	255670	1995/11/16	150.50	8.52	.00	159.02
REPAIR TYPE TOTAL							
4420I	FUEL PUMP	254670	1995/10/16	75.25	.00	.00	75.25
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
4500I	ENGINE	251777	1995/06/02	32.25	.00	.00	32.25
4500O	ENGINE	254670	1995/10/16	64.50	.00	35.41	99.91
REPAIR TYPE TOTAL							
4562O	OIL FILTER ASSEMBLY	255927	1995/11/28	43.00	.00	.00	43.00
REPAIR TYPE TOTAL							

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HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
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REPAIR CODE	DESCRIPTION	WORK ORDER	NO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
VEHICLE 3221 INT' ETHANOL TANDEM AXLE							
3101I	ALTERNATOR	254552	1995/10/03	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				21.50	.00	.00	21.50
3107L	ALTERNATOR BELT	252914	1995/07/20	86.00	.00	.00	86.00
REPAIR TYPE TOTAL				86.00	.00	.00	86.00
REPAIR SUB GROUP TOTAL				107.50	.00	.00	107.50
3201R	BATTERY	252813	1995/07/14	161.25	164.08	.00	325.33
3201I	BATTERY	254552	1995/10/03	75.25	.00	.00	75.25
REPAIR TYPE TOTAL				236.50	164.08	.00	400.58
3202O	BATTERY CABLE	254552	1995/10/03	53.75	.00	.00	53.75
3202O	BATTERY CABLE	254670	1995/10/16	86.00	.00	.00	86.00
REPAIR TYPE TOTAL				139.75	.00	.00	139.75
REPAIR SUB GROUP TOTAL				376.25	164.08	.00	540.33
3325I	GLOW PLUG(S)	253458	1995/08/21	107.50	.00	.00	107.50
REPAIR TYPE TOTAL				107.50	.00	.00	107.50
REPAIR SUB GROUP TOTAL				107.50	.00	.00	107.50
3401O	HEADLAMP	256769	1995/12/28	21.50	.00	.00	21.50
3401O	HEADLAMP	256716	1995/12/28	53.75	12.36	.00	66.11
REPAIR TYPE TOTAL				75.25	12.36	.00	87.61
3415O	TURN SIGNAL LAMP	250657	1995/04/18	311.75	8.88	.00	320.63
3415R	TURN SIGNAL LAMP	256716	1995/12/28	.00	.34	.00	.34
REPAIR TYPE TOTAL				311.75	9.22	.00	320.97
3430O	CLEARANCE/MARKER LMP	250538	1995/04/14	10.75	.00	.00	10.75
3430O	CLEARANCE/MARKER LMP	255697	1995/11/16	21.50	12.79	.00	34.29
3430O	CLEARANCE/MARKER LMP	255927	1995/11/28	21.50	1.95	.00	23.45
3430O	CLEARANCE/MARKER LMP	255901	1995/11/28	86.00	1.49	.00	87.49
REPAIR TYPE TOTAL				139.75	16.23	.00	155.98
3433O	MISC. LAMPS	256654	1995/12/19	86.00	.00	.00	86.00
REPAIR TYPE TOTAL				86.00	.00	.00	86.00
3440O	STROBE LAMP	249853	1995/03/10	86.00	.00	.00	86.00
REPAIR TYPE TOTAL				86.00	.00	.00	86.00
REPAIR SUB GROUP TOTAL				698.75	37.81	.00	736.56
REPAIR GROUP TOTAL				1,290.00	201.89	.00	1,491.89
4100I	INTAKE SYSTEM	250538	1995/04/14	64.50	5.37	.00	69.87
REPAIR TYPE TOTAL				64.50	5.37	.00	69.87

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

VEHICLE 3221 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
ENDYR TOTAL							
1115L PMA		250538	1995/04/14	118.25	10.97	44.20	173.42
1115L PMA		256654	1995/12/19	175.44	10.98	49.20	235.62
REPAIR TYPE TOTAL				293.69	21.95	93.40	409.04
1120L PMB		253217	1995/08/17	161.25	.00	.00	161.25
REPAIR TYPE TOTAL				161.25	.00	.00	161.25
REPAIR SUB GROUP TOTAL				454.94	21.95	93.40	570.29
REPAIR GROUP TOTAL				454.94	21.95	93.40	570.29
PM/MINUS PM TOTAL							
0215R MIRROR, EXTERNAL		254552	1995/10/03	43.00	13.81	.00	56.81
REPAIR TYPE TOTAL				43.00	13.81	.00	56.81
REPAIR SUB GROUP TOTAL				43.00	13.81	.00	56.81
07300 HOOD		256769	1995/12/28	64.50	.00	.00	64.50
REPAIR TYPE TOTAL				64.50	.00	.00	64.50
0797R DMPBODY SPILL SHIELD		252153	1995/06/19	215.00	11.77	35.66	262.43
REPAIR TYPE TOTAL				215.00	11.77	35.66	262.43
REPAIR SUB GROUP TOTAL				279.50	11.77	35.66	326.93
REPAIR GROUP TOTAL				322.50	25.58	35.66	383.74
17010 TIRE, FLAT		253019	1995/07/26	86.00	.00	.00	86.00
1701R TIRE, FLAT		254019	1995/09/15	67.94	95.85	.00	163.79
REPAIR TYPE TOTAL				153.94	95.85	.00	249.79
REPAIR SUB GROUP TOTAL				153.94	95.85	.00	249.79
1821R LUG NUTS		256113	1995/12/05	43.00	.00	6.32	49.32
REPAIR TYPE TOTAL				43.00	.00	6.32	49.32
REPAIR SUB GROUP TOTAL				43.00	.00	6.32	49.32
REPAIR GROUP TOTAL				196.94	95.85	6.32	299.11
26000 TRANSMISSION, MANUAL		255927	1995/11/28	64.50	.00	.00	64.50
REPAIR TYPE TOTAL				64.50	.00	.00	64.50
REPAIR SUB GROUP TOTAL				64.50	.00	.00	64.50
REPAIR GROUP TOTAL				64.50	.00	.00	64.50

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

VEHICLE 3221 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
REPAIR GROUP TOTAL							
73010	HYD LINE, PRESSURE	242859	1994/06/15	129.00	.00	.00	129.00
73011	HYD LINE, PRESSURE	246436	1994/10/28	86.00	.00	.00	86.00
73010	HYD LINE, PRESSURE	246436	1994/10/28	21.50	.00	.00	21.50
				64.50	.00	.00	64.50
REPAIR TYPE TOTAL							
				172.00	.00	.00	172.00
REPAIR SUB GROUP TOTAL							
				172.00	.00	.00	172.00
76010	QUICK DISCONNECT	243006	1994/06/21	43.00	.00	.00	43.00
REPAIR TYPE TOTAL							
				43.00	.00	.00	43.00
REPAIR SUB GROUP TOTAL							
				43.00	.00	.00	43.00
7720R	HYD TANK FILTER ASSM	244783	1994/09/14	118.25	1.94	.00	120.19
REPAIR TYPE TOTAL							
				118.25	1.94	.00	120.19
7721R	HYD TANK FILTER	245913	1994/10/05	32.25	6.67	.00	38.92
REPAIR TYPE TOTAL							
				32.25	6.67	.00	38.92
REPAIR SUB GROUP TOTAL							
				150.50	8.61	.00	159.11
REPAIR GROUP TOTAL							
				365.50	8.61	.00	374.11
98200	GENERAL GREASING	M05296	1994/02/22	86.00	.80	2.56	89.36
98200	GENERAL GREASING	M05443	1994/03/15	86.00	.80	2.56	89.36
98200	GENERAL GREASING	M05661	1994/05/11	107.50	.80	1.28	109.58
98200	GENERAL GREASING	M05986	1994/08/20	64.50	.80	7.92	73.22
98200	GENERAL GREASING	M06025	1994/09/08	96.75	.80	.00	97.55
98200	GENERAL GREASING	M06448	1994/12/14	86.00	.80	5.96	92.76
REPAIR TYPE TOTAL							
				526.75	4.80	20.28	551.83
98601	TRUCK INSPECTION	244783	1994/09/14	21.50	.00	.00	21.50
REPAIR TYPE TOTAL							
				21.50	.00	.00	21.50
98951	DIAGNOSTIC MECHANIC	245913	1994/10/05	21.50	.00	.00	21.50
REPAIR TYPE TOTAL							
				21.50	.00	.00	21.50
REPAIR SUB GROUP TOTAL							
				569.75	4.80	20.28	594.83
99400	POWER PLANT GROUP	239868	1994/03/09	.00	.00	.00	.00
99400	POWER PLANT GROUP	240844	1994/04/04	.00	.00	183.37	183.37
REPAIR TYPE TOTAL							
				.00	.00	183.37	183.37
REPAIR SUB GROUP TOTAL							
				.00	.00	183.37	183.37
REPAIR GROUP TOTAL							
				569.75	4.80	203.65	778.20
PM/MINUS PM TOTAL							
				6,874.00	334.12	1,978.16	9,186.28

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

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VEHICLE 3221 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
44200	FUEL PUMP	242400	1994/06/01	139.75	.93	.00	140.68
	REPAIR TYPE TOTAL			139.75	.93	.00	140.68
	REPAIR SUB GROUP TOTAL			473.00	.93	477.09	951.02
45001	ENGINE	247777	1994/12/30	75.25	.00	.00	75.25
	REPAIR TYPE TOTAL			75.25	.00	.00	75.25
45200	VALVETRAIN ASSEMBLY	244660	1994/08/26	64.50	.00	.00	64.50
	REPAIR TYPE TOTAL			64.50	.00	.00	64.50
	REPAIR SUB GROUP TOTAL			139.75	.00	.00	139.75
	REPAIR GROUP TOTAL			1,575.75	62.06	519.31	2,157.12
51000	ACCESSORIES, GENERAL	240994	1994/04/12	569.75	3.62	.00	573.37
	REPAIR TYPE TOTAL			569.75	3.62	.00	573.37
51021	MUD FLAP(S)	243006	1994/06/21	10.75	.00	.00	10.75
	REPAIR TYPE TOTAL			10.75	.00	.00	10.75
5105R	AIR HORN ASSEMBLY	243583	1994/07/12	258.00	.00	64.76	322.76
	REPAIR TYPE TOTAL			258.00	.00	64.76	322.76
5110R	TARPALIN ASSEMBLY	240994	1994/04/12	.00	.00	852.71	852.71
51100	TARPALIN ASSEMBLY	246026	1994/10/10	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	852.71	895.71
	REPAIR SUB GROUP TOTAL			881.50	3.62	917.47	1,802.59
5244R	BOX SPRAY PUMP	243726	1994/07/29	645.00	22.07	182.50	849.57
	REPAIR TYPE TOTAL			645.00	22.07	182.50	849.57
	REPAIR SUB GROUP TOTAL			645.00	22.07	182.50	849.57
54050	SNOW FLOW LIFT CYLIN	246993	1994/11/22	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
54220	UNDERBODY FLOW RAM	246993	1994/11/22	129.00	.00	.00	129.00
	REPAIR TYPE TOTAL			129.00	.00	.00	129.00
	REPAIR SUB GROUP TOTAL			150.50	.00	.00	150.50
	REPAIR GROUP TOTAL			1,677.00	25.69	1,099.97	2,802.66
66000	SP EQUIP ACCESSORIES	243006	1994/06/21	86.00	.00	.00	86.00
66000	SP EQUIP ACCESSORIES	247224	1994/12/01	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			129.00	.00	.00	129.00
	REPAIR SUB GROUP TOTAL			129.00	.00	.00	129.00

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

VEHICLE		3221	INT'	ETHANOL TANDEM AXLE			
REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
REPAIR GROUP TOTAL				579.00	224.65	.00	803.65
4200I	COOLING SYSTEM	245792	1994/09/29	75.25	.00	.00	75.25
4200I	COOLING SYSTEM	246495	1994/10/31	53.75	.00	.00	53.75
4200O	COOLING SYSTEM	246495	1994/10/31	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				150.50	.00	.00	150.50
4204O	RAD HOSE, LOWER	246495	1994/10/31	64.50	.00	.00	64.50
REPAIR TYPE TOTAL				64.50	.00	.00	64.50
4205R	RAD HOSE CLAMP	245792	1994/09/29	86.00	.00	4.22	90.22
4205L	RAD HOSE CLAMP	245792	1994/09/29	32.25	.00	.00	32.25
4205R	RAD HOSE CLAMP	246495	1994/10/31	.00	.00	38.00	38.00
REPAIR TYPE TOTAL				118.25	.00	42.22	160.47
4212R	COOLANT FILTER	244783	1994/09/14	53.75	44.74	.00	98.49
REPAIR TYPE TOTAL				53.75	44.74	.00	98.49
4226O	FAN CLUTCH	238557	1994/01/24	60.00	.00	.00	60.00
4226O	FAN CLUTCH	244660	1994/08/26	75.25	.00	.00	75.25
4226O	FAN CLUTCH	244783	1994/09/14	32.25	.00	.00	32.25
REPAIR TYPE TOTAL				167.50	.00	.00	167.50
4230R	WATER PUMP	246522	1994/11/17	225.75	.00	.00	225.75
4230I	WATER PUMP	246522	1994/11/17	75.25	.00	.00	75.25
REPAIR TYPE TOTAL				301.00	.00	.00	301.00
4231O	WATER PUMP BELT	239135	1994/02/04	32.25	.00	.00	32.25
REPAIR TYPE TOTAL				32.25	.00	.00	32.25
REPAIR SUB GROUP TOTAL				887.75	44.74	42.22	974.71
4350O	CLAMPS	248025	1994/12/30	75.25	16.39	.00	91.64
REPAIR TYPE TOTAL				75.25	16.39	.00	91.64
REPAIR SUB GROUP TOTAL				75.25	16.39	.00	91.64
4401O	TANK, DIESEL	238696	1994/01/25	86.00	.00	.00	86.00
REPAIR TYPE TOTAL				86.00	.00	.00	86.00
4410R	FILTER, PRIMARY	238220	1994/01/10	64.50	.00	145.42	209.92
4410R	FILTER, PRIMARY	241536	1994/04/25	21.50	.00	.00	21.50
4410R	FILTER, PRIMARY	243006	1994/06/21	64.50	.00	136.54	201.04
4410R	FILTER, PRIMARY	246263	1994/10/20	43.00	.00	145.42	188.42
4410R	FILTER, PRIMARY	247515	1994/12/12	53.75	.00	.00	53.75
REPAIR TYPE TOTAL				247.25	.00	427.38	674.63
4411R	FILTER, SECONDARY	238696	1994/01/25	.00	.00	49.71	49.71
REPAIR TYPE TOTAL				.00	.00	49.71	49.71

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
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VEHICLE 3221 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
17010	TIRE, FLAT	246993	1994/11/22	43.00	.00	.00	43.00
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
18010	RIM	246522	1994/11/17	215.00	.00	26.66	241.66
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
2300L	CLUTCH ASSEMBLY	244783	1994/09/14	64.50	.00	.00	64.50
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
32010	BATTERY	238879	1994/01/25	21.50	66.42	.00	87.92
3201R	BATTERY	247777	1994/12/30	10.75	70.04	.00	80.79
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
32020	BATTERY CABLE	238879	1994/01/25	43.00	9.24	.00	52.24
REPAIR TYPE TOTAL							
32060	BATTERY HOLDDOWNS	238879	1994/01/25	43.00	1.48	.00	44.48
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
3401L	HEADLAMP	238557	1994/01/24	20.00	.00	.00	20.00
3401R	HEADLAMP	247185	1994/11/29	32.25	10.87	.00	43.12
REPAIR TYPE TOTAL							
34150	TURN SIGNAL LAMP	239274	1994/03/29	43.00	.00	.00	43.00
REPAIR TYPE TOTAL							
34300	CLEARANCE/MARKER LMP	240567	1994/03/18	21.50	.00	.00	21.50
3430R	CLEARANCE/MARKER LMP	243006	1994/06/21	64.50	10.41	.00	74.91
REPAIR TYPE TOTAL							
34400	STROBE LAMP	247224	1994/12/01	139.75	37.80	.00	177.55
REPAIR TYPE TOTAL							
3450R	SANDER/WORK LAMP	246757	1994/11/10	86.00	9.16	.00	95.16
3450R	SANDER/WORK LAMP	247127	1994/11/29	53.75	9.23	.00	62.98
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
VEHICLE 3221 INT' ETHANOL TANDEM AXLE							
REPAIR SUB GROUP TOTAL							
				311.75	22.42	67.74	401.91
REPAIR GROUP TOTAL							
				311.75	22.42	67.74	401.91
PM/MINUS PM TOTAL							
				311.75	22.42	67.74	401.91
01530	HEATER SHUTOFF VALVE	242292	1994/05/23	53.75	.00	.00	53.75
REPAIR TYPE TOTAL							
				53.75	.00	.00	53.75
REPAIR SUB GROUP TOTAL							
				53.75	.00	.00	53.75
0300R	GAUGES/INSTRUMENTS	240614	1994/05/04	731.00	4.07	17.98	753.05
REPAIR TYPE TOTAL							
				731.00	4.07	17.98	753.05
03250	FUEL GAUGE	239117	1994/02/14	129.00	.00	.00	129.00
REPAIR TYPE TOTAL							
				129.00	.00	.00	129.00
0326R	FUEL GG SENDER UNIT	239117	1994/02/14	.00	.00	26.18	26.18
0326O	FUEL GG SENDER UNIT	242400	1994/06/01	182.75	.00	.00	182.75
0326R	FUEL GG SENDER UNIT	242400	1994/06/01	.00	.00	28.90	28.90
REPAIR TYPE TOTAL							
				182.75	.00	55.08	237.83
REPAIR SUB GROUP TOTAL							
				1,042.75	4.07	73.06	1,119.88
0712O	DOOR LATCH ASSEMBLY	247674	1994/12/19	161.25	.00	.00	161.25
REPAIR TYPE TOTAL							
				161.25	.00	.00	161.25
0738O	ENGINE COVER(S)	239274	1994/03/29	75.25	.00	.00	75.25
REPAIR TYPE TOTAL							
				75.25	.00	.00	75.25
0798O	DUMP BODY TAILGATE	246263	1994/10/20	21.50	.00	.00	21.50
REPAIR TYPE TOTAL							
				21.50	.00	.00	21.50
REPAIR SUB GROUP TOTAL							
				258.00	.00	.00	258.00
REPAIR GROUP TOTAL							
				1,354.50	4.07	73.06	1,431.63
1335O	BRAKE, POWER ASSIST	239274	1994/03/29	32.25	.00	.00	32.25
REPAIR TYPE TOTAL							
				32.25	.00	.00	32.25
1350O	AIR COMPRESSOR	239077	1994/02/01	139.75	4.24	.00	143.99
REPAIR TYPE TOTAL							
				139.75	4.24	.00	143.99
1352O	AIR COMPR FILTER	239517	1994/02/14	129.00	.00	.00	129.00
REPAIR TYPE TOTAL							
				129.00	.00	.00	129.00
1355O	AIR DRYER ASSEMBLY	239517	1994/02/14	.00	.00	55.51	55.51
REPAIR TYPE TOTAL							
				.00	.00	55.51	55.51
REPAIR SUB GROUP TOTAL							
				301.00	4.24	55.51	360.75

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

VEHICLE 3221 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
51050	AIR HORN ASSEMBLY	236740	1993/11/12	21.50	.00	.00	21.50
51050	AIR HORN ASSEMBLY	237426	1993/12/03	53.75	.54	.00	54.29
51050	AIR HORN ASSEMBLY	238027	1993/12/22	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			118.25	.54	.00	118.79
	REPAIR SUB GROUP TOTAL			118.25	.54	.00	118.79
52000	ACCESSORY, ELECTRIC	236706	1993/11/17	75.25	.00	.00	75.25
	REPAIR TYPE TOTAL			75.25	.00	.00	75.25
52300	RADIO ANTENNA	236740	1993/11/12	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
	REPAIR SUB GROUP TOTAL			96.75	.00	.00	96.75
5910R	PINTLE HOOK	231148	1993/09/28	.00	.00	45.12	45.12
	REPAIR TYPE TOTAL			.00	.00	45.12	45.12
	REPAIR SUB GROUP TOTAL			.00	.00	45.12	45.12
	REPAIR GROUP TOTAL			215.00	.54	45.12	260.66
66000	SP EQUIP ACCESSORIES	237741	1993/12/22	225.75	3.56	8.83	238.14
	REPAIR TYPE TOTAL			225.75	3.56	8.83	238.14
	REPAIR SUB GROUP TOTAL			225.75	3.56	8.83	238.14
	REPAIR GROUP TOTAL			225.75	3.56	8.83	238.14
98300	NEW VEHICLE PREP.	231148	1993/09/28	3,033.65	274.44	243.73	3,551.82
9830I	NEW VEHICLE PREP.	231148	1993/09/28	.00	.00	271.20	271.20
98300	NEW VEHICLE PREP.	235740	1993/10/01	75.25	.00	97.65	172.90
98300	NEW VEHICLE PREP.	236740	1993/11/12	.00	.00	316.35	316.35
	REPAIR TYPE TOTAL			3,108.90	274.44	928.93	4,312.27
	REPAIR SUB GROUP TOTAL			3,108.90	274.44	928.93	4,312.27
	REPAIR GROUP TOTAL			3,108.90	274.44	928.93	4,312.27
	PM/MINUS PM TOTAL			4,764.40	280.69	1,513.72	6,558.81
	ENDYR TOTAL			4,764.40	280.69	1,513.72	6,558.81
1115L	PMA	238557	1994/01/24	150.50	11.52	20.48	182.50
1115L	PMA	239517	1994/02/14	.00	.00	2.56	2.56
1115L	PMA	246757	1994/11/10	118.25	10.90	44.70	173.85
	REPAIR TYPE TOTAL			268.75	22.42	67.74	358.91
1120L	PMB	244783	1994/09/14	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

VEHICLE 3221 INT' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
98951	DIAGNOSTIC MECHANICAL	263658	0000/00/00	129.00	.00	.00	129.00
	REPAIR TYPE TOTAL			129.00	.00	.00	129.00
	REPAIR SUB GROUP TOTAL			129.00	.00	.00	129.00
	REPAIR GROUP TOTAL			129.00	.00	.00	129.00
	PM/MINUS PM TOTAL			129.00	.00	.00	129.00
	ENDYR TOTAL			129.00	.00	.00	129.00
0215L	MIRROR, EXTERNAL	237464	1993/12/06	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
	REPAIR SUB GROUP TOTAL			21.50	.00	.00	21.50
	REPAIR GROUP TOTAL			21.50	.00	.00	21.50
13610	AIR SUPPLY LINES	236515	1993/10/29	419.25	.00	.00	419.25
13610	AIR SUPPLY LINES	237426	1993/12/03	150.50	1.34	.00	151.84
	REPAIR TYPE TOTAL			569.75	1.34	.00	571.09
	REPAIR SUB GROUP TOTAL			569.75	1.34	.00	571.09
	REPAIR GROUP TOTAL			.00	.00	347.21	347.21
1800R	WHEEL/RIM	236706	1993/11/17	.00	.00	347.21	347.21
	REPAIR TYPE TOTAL			.00	.00	347.21	347.21
	REPAIR SUB GROUP TOTAL			.00	.00	347.21	347.21
	REPAIR GROUP TOTAL			569.75	1.34	347.21	918.30
4400L	FUEL SYSTEM	237279	1993/12/03	53.75	.00	.00	53.75
4400I	FUEL SYSTEM	237542	1993/12/09	.00	.00	.00	.00
	REPAIR TYPE TOTAL			53.75	.00	.00	53.75
4410R	FILTER, PRIMARY	237319	1993/12/03	.00	.00	183.63	183.63
	REPAIR TYPE TOTAL			.00	.00	183.63	183.63
44150	FUEL LINES	237319	1993/12/03	301.00	.00	.00	301.00
44150	FUEL LINES	237348	1993/12/03	225.75	.81	.00	226.56
	REPAIR TYPE TOTAL			526.75	.81	.00	527.56
	REPAIR SUB GROUP TOTAL			580.50	.81	183.63	764.94
4500I	ENGINE	237426	1993/12/03	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
	REPAIR SUB GROUP TOTAL			43.00	.00	.00	43.00
	REPAIR GROUP TOTAL			623.50	.81	183.63	807.94

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HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

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VEHICLE 3220 INT'' ETHANOL TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
	UNIT TOTAL			17,443.19	3,041.69	4,943.73	25,428.61

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

REPAIR CODE	DESCRIPTION	WORK ORDER	NO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
66000	SP EQUIP ACCESSORIES	263446	1996/09/19	10.75	.00	.00	10.75
	REPAIR TYPE TOTAL			32.25	.00	.00	32.25
	REPAIR SUB GROUP TOTAL			32.25	.00	.00	32.25
	REPAIR GROUP TOTAL			32.25	.00	.00	32.25
73010	HYD LINE, PRESSURE	258825	1996/03/11	279.50	52.19	.00	331.69
73010	HYD LINE, PRESSURE	258898	1996/03/14	43.00	.00	.00	43.00
73010	HYD LINE, PRESSURE	259226	1996/03/29	86.00	29.56	.00	115.56
	REPAIR TYPE TOTAL			408.50	81.75	.00	490.25
73100	HYD LINE, RETURN	259015	1996/03/18	75.25	.00	.00	75.25
	REPAIR TYPE TOTAL			75.25	.00	.00	75.25
	REPAIR SUB GROUP TOTAL			483.75	81.75	.00	565.50
7721R	HYD TANK FILTER	262383	1996/09/20	21.50	6.49	.00	27.99
	REPAIR TYPE TOTAL			21.50	6.49	.00	27.99
7725L	HYDRAULIC FLUID	259020	1996/03/18	43.00	17.76	.00	60.76
	REPAIR TYPE TOTAL			43.00	17.76	.00	60.76
	REPAIR SUB GROUP TOTAL			64.50	24.25	.00	88.75
	REPAIR GROUP TOTAL			548.25	106.00	.00	654.25
91320	AUX AIR CYLINDER	262734	1996/08/26	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
	REPAIR SUB GROUP TOTAL			21.50	.00	.00	21.50
98200	GENERAL GREASING	M08223	1996/02/08	86.00	.88	.00	86.88
98200	GENERAL GREASING	M08408	1996/03/14	86.00	.88	.00	86.88
98200	GENERAL GREASING	M09047	1996/08/15	86.00	.88	.00	86.88
98200	GENERAL GREASING	M09176	1996/09/20	86.00	.88	.00	86.88
98200	GENERAL GREASING	M09297	1996/10/28	86.00	.88	.00	86.88
	REPAIR TYPE TOTAL			430.00	4.40	.00	434.40
98601	TRUCK INSPECTION	262383	1996/09/20	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
	REPAIR SUB GROUP TOTAL			473.00	4.40	.00	477.40
	REPAIR GROUP TOTAL			494.50	4.40	.00	498.90
	PM/MINUS PM TOTAL			5,657.94	1,538.77	864.65	8,061.36
	ENDYR TOTAL			5,829.94	1,549.75	890.39	8,270.08

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

VEHICLE 3220 INT' EXPBASE TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
42001	COOLING SYSTEM	264342	1996/11/05	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
4212R	COOLANT FILTER	262383	1996/09/20	21.50	8.88	.00	30.38
	REPAIR TYPE TOTAL			21.50	8.88	.00	30.38
4226R	FAN CLUTCH	263529	1996/10/31	311.75	.00	.00	311.75
4226O	FAN CLUTCH	263529	1996/10/31	236.50	1.64	567.58	805.72
4226I	FAN CLUTCH	263529	1996/10/31	64.50	.00	.00	64.50
	REPAIR TYPE TOTAL			612.75	1.64	567.58	1,181.97
4231L	WATER PUMP BELT	262383	1996/09/20	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
	REPAIR SUB GROUP TOTAL			698.75	10.52	567.58	1,276.85
4410R	FILTER, PRIMARY	259316	1996/03/29	118.25	.00	.00	118.25
4410R	FILTER, PRIMARY	262383	1996/09/20	.00	.00	8.22	8.22
	REPAIR TYPE TOTAL			118.25	.00	8.22	126.47
4411R	FILTER, SECONDARY	262383	1996/09/20	.00	.00	8.22	8.22
	REPAIR TYPE TOTAL			.00	.00	8.22	8.22
	REPAIR SUB GROUP TOTAL			118.25	.00	16.44	134.69
	REPAIR GROUP TOTAL			817.00	10.52	584.02	1,411.54
5100O	ACCESSORIES, GENERAL	258681	1996/03/18	408.50	3.09	.00	411.59
	REPAIR TYPE TOTAL			408.50	3.09	.00	411.59
5110O	TARPALIN ASSEMBLY	261055	1996/06/14	215.00	.84	.00	215.84
	REPAIR TYPE TOTAL			215.00	.84	.00	215.84
	REPAIR SUB GROUP TOTAL			623.50	3.93	.00	627.43
5240O	BOX SHAKER	258610	1996/02/29	86.00	105.00	.00	191.00
5240O	BOX SHAKER	260747	1996/05/30	161.25	36.27	.00	197.52
	REPAIR TYPE TOTAL			247.25	141.27	.00	388.52
	REPAIR SUB GROUP TOTAL			247.25	141.27	.00	388.52
5410O	SNOW FLOW FRAME	256942	1996/01/10	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
	REPAIR SUB GROUP TOTAL			43.00	.00	.00	43.00
	REPAIR GROUP TOTAL			913.75	145.20	.00	1,058.95
6600L	SP EQUIP ACCESSORIES	262522	1996/08/15	21.50	.00	.00	21.50

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
3107R	ALTERNATOR BELT	263660	1996/10/09	107.50	.00	10.56	118.06
REPAIR TYPE TOTAL				107.50	.00	10.56	118.06
31200	WIRES	260975	1996/06/07	53.75	.00	.00	53.75
REPAIR TYPE TOTAL				53.75	.00	.00	53.75
REPAIR SUB GROUP TOTAL				182.75	.00	10.56	193.31
3201R	BATTERY	263916	1996/10/21	75.25	346.08	.00	421.33
REPAIR TYPE TOTAL				75.25	346.08	.00	421.33
REPAIR SUB GROUP TOTAL				75.25	346.08	.00	421.33
34000	LIGHTING SYSTEM	261426	1996/07/02	107.50	13.00	.00	120.50
REPAIR TYPE TOTAL				107.50	13.00	.00	120.50
3401R	HEADLAMP	256887	1996/01/05	10.75	12.36	.00	23.11
34010	HEADLAMP	256942	1996/01/10	21.50	12.36	.00	33.86
REPAIR TYPE TOTAL				32.25	24.72	.00	56.97
34100	STOPLAMP	259084	1996/03/20	64.50	.00	.00	64.50
34100	STOPLAMP	262855	1996/09/03	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				107.50	.00	.00	107.50
34150	TURN SIGNAL LAMP	262855	1996/09/03	107.50	12.97	.00	120.47
34150	TURN SIGNAL LAMP	262860	1996/09/10	.00	1.76	.00	1.76
REPAIR TYPE TOTAL				107.50	14.73	.00	122.23
34300	CLEARANCE/MARKER LMP	258560	1996/02/29	43.00	.00	.00	43.00
34300	CLEARANCE/MARKER LMP	259431	1996/04/03	21.50	1.83	.00	23.33
34300	CLEARANCE/MARKER LMP	261107	1996/06/14	43.00	1.82	.00	44.82
REPAIR TYPE TOTAL				107.50	3.65	.00	111.15
34310	INTERIOR/DASH LAMP	259046	1996/03/20	21.50	.80	.00	22.30
34310	INTERIOR/DASH LAMP	260283	1996/06/07	21.50	.93	.00	22.43
REPAIR TYPE TOTAL				43.00	1.73	.00	44.73
34400	STROBE LAMP	257464	1996/01/23	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				43.00	.00	.00	43.00
34500	SANDER/WORK LAMP	264574	1996/11/08	53.75	9.68	.00	63.43
REPAIR TYPE TOTAL				53.75	9.68	.00	63.43
3455R	LAMP SWITCH(S)	259084	1996/03/20	.00	.00	9.81	9.81
REPAIR TYPE TOTAL				.00	.00	9.81	9.81
REPAIR SUB GROUP TOTAL				602.00	67.51	9.81	679.32
REPAIR GROUP TOTAL				860.00	413.59	20.37	1,293.96

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
07950	DUMP BODY	262822	1996/08/28	96.75	.00	.00	96.75
	REPAIR TYPE TOTAL			96.75	.00	.00	96.75
	REPAIR SUB GROUP TOTAL			96.75	.00	.00	96.75
	REPAIR GROUP TOTAL			967.50	41.25	.00	1,008.75
1310L	REAR BRAKE SHOES/PAD	264342	1996/11/05	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
13230	BRAKE LINES	261426	1996/07/02	43.00	1.52	.00	44.52
	REPAIR TYPE TOTAL			43.00	1.52	.00	44.52
1365R	AIR VALVES	264342	1996/11/05	86.00	13.56	.00	99.56
	REPAIR TYPE TOTAL			86.00	13.56	.00	99.56
1380R	SLACK ADJUSTERS	263529	1996/10/31	.00	.00	13.44	13.44
	REPAIR TYPE TOTAL			.00	.00	13.44	13.44
	REPAIR SUB GROUP TOTAL			150.50	15.08	13.44	179.02
1620R	SPRING	264342	1996/11/05	.00	.00	246.82	246.82
	REPAIR TYPE TOTAL			.00	.00	246.82	246.82
1660R	SHOCK, REAR	264342	1996/11/05	634.25	.33	.00	634.58
	REPAIR TYPE TOTAL			634.25	.33	.00	634.58
	REPAIR SUB GROUP TOTAL			634.25	.33	246.82	881.40
17010	TIRE, FLAT	264342	1996/11/05	64.50	.00	.00	64.50
	REPAIR TYPE TOTAL			64.50	.00	.00	64.50
1702R	TIRE, WORN	258095	1996/02/09	153.94	802.40	.00	956.34
	REPAIR TYPE TOTAL			153.94	802.40	.00	956.34
	REPAIR SUB GROUP TOTAL			218.44	802.40	.00	1,020.84
	REPAIR GROUP TOTAL			1,003.19	817.81	260.26	2,081.26
2301L	PRESSURE PLATE	260283	1996/06/07	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
	REPAIR SUB GROUP TOTAL			21.50	.00	.00	21.50
	REPAIR GROUP TOTAL			21.50	.00	.00	21.50
3101L	ALTERNATOR	262383	1996/09/20	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
9895I	DIAGNOSTIC MECHANICAL	251266	1995/06/12	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				43.00	.00	.00	43.00
REPAIR SUB GROUP TOTAL				688.00	6.13	10.86	704.99
REPAIR GROUP TOTAL				688.00	6.13	10.86	704.99
PM/MINUS PM TOTAL				3,375.50	959.74	1,099.65	5,434.89
ENDYR TOTAL				3,687.25	980.82	1,168.03	5,836.10
1110R	WET TYPE HUB ASSEMB.	263529	1996/10/31	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				21.50	.00	.00	21.50
1115L	PMA	260753	1996/05/30	129.00	10.98	25.74	165.72
REPAIR TYPE TOTAL				129.00	10.98	25.74	165.72
1120L	PMB	262383	1996/09/20	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				21.50	.00	.00	21.50
REPAIR SUB GROUP TOTAL				172.00	10.98	25.74	208.72
REPAIR GROUP TOTAL				172.00	10.98	25.74	208.72
PM/MINUS PM TOTAL				172.00	10.98	25.74	208.72
0215R	MIRROR, EXTERNAL	257464	1996/01/23	64.50	13.81	.00	78.31
0215R	MIRROR, EXTERNAL	257648	1996/01/30	10.75	13.81	.00	24.56
0215O	MIRROR, EXTERNAL	261497	1996/07/03	53.75	.82	.00	54.57
0215I	MIRROR, EXTERNAL	261865	1996/07/23	107.50	.00	.00	107.50
REPAIR TYPE TOTAL				236.50	28.44	.00	264.94
0217R	MIRROR, EXT CONVEX	261603	1996/07/03	32.25	12.81	.00	45.06
REPAIR TYPE TOTAL				32.25	12.81	.00	45.06
REPAIR SUB GROUP TOTAL				268.75	41.25	.00	310.00
0300O	GAUGES/INSTRUMENTS	260283	1996/06/07	236.50	.00	.00	236.50
REPAIR TYPE TOTAL				236.50	.00	.00	236.50
0340O	SPEEDOMETER	259020	1996/03/18	86.00	.00	.00	86.00
0340O	SPEEDOMETER	259046	1996/03/20	139.75	.00	.00	139.75
REPAIR TYPE TOTAL				225.75	.00	.00	225.75
0350O	TACHOMETER	259020	1996/03/18	96.75	.00	.00	96.75
0350O	TACHOMETER	259046	1996/03/20	43.00	.00	.00	43.00
REPAIR TYPE TOTAL				139.75	.00	.00	139.75
REPAIR SUB GROUP TOTAL				602.00	.00	.00	602.00

HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
WORK ORDER COST HISTORY

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
52400	BOX SHAKER	252989	1995/07/26	107.50	7.43	.00	114.93
	REPAIR TYPE TOTAL			107.50	7.43	.00	114.93
52440	BOX SPRAY PUMP	242973	1995/02/02	86.00	8.75	.00	94.75
	REPAIR TYPE TOTAL			86.00	8.75	.00	94.75
	REPAIR SUB GROUP TOTAL			193.50	16.18	.00	209.68
	REPAIR GROUP TOTAL			440.75	16.18	77.43	534.36
73010	HYD LINE, PRESSURE	251190	1995/05/03	86.00	1.42	.00	87.42
	REPAIR TYPE TOTAL			86.00	1.42	.00	87.42
	REPAIR SUB GROUP TOTAL			86.00	1.42	.00	87.42
74001	HYDRAULIC VALVES	255966	1995/11/30	75.25	.00	.00	75.25
	REPAIR TYPE TOTAL			75.25	.00	.00	75.25
74010	HYDRAULIC VALVE	256084	1995/12/07	64.50	.00	.00	64.50
	REPAIR TYPE TOTAL			64.50	.00	.00	64.50
	REPAIR SUB GROUP TOTAL			139.75	.00	.00	139.75
76010	QUICK DISCONNECT	242973	1995/02/02	21.50	3.24	.00	24.74
	REPAIR TYPE TOTAL			21.50	3.24	.00	24.74
	REPAIR SUB GROUP TOTAL			21.50	3.24	.00	24.74
7721R	HYD TANK FILTER	253215	1995/08/21	10.75	6.49	.00	17.24
	REPAIR TYPE TOTAL			10.75	6.49	.00	17.24
7725L	HYDRAULIC FLUID	251190	1995/05/03	.00	29.60	.00	29.60
7725L	HYDRAULIC FLUID	255966	1995/11/30	.00	44.40	.00	44.40
	REPAIR TYPE TOTAL			.00	74.00	.00	74.00
	REPAIR SUB GROUP TOTAL			10.75	80.49	.00	91.24
	REPAIR GROUP TOTAL			258.00	85.15	.00	343.15
98200	GENERAL GREASING	M06599	1995/01/19	86.00	.87	.00	86.87
98200	GENERAL GREASING	M06920	1995/03/15	107.50	.87	4.92	113.29
98200	GENERAL GREASING	M07085	1995/04/26	86.00	.87	.00	86.87
98200	GENERAL GREASING	M07393	1995/07/21	86.00	.88	.00	86.88
98200	GENERAL GREASING	M07547	1995/08/24	86.00	.88	5.94	92.82
98200	GENERAL GREASING	M07633	1995/09/18	86.00	.88	.00	86.88
98200	GENERAL GREASING	M07963	1995/12/07	86.00	.88	.00	86.88
	REPAIR TYPE TOTAL			623.50	6.13	10.86	640.49
98601	TRUCK INSPECTION	253215	1995/08/21	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50

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REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
34500	SANDER/WORK LAMP	249176	1995/02/14	10.75	.00	.00	10.75
	REPAIR TYPE TOTAL			10.75	.00	.00	10.75
	REPAIR SUB GROUP TOTAL			698.75	46.29	.00	745.04
	REPAIR GROUP TOTAL			698.75	46.29	.00	745.04
42001	COOLING SYSTEM	248571	1995/01/25	64.50	.00	.00	64.50
	REPAIR TYPE TOTAL			64.50	.00	.00	64.50
4212R	COOLANT FILTER	253215	1995/08/21	10.75	8.88	.00	19.63
	REPAIR TYPE TOTAL			10.75	8.88	.00	19.63
4226R	FAN CLUTCH	250685	1995/06/12	86.00	.66	753.93	840.59
	REPAIR TYPE TOTAL			86.00	.66	753.93	840.59
	REPAIR SUB GROUP TOTAL			161.25	9.54	753.93	924.72
43500	CLAMPS	254394	1995/09/22	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
	REPAIR SUB GROUP TOTAL			21.50	.00	.00	21.50
4410R	FILTER, PRIMARY	253215	1995/08/21	10.75	.00	7.72	18.47
	REPAIR TYPE TOTAL			10.75	.00	7.72	18.47
4411R	FILTER, SECONDARY	253215	1995/08/21	10.75	.00	7.72	18.47
	REPAIR TYPE TOTAL			10.75	.00	7.72	18.47
	REPAIR SUB GROUP TOTAL			21.50	.00	15.44	36.94
	REPAIR GROUP TOTAL			204.25	9.54	769.37	983.16
51000	ACCESSORIES, GENERAL	254427	1995/09/26	.00	.00	58.62	58.62
	REPAIR TYPE TOTAL			.00	.00	58.62	58.62
5102R	MUD FLAP(S)	242973	1995/02/02	32.25	.00	.00	32.25
5102R	MUD FLAP(S)	253215	1995/08/21	32.25	.00	.00	32.25
5102R	MUD FLAP(S)	256216	1995/12/07	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			107.50	.00	.00	107.50
51100	TARPALIN ASSEMBLY	248131	1995/01/12	75.25	.00	.00	75.25
51100	TARPALIN ASSEMBLY	254427	1995/09/26	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			96.75	.00	.00	96.75
5115R	W/WASHER BLADES	249363	1995/02/27	43.00	.00	18.81	61.81
	REPAIR TYPE TOTAL			43.00	.00	18.81	61.81
	REPAIR SUB GROUP TOTAL			247.25	.00	77.43	324.68

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VEHICLE 3220 INT' EXPBASE TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
1701O	TIRE, FLAT	250061	1995/03/17	64.50	.00	.00	64.50
	REPAIR TYPE TOTAL			64.50	.00	.00	64.50
1702R	TIRE, WORN	253774	1995/08/28	75.25	592.84	.00	668.09
	REPAIR TYPE TOTAL			75.25	592.84	.00	668.09
	REPAIR SUB GROUP TOTAL			139.75	592.84	.00	732.59
	REPAIR GROUP TOTAL			516.00	748.14	161.24	1,425.38
2301L	PRESSURE PLATE	253707	1995/08/28	32.25	.00	.00	32.25
2301L	PRESSURE PLATE	256461	1995/12/15	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			53.75	.00	.00	53.75
	REPAIR SUB GROUP TOTAL			53.75	.00	.00	53.75
2791L	TRANSMISSION FLUID	255091	1995/10/25	.00	14.80	.00	14.80
	REPAIR TYPE TOTAL			.00	14.80	.00	14.80
	REPAIR SUB GROUP TOTAL			.00	14.80	.00	14.80
	REPAIR GROUP TOTAL			53.75	14.80	.00	68.55
3401R	HEADLAMP	249176	1995/02/14	10.75	11.00	.00	21.75
3401O	HEADLAMP	255544	1995/11/14	43.00	12.36	.00	55.36
	REPAIR TYPE TOTAL			53.75	23.36	.00	77.11
3415O	TURN SIGNAL LAMP	250656	1995/04/20	204.25	.00	.00	204.25
3415O	TURN SIGNAL LAMP	251266	1995/06/12	32.25	8.29	.00	40.54
	REPAIR TYPE TOTAL			236.50	8.29	.00	244.79
3420O	TAIL/PARK LAMP	251266	1995/06/12	.00	.00	.00	.00
	REPAIR TYPE TOTAL			.00	.00	.00	.00
3430O	CLEARANCE/MARKER LMP	242973	1995/02/02	86.00	2.28	.00	88.28
3430R	CLEARANCE/MARKER LMP	242973	1995/02/02	.00	10.41	.00	10.41
3430O	CLEARANCE/MARKER LMP	250394	1995/04/04	75.25	.00	.00	75.25
3430O	CLEARANCE/MARKER LMP	252675	1995/07/10	43.00	.00	.00	43.00
3430O	CLEARANCE/MARKER LMP	252810	1995/07/14	32.25	.00	.00	32.25
3430O	CLEARANCE/MARKER LMP	254394	1995/09/22	32.25	.00	.00	32.25
3430O	CLEARANCE/MARKER LMP	256753	1995/12/28	21.50	1.95	.00	23.45
	REPAIR TYPE TOTAL			290.25	14.64	.00	304.89
3433O	MISC. LAMPS	254394	1995/09/22	21.50	.00	.00	21.50
	REPAIR TYPE TOTAL			21.50	.00	.00	21.50
3440O	STROBE LAMP	248213	1995/01/12	86.00	.00	.00	86.00
	REPAIR TYPE TOTAL			86.00	.00	.00	86.00

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VEHICLE 3220 INT' EXPENSE TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
PM/MINUS PM TOTAL							
01410	HOSE CLAMPS/FITTINGS	253215	1995/08/21	64.50	.55	.00	65.05
REPAIR TYPE TOTAL							
01530	HEATER SHUTOFF VALVE	251266	1995/06/12	75.25	2.20	.00	77.45
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
0215R	MIRROR, EXTERNAL	253035	1995/07/28	10.75	12.41	.00	23.16
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
0330R	AIR PRESSURE GAUGE	255945	1995/11/30	.00	.00	56.91	56.91
03300	AIR PRESSURE GAUGE	255945	1995/11/30	86.00	.00	.00	86.00
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
07120	DOOR LATCH ASSEMBLY	249988	1995/03/16	43.00	.00	.00	43.00
REPAIR TYPE TOTAL							
0797R	DMPBODY SPILL SHIELD	251778	1995/06/12	193.50	18.35	23.84	235.69
REPAIR TYPE TOTAL							
0799R	PAINTING	251778	1995/06/12	43.00	.00	.00	43.00
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
13500	AIR COMPRESSOR	250952	1995/04/26	86.00	13.98	.00	99.98
REPAIR TYPE TOTAL							
13550	AIR DRYER ASSEMBLY	250685	1995/06/12	43.00	.00	25.07	68.07
13551	AIR DRYER ASSEMBLY	250685	1995/06/12	21.50	.00	.00	21.50
REPAIR TYPE TOTAL							
13800	SLACK ADJUSTERS	255091	1995/10/25	75.25	.00	.00	75.25
REPAIR TYPE TOTAL							
1385R	SPRING PARKING BRAKE	251910	1995/06/02	150.50	141.32	136.17	427.99
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR SUB GROUP TOTAL							

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VEHICLE 3220 INT' EXPBASE TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
REPAIR SUB GROUP TOTAL							
7721R	HYD TANK FILTER	244649	1994/08/24	53.75	.00	.00	53.75
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
98000	MISC INSIDE WORK	M05306	1994/03/01	.00	.00	2.56	2.56
REPAIR TYPE TOTAL							
98200	GENERAL GREASING	M05155	1994/01/21	86.00	.80	.00	86.80
98200	GENERAL GREASING	M05440	1994/03/15	107.50	.80	.00	108.30
98200	GENERAL GREASING	M05605	1994/04/29	118.25	3.44	.00	121.69
98200	GENERAL GREASING	M05660	1994/05/10	107.50	.80	1.28	109.58
98200	GENERAL GREASING	M05706	1994/06/01	64.50	2.81	.00	67.31
98200	GENERAL GREASING	M05980	1994/08/16	64.50	.00	20.40	84.90
98200	GENERAL GREASING	M05983	1994/08/17	64.50	.80	.00	65.30
98200	GENERAL GREASING	M06317	1994/11/09	139.75	11.84	.00	151.59
98200	GENERAL GREASING	M06447	1994/12/14	86.00	.80	4.92	91.72
REPAIR TYPE TOTAL							
98601	TRUCK INSPECTION	244649	1994/08/24	172.00	.00	.00	172.00
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
99500	ACCESSORIES GROUP	244761	1994/09/14	.00	.00	.00	.00
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							
PM/MINUS PM TOTAL							
ENDYR TOTAL							
1115L	PMA	250328	1995/03/29	107.50	10.10	42.64	160.24
1115L	PMA	255091	1995/10/25	172.00	10.98	25.74	208.72
REPAIR TYPE TOTAL							
1120L	PMB	253215	1995/08/21	32.25	.00	.00	32.25
REPAIR TYPE TOTAL							
REPAIR SUB GROUP TOTAL							
REPAIR GROUP TOTAL							

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VEHICLE 3220 INT'' EXPBASE TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
4212R	COOLANT FILTER	244649	1994/08/24	118.25	48.05	40.70	207.00
	REPAIR TYPE TOTAL			118.25	48.05	40.70	207.00
	REPAIR SUB GROUP TOTAL			161.25	48.05	40.70	250.00
4410R	FILTER, PRIMARY	244649	1994/08/24	10.75	.00	4.69	15.44
	REPAIR TYPE TOTAL			10.75	.00	4.69	15.44
4411R	FILTER, SECONDARY	244649	1994/08/24	10.75	.00	7.43	18.18
	REPAIR TYPE TOTAL			10.75	.00	7.43	18.18
	REPAIR SUB GROUP TOTAL			21.50	.00	12.12	33.62
4562I	OIL FILTER ASSEMBLY	247663	1994/12/19	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
	REPAIR SUB GROUP TOTAL			43.00	.00	.00	43.00
	REPAIR GROUP TOTAL			376.25	48.05	63.70	488.00
51000	ACCESSORIES, GENERAL	240993	1994/04/12	526.75	.00	.00	526.75
51000	ACCESSORIES, GENERAL	243064	1994/06/21	43.00	3.27	.00	46.27
	REPAIR TYPE TOTAL			569.75	3.27	.00	573.02
5110R	TARPALIN ASSEMBLY	240993	1994/04/12	.00	.00	852.72	852.72
	REPAIR TYPE TOTAL			.00	.00	852.72	852.72
	REPAIR SUB GROUP TOTAL			569.75	3.27	852.72	1,425.74
5221O	RADIO, AM/FM	244712	1994/09/22	64.50	.00	104.00	168.50
5221O	RADIO, AM/FM	245791	1994/10/17	182.75	.00	.00	182.75
	REPAIR TYPE TOTAL			247.25	.00	104.00	351.25
5250O	MISC SWITCHES	246233	1994/10/19	.00	.00	24.24	24.24
	REPAIR TYPE TOTAL			.00	.00	24.24	24.24
	REPAIR SUB GROUP TOTAL			247.25	.00	128.24	375.49
5410O	SNOW PLOW FRAME	239230	1994/02/04	64.50	.00	.00	64.50
	REPAIR TYPE TOTAL			64.50	.00	.00	64.50
	REPAIR SUB GROUP TOTAL			64.50	.00	.00	64.50
	REPAIR GROUP TOTAL			881.50	3.27	980.96	1,865.73
7476R	CABLE, CONT'L LEVER	243876	1994/07/29	64.50	.00	.00	64.50
7476O	CABLE, CONT'L LEVER	243876	1994/07/29	.00	1.90	3.86	5.76
7476O	CABLE, CONT'L LEVER	243998	1994/07/29	64.50	1.85	.00	66.35
	REPAIR TYPE TOTAL			129.00	3.75	3.86	136.61

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REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
34010	HEADLAMP	239025	1994/02/01	118.25	.00	.00	118.25
REPAIR TYPE TOTAL							118.25
34100	STOPLAMP	245198	1994/09/14	21.50	.00	.00	21.50
REPAIR TYPE TOTAL							21.50
3425R	BACKUP LAMP	246763	1994/11/10	.00	9.16	.00	9.16
REPAIR TYPE TOTAL							9.16
3430R	CLEARANCE/MARKER LMP	238204	1994/01/10	53.75	.00	22.75	76.50
34300	CLEARANCE/MARKER LMP	240079	1994/03/03	21.50	.00	.00	21.50
34300	CLEARANCE/MARKER LMP	240921	1994/04/04	64.50	.00	.00	64.50
34300	CLEARANCE/MARKER LMP	243876	1994/07/29	193.50	.00	.00	193.50
34300	CLEARANCE/MARKER LMP	245791	1994/10/17	96.75	.00	.00	96.75
3430R	CLEARANCE/MARKER LMP	247734	1994/12/19	21.50	2.05	11.76	35.31
REPAIR TYPE TOTAL							488.06
34340	FLOOD LAMPS	243876	1994/07/29	.00	.00	9.83	9.83
REPAIR TYPE TOTAL							9.83
34400	STROBE LAMP	239065	1994/02/01	32.25	.00	.00	32.25
34400	STROBE LAMP	239479	1994/02/14	172.00	.00	.00	172.00
34400	STROBE LAMP	239384	1994/02/14	21.50	.00	.00	21.50
34400	STROBE LAMP	247806	1994/12/20	86.00	.00	.00	86.00
REPAIR TYPE TOTAL							311.75
3450R	SANDER/WORK LAMP	246763	1994/11/10	75.25	.00	.00	75.25
3450R	SANDER/WORK LAMP	246876	1994/11/16	43.00	9.23	.00	52.23
REPAIR TYPE TOTAL							127.48
3455R	LAMP SWITCH(S)	243876	1994/07/29	21.50	.00	.00	21.50
REPAIR TYPE TOTAL							21.50
REPAIR SUB GROUP TOTAL							1,107.53
REPAIR GROUP TOTAL							1,406.97
41000	INTAKE SYSTEM	240427	1994/03/11	139.75	.00	.00	139.75
REPAIR TYPE TOTAL							139.75
41460	INTAKE DUCTING, AC	240079	1994/03/03	10.75	.00	.00	10.75
41460	INTAKE DUCTING, AC	240427	1994/03/11	.00	.00	10.88	10.88
REPAIR TYPE TOTAL							21.63
REPAIR SUB GROUP TOTAL							161.38
42010	RADIATOR	240079	1994/03/03	43.00	.00	.00	43.00
REPAIR TYPE TOTAL							43.00

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REPAIR CODE	DESCRIPTION	WORK ORDER	NO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
17010	TIRE, FLAT	245567	1994/09/21	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
	REPAIR SUB GROUP TOTAL			43.00	.00	.00	43.00
18010	RIM	246763	1994/11/10	129.00	.00	26.66	155.66
	REPAIR TYPE TOTAL			129.00	.00	26.66	155.66
	REPAIR SUB GROUP TOTAL			129.00	.00	26.66	155.66
	REPAIR GROUP TOTAL			172.00	.00	26.66	198.66
22070	GASKET, AXLE SHAFT	246020	1994/10/10	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
	REPAIR SUB GROUP TOTAL			43.00	.00	.00	43.00
2300L	CLUTCH ASSEMBLY	244649	1994/08/24	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			43.00	.00	.00	43.00
2301L	PRESSURE PLATE	242282	1994/05/23	43.00	.00	.00	43.00
2301L	PRESSURE PLATE	247663	1994/12/19	43.00	.00	.00	43.00
	REPAIR TYPE TOTAL			86.00	.00	.00	86.00
	REPAIR SUB GROUP TOTAL			129.00	.00	.00	129.00
2787L	LINKAGE	244096	1994/08/01	86.00	.00	.00	86.00
	REPAIR TYPE TOTAL			86.00	.00	.00	86.00
	REPAIR SUB GROUP TOTAL			86.00	.00	.00	86.00
	REPAIR GROUP TOTAL			258.00	.00	.00	258.00
32010	BATTERY	238878	1994/01/25	21.50	66.42	.00	87.92
	REPAIR TYPE TOTAL			21.50	66.42	.00	87.92
32020	BATTERY CABLE	238878	1994/01/25	64.50	6.54	.00	71.04
	REPAIR TYPE TOTAL			64.50	6.54	.00	71.04
32060	BATTERY HOLDOWNS	238878	1994/01/25	53.75	.73	.00	54.48
	REPAIR TYPE TOTAL			53.75	.73	.00	54.48
	REPAIR SUB GROUP TOTAL			139.75	73.69	.00	213.44
33350	IGNITION SWITCH	246233	1994/10/19	86.00	.00	.00	86.00
	REPAIR TYPE TOTAL			86.00	.00	.00	86.00
	REPAIR SUB GROUP TOTAL			86.00	.00	.00	86.00

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REPAIR CODE	DESCRIPTION	WORK ORDER	WO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
VEHICLE 3220 INT' EXPBASE TANDEM AXLE							
66000	SP EQUIP ACCESSORIES	237740	1993/12/21	75.25	.00	.00	75.25
6600R	SP EQUIP ACCESSORIES	237740	1993/12/21	.00	3.56	.00	3.56
REPAIR TYPE TOTAL				75.25	3.56	.00	78.81
REPAIR SUB GROUP TOTAL				75.25	3.56	.00	78.81
REPAIR GROUP TOTAL				75.25	3.56	.00	78.81
74000	HYDRAULIC VALVES	236759	1993/11/19	107.50	.00	.00	107.50
REPAIR TYPE TOTAL				107.50	.00	.00	107.50
REPAIR SUB GROUP TOTAL				107.50	.00	.00	107.50
REPAIR GROUP TOTAL				107.50	.00	.00	107.50
98301	NEW VEHICLE PREP.	231147	1993/09/17	.00	.00	271.20	271.20
98300	NEW VEHICLE PREP.	231147	1993/09/17	2,655.25	266.59	207.69	3,129.53
98300	NEW VEHICLE PREP.	235739	1993/10/01	64.50	.00	413.99	478.49
REPAIR TYPE TOTAL				2,719.75	266.59	892.88	3,879.22
98500	SEASONAL PREP	231147	1993/09/17	75.25	.00	301.92	377.17
REPAIR TYPE TOTAL				75.25	.00	301.92	377.17
REPAIR SUB GROUP TOTAL				2,795.00	266.59	1,194.80	4,256.39
REPAIR GROUP TOTAL				2,795.00	266.59	1,194.80	4,256.39
PM/MINUS PM TOTAL				3,278.75	272.50	1,693.99	5,245.24
ENDYR TOTAL				3,421.75	284.01	1,719.99	5,425.75
1115L	PMA	240079	1994/03/03	193.50	28.32	.00	221.82
1115L	PMA	245567	1994/09/21	86.00	10.90	16.64	113.54
REPAIR TYPE TOTAL				279.50	39.22	16.64	335.36
1120L	PMB	244649	1994/08/24	43.00	.90	.00	43.90
REPAIR TYPE TOTAL				43.00	.90	.00	43.90
REPAIR SUB GROUP TOTAL				322.50	40.12	16.64	379.26
REPAIR GROUP TOTAL				322.50	40.12	16.64	379.26
PM/MINUS PM TOTAL				322.50	40.12	16.64	379.26
0787R	MISC DECAL(S)	245137	1994/09/14	32.25	15.70	.00	47.95
REPAIR TYPE TOTAL				32.25	15.70	.00	47.95
REPAIR SUB GROUP TOTAL				32.25	15.70	.00	47.95
REPAIR GROUP TOTAL				32.25	15.70	.00	47.95

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HENNEPIN COUNTY EQUIPMENT MANAGEMENT SYSTEM
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VEHICLE 3220 INT' EXPBASE TANDEM AXLE

REPAIR CODE	DESCRIPTION	WORK ORDER	NO COMPLETED	LABOR COST	PARTS COST	OUTSIDE COST	TOTAL COST
1115L PMA		238003	1993/12/22	143.00	11.51	26.00	180.51
REPAIR TYPE TOTAL				143.00	11.51	26.00	180.51
REPAIR SUB GROUP TOTAL				143.00	11.51	26.00	180.51
REPAIR GROUP TOTAL				143.00	11.51	26.00	180.51
PM/MINUS PM TOTAL				143.00	11.51	26.00	180.51
13600 AIR SUPPLY TANKS		236872	1993/11/17	96.75	.00	30.24	126.99
REPAIR TYPE TOTAL				96.75	.00	30.24	126.99
1365R AIR VALVES		231147	1993/09/17	64.50	.00	14.53	79.03
REPAIR TYPE TOTAL				64.50	.00	14.53	79.03
REPAIR SUB GROUP TOTAL				161.25	.00	44.77	206.02
1800R WHEEL/RIM		236759	1993/11/19	.00	.00	347.21	347.21
REPAIR TYPE TOTAL				.00	.00	347.21	347.21
REPAIR SUB GROUP TOTAL				.00	.00	347.21	347.21
REPAIR GROUP TOTAL				161.25	.00	391.98	553.23
4320R EXHAUST TUBING		231147	1993/09/17	.00	.00	62.09	62.09
REPAIR TYPE TOTAL				.00	.00	62.09	62.09
REPAIR SUB GROUP TOTAL				.00	.00	62.09	62.09
REPAIR GROUP TOTAL				.00	.00	62.09	62.09
5105Q AIR HORN ASSEMBLY		238026	1993/12/22	75.25	.00	.00	75.25
REPAIR TYPE TOTAL				75.25	.00	.00	75.25
REPAIR SUB GROUP TOTAL				75.25	.00	.00	75.25
5200Q ACCESSORY, ELECTRIC		236705	1993/11/12	21.50	.00	.00	21.50
REPAIR TYPE TOTAL				21.50	.00	.00	21.50
5225Q 2-WAY RADIO		236759	1993/11/19	43.00	2.35	.00	45.35
REPAIR TYPE TOTAL				43.00	2.35	.00	45.35
REPAIR SUB GROUP TOTAL				64.50	2.35	.00	66.85
5910R PINTLE HOOK		231147	1993/09/17	.00	.00	45.12	45.12
REPAIR TYPE TOTAL				.00	.00	45.12	45.12
REPAIR SUB GROUP TOTAL				.00	.00	45.12	45.12
REPAIR GROUP TOTAL				139.75	2.35	45.12	187.22

Appendix 6
Oil Analysis Results

Summary of All Oil Analyses

Unit #	Miles at sample	Pass/Fail	Was oil changed?
3220	37065	Pass	
	40485	Fail	Yes
	48880	Pass	
	57112	Pass	Yes
	65403	Pass	
	69405	Pass	
	72051	Pass	
	81301	Pass	
	87817	Fail	Yes
3221	28992	Fail	Yes
	35381	Pass	
	41029	Pass	
	45090	Fail	Yes
	50681	Pass	
	58347	Pass	
	60715	Fail	Yes
3228	21564	Pass	
	26740	Fail	Yes
	29638	Pass	
	32803	Pass	



ZIEGLER OIL ANALYSIS
901 WEST 94TH STREET
MINNEAPOLIS, MN 55420-4299
(612) 888-4121 - (800) 352-2812



SCHEDULED OIL SAMPLING
WEAR ANALYSIS REPORT

Sample For:	HENNEPIN CTY HIGHWAY DEPT	Serial #:	4A32254	Sample #:	96120446
	JIM ALLEN	Compartment:	Diesel Engine	Date Received:	12/03/96
	320 WASHINGTON AVE. S.	Unit #:	3220	Oil Brand:	Caterpillar
	HOPKINS, MN. 55343	Model #:		Oil Blend:	Diesel Engine 0
				Oil Weight:	15W40

DETROIT 6V92

CURRENT SAMPLE INFORMATION					WEAR METALS ANALYSIS										INFRARED ANALYSIS PERCENT OF ALLOWABLE				PHYSICAL TESTS			
DATE SAMPLE TAKEN	CHANGED		QUARTS OIL ADDED	HOURS ON METER	HOURS ON OIL	CU Copper PPM	FE Iron PPM	CR Chromium PPM	AL Aluminum PPM	SI Silicon PPM	PB Lead PPM	NA Sodium PPM	MO Molybdenum PPM	SN Tin PPM	Soot %	Sulfation %	Oxidation %	Nitration %	Anti-Freeze	Fuel Dilution		Water
	Oil	Filter	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y						N	N	
12/02/96	Y	Y		87817		15	128	4	2	8	28	9	2	23	180	65	93	65	N	N	N	N

Interpretation

The analysis of the oil sample taken from your Diesel Engine indicates that Iron and Lead are slightly high; Soot is high. When the MILES/HOURS ON OIL data are unknown, we use the full oil change interval to analyze the sample. If your HOURS ON OIL reading is known please call us, we will reinterpret your results.

Recommendation

Continue to monitor compartment by sampling at recommended intervals. Be sure to fill out labels as complete as possible!

TRENDING SAMPLE INFORMATION					WEAR METALS ANALYSIS										INFRARED ANALYSIS PERCENT OF ALLOWABLE					PHYSICAL TESTS		
DATE SAMPLE TAKEN	CHANGED		QUARTS OIL ADDED	HOURS ON METER	HOURS ON OIL	CU Copper PPM	FE Iron PPM	CR Chromium PPM	AL Aluminum PPM	SI Silicon PPM	PB Lead PPM	NA Sodium PPM	MO Molybdenum PPM	SN Tin PPM	Soot %	Sulfation %	Oxidation %	Nitration %	Anti-Freeze	Fuel Dilution	Water	
	Oil	Filter																				
12/02/96	Y	Y		87817		15	128	4	2	8	28	9	2	23	180	65	93	65	N	N	N	
9/20/96	N	N		81301	9250	10	65	3	1	6	14	6	1	11	160	28	64	29	N	N	N	
8/12/96	N	N		72051	6441	8	43	2	1	5	9	8	1	7	132	16	55	16	N	N	N	
CURRENT SAMPLE IS INCLUDED IN TRENDING					SEE REVERSE SIDE FOR TEST EXPLANATIONS																	

THIS ANALYSIS IS INTENDED AS AN AID IN PREDICTING MECHANICAL WEAR, NO GUARANTEE, EXPRESSED OR IMPLIED, IS MADE AGAINST FAILURE OF THIS COMPONENT

HENNEPIN COUNTY
JIM ALLEN
320 WASHINGTON AVENUE
HOPKINS MN 55343

ANALYSTS, INC.

2450 HASSELL ROAD
HOFFMAN ESTATES, IL 60195
(847) 884-7877
(800) 222-0071



STATUS WAS
Abnormal ON 29-MAR-96

UNIT ID: 3220
COMPONENT: ENGINE
COMP REF NO: 249112
P.O. REF NO: JCC-4-14245-01

WORKSITE

UNIT MANUFACTURER

OIL TYPE

INTN'L HARVESTER 5000

MOBIL DELVAC SAE 40

COMPONENT TYPE

COMPONENT MANUFACTURER AND MODEL

COMPONENT SERIAL NUMBER

DIESEL ENGINE

DETROIT DIESEL 6V92

4A32254

MAINTENANCE RECOMMENDATIONS FOR LAB NO 0832 Reported on 05-APR-96

ANALYSIS INDICATES ABNORMAL LUBRICANT CONDITIONS! VISCOSITY is HIGH for the reported oil type/grade. CHANGE the OIL and FILTER(s) if not already performed. CHECK for proper operating temperatures. RESAMPLE at the next scheduled interval.

EVAL ID:

1289

SPECTROCHEMICAL ANALYSIS IN PARTS PER MILLION BY WEIGHT

# 1289																						SAMPLE DRAWN
LAB NO.	WT.	COBALT	CHROMIUM	IRON	NICKEL	COPPER	LEAD	ALUMINUM	SILICON	PHOSPHORUS	SODIUM	POTASSIUM	MAGNESIUM	CA	CELESIUM	STRONTIUM	BARIUM	CHLORINE	FLUORINE	BROMINE	IODINE	SAMPLE DRAWN
8148	101	6	<1	2	23	16	21	<1	<1	11	20	9	<10	<5	1050	1185	355	<10	1324	<1	<1	19-OCT-95
6334	74	3	<1	<1	18	13	20	<1	<1	6	5	7	<10	<5	1097	1175	81	<10	1427	22	<1	07-FEB-96
0832	93	5	2	<1	28	17	24	<1	<1	7	2	8	<10	<5	979	1112	74	<10	1218	<1	<1	29-MAR-96

SAMPLE INFORMATION

PHYSICAL TEST RESULTS

LAB NO.	TEST	RESULT	FUEL	LEM	WATER	VIS @	SAE	TAN	TBN
			XVOL	XSDOT	% HCL	100°C	GRADE		
8148	57112 0	45453 0	<.5	1.71	<.05	19.1	50	3.37	6.51
6334	65403	8291.0	<.5	1.00	<.05	19.4	50	2.08	5.11
0832	89405 0	8300.0	<.5	1.21	<.05	19.7	50	2.41	5.05

	FUEL	LEN	WATER	VIS CS	SAE	TAN	TBN
	XUGL	XSGOT	% VOL	100°C	GRADE		
6835 37065.0 41127 0	< 5	1.03	< .05	17.2	50	3.20	5.89
6910 40485.0 14547 0	< 5	1.19	< .05	18.1	50	2.75	6.34
2357 48380.0 7330 0	< 5	0.92	< .05	15.0	40	2.52	5.89

ZIEGLER



ZIEGLER OIL ANALYSIS LAB
901 WEST 94TH STREET
MINNEAPOLIS, MN 55420-4299
(612) 888-4121 • (800) 352-2812

S.O.S



SCHEDULED OIL SAMPLING
WEAR ANALYSIS REPORT

Sample For:

HENNEPIN CTY HIGHWAY DEPT
JIM ALLEN
320 WASHINGTON AVENUE S
HOPKINS MN 55343-8496

Serial #:

06VF200396

Compartment:

Diesel Engine

Unit #:

3221

Model #:

Sample #:

96094334

Date Received:

9/23/96

Oil Brand:

Caterpillar

Oil Blend:

Diesel Engine 0

Oil Weight:

15W40

ACTION

DETROIT 6V92

CURRENT SAMPLE INFORMATION				WEAR METALS ANALYSIS										INFRARED ANALYSIS PERCENT OF ALLOWABLE				PHYSICAL TESTS						
DATE SAMPLE TAKEN	CHANGED	QUARTS OIL ADDED	HOURS ON METER	HOURS ON OIL	CU Copper PPM	FE Iron PPM	CR Chromium PPM	AL Aluminum PPM	SI Silicon PPM	PB Lead PPM	NA Sodium PPM	MO Molybdenum PPM	SN Tin PPM	Soot		Sulfation		Oxidation		Nitration		Anti- Freeze	Fuel Dilution	Water
														Oil	Filter	%	%	%	%	%	%			
9/19/96	U	U	60715	15625	65	39	1	1	10	92	251	1	12	23	7	4	1	23				P	N	T

Interpretation

The analysis of the oil sample taken from your Diesel Engine indicates that Copper and Sodium are high; Lead is extremely high. This oil sample tests positive for water and antifreeze contamination. Oil sample has a trace of water contamination.

Recommendation

Antifreeze in the oil requires attention to prevent a possible failure. Also suggest cutting oil filter open, pulling out pleats and checking for metal pieces. Condensation possible cause of water in this compartment, oil may not be warm enough to evaporate moisture.

TRENDING SAMPLE INFORMATION					WEAR METALS ANALYSIS										INFRARED ANALYSIS PERCENT OF ALLOWABLE					PHYSICAL TESTS		
DATE SAMPLE TAKEN	CHANGED		QUARTS OIL ADDED	HOURS ON METER	HOURS ON OIL	CU Copper PPM	FE Iron PPM	CR Chromium PPM	AL Aluminum PPM	SI Silicon PPM	PB Lead PPM	NA Sodium PPM	MO Molybdenum PPM	SN Tin PPM	Soot %	Sulfation %	Oxidation %	Nitration %	Anti- Freeze	Fuel Dilution	Water	
	Oil	Filter																				
9/19/96	U	U		60715	15625	65	39	1	1	10	92	251	1	12	23	7	4	1	P	N	T	
8/15/96	N	N		58347	13257	12	35	1	1	9	27	48	1	5	33	10	23	1	N	N	N	
CURRENT SAMPLE IS INCLUDED IN TRENDING					SEE REVERSE SIDE FOR TEST EXPLANATIONS																	

CURRENT SAMPLE IS INCLUDED IN TRENDING

SEE REVERSE SIDE FOR TEST EXPLANATIONS

THIS ANALYSIS IS INTENDED AS AN AID IN PREDICTING MECHANICAL WEAR, NO GUARANTEE, EXPRESSED OR IMPLIED, IS MADE AGAINST FAILURE OF THIS COMPONENT

Form 50-1 (Rev. 5/94)

HENNEPIN COUNTY
JIM ALLEN
323 WASHINGTON AVENUE
ROCKFORD MN 55343

ANALYSTS, INC.

2450 HASSELL ROAD
HOFFMAN ESTATES, IL 60195
(708) 884-7877
(800) 322-3071

STATUS WAS

Normal Oil 21-JUL-95

UNIT ID 3221
COMPONENT ENGINE
OIL REF ID 324632
OIL REF ID JCC-4-14245-01

ADDRESS	UNIT MANUFACTURER	OIL TYPE
HENNEPIN COUNTY	INT'L HARVESTER DAYSTAR 5000	MOBIL DELVAC SAE 40
COMPONENT TYPE	COMPONENT MANUFACTURER AND MODEL	COMPONENT SERIAL NUMBER
DIESEL ENGINE	DETROIT DIESEL 6V92	06VF260396

ENTER AND RECOMMENDATIONS FOR LAB NO 2358 Reported on 27-JUL-95 From : NATIONAL RENEWABLE ENERGY LABORATORIES GOLDEN, CO

ANALYSIS INDICATES COMPONENT & LUBRICANT CONDITIONS ARE ACCEPTABLE. If still in service, the oil is suitable for continued use RESAMPLE at the next scheduled interval.

EVAL ID:

1314

SPECTROCHEMICAL ANALYSIS IN PARTS PER MILLION BY WEIGHT

LAB NO.

SAMPLE
DATE

LAB NO.	34	2	5	(1)	41.	15	11	(1)	2	20	3	7	(10)	(5)	509	603	50	(10)	824	(1)	2	15-MAR-95
8011																						
0765	34	2	(1)	1	43.	14	9	(1)	(1)	19	2	3	(10)	(5)	523	618	34	(10)	941	3	(1)	11-APR-95
2358	59	2	(1)	1	29	23	12	(1)	(1)	15	2	11	(10)	(5)	492	615	27	(10)	687	3	(1)	21-JUL-95

SAMPLE INFORMATION

PHYSICAL TEST RESULTS

LAB NO.	FUEL	LEM	WATER	VIS DS	SAE	TAN	TEN
	XVOL	ASDOT	X VOL	100°C	GRADE		
8011 25992.0 8891.0	1.5	0.04	1.05	15.8	40	2.52	2.02
0765 28869 8765.0	1.5	0.04	1.05	14.3	40	2.02	2.36
2358 35381.0 5672.0	1.5	0.01	1.05	16.0	40	2.30	2.19

HENNEPIN COUNTY
JIM ALLEN
320 WASHINGTON AVENUE
HOPKINS MN 55343

ANALYSTS, INC.

2450 HASSELL ROAD
HOFFMAN ESTATES, IL 60195
(847) 884-7877
(800) 222-6071

Normal 15-MAR-96

3221
ENGINE
249113
JCC-4-14245-01

COMPONENT TYPE	UNIT MANUFACTURER	UNIT TYPE
ALCOHOL FUELED ENGINE	INTN'L HARVESTER PAYSTAR 5000	MOBIL DELVAC SAE 40
COMPONENT TYPE	COMPONENT MANUFACTURER AND MODEL	COMPONENT SERIAL NUMBER
	DETROIT DIESEL 6V92	06VE200396
MAINTENANCE RECOMMENDATION FOR LAB NO. 1092 Reported on 22-MAR-96		

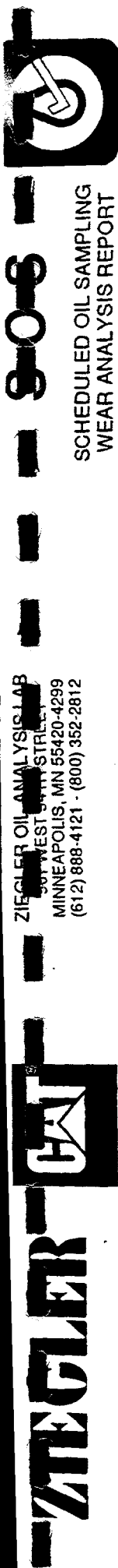
ANALYSIS INDICATES COMPONENT & LUBRICANT CONDITIONS ARE ACCEPTABLE. If still in service, the oil is suitable for continued use. RESAMPLE at the next scheduled interval.

EVAL ID: 1328		SPECTROCHEMICAL ANALYSIS IN PARTS PER MILLION BY WEIGHT																				SAMPLE DATE	
LAB NO.		COBALT	COPPER	IRON	LEAD	MANGANESE	NICKEL	SILICON	SODIUM	POTASSIUM	STRONTIUM	TANTALUM	WOLFRAM	ZINC	ALUMINUM	BARIUM	CADMIUM	CHROMIUM	COBALT	COPPER	IRON		
1149		66	2	<1	<1	46	19	16	<1	14	2	12	<10	<5	520	573	41	<10	662	4	<1	23-OCT-95	
1494		94	4	1	5	59	18	17	0.1	<1	17	2	16	13	<5	478	256	30	<10	694	7	2	21-DEC-95
1092		44	2	4	<1	29	24	4	<1	<1	12	<1	52	<10	<5	571	646	25	<10	1411	5	<1	15-MAR-96

SAMPLE INFORMATION				PHYSICAL TEST RESULTS					
LAB NO.	TIME	DATE	QIL	T/S	WATER	VIS CO	SAE.	TAN	TBN
			ADD	XVOL	% VOL	100°C	GRADE		
1149	41029.0	11130.0		2.0	<.05	16.1	40	2.36	3.93
1494	45090.0	15221.0		0.1	<.05	17.7	50	2.52	1.68
1092	50681.0	55911.0		0.5	<.05	16.0	40	2.24	1.96

TESTING PERFORMED BY ANALYSTS, INC. ANALYSTS, INC. IS NOT RESPONSIBLE FOR THE QUALITY OF THE SAMPLES SUBMITTED FOR TESTING. THE RESULTS OF THE TESTING ARE THE PROPERTY OF ANALYSTS, INC. AND ARE NOT TO BE USED FOR ANY OTHER PURPOSE. THE RESULTS OF THE TESTING ARE THE PROPERTY OF ANALYSTS, INC. AND ARE NOT TO BE USED FOR ANY OTHER PURPOSE.

FOR LEGEND AND EXPLANATION OF PHYSICAL
PROPERTIES TESTS PLEASE SEE PP. 1008-1009
OR A TESTING REFERENCE



SCHEDULED OIL SAMPLING
WEAR ANALYSIS REPORT

Sample For: HENNEPIN CTY HIGHWAY DEPT
JIM ALLEN
320 WASHINGTON AVENUE S
HOPKINS MN 55343-8496

Serial #: 06V200397
Compartment: Diesel Engine
Unit #: 3228
Model #:

Sample #: 96103208
Date Received: 10/15/96
Oil Brand: Shell
Oil Blend: Rotella T
Oil Weight: 15W40

CURRENT SAMPLE INFORMATION					WEAR METALS ANALYSIS									INFRARED ANALYSIS PERCENT OF ALLOWABLE					PHYSICAL TESTS		
DATE SAMPLE TAKEN	CHANGED	QUARTS OIL ADDED	HOURS ON METER	HOURS ON OIL	CU Copper PPM	FE Iron PPM	CR Chromium PPM	AL Aluminum PPM	SI Silicon PPM	PB Lead PPM	NA Sodium PPM	MO Molybdenum PPM	SN Tin PPM	Soot %	Sulfation %	Oxidation %	Nitration %	Anti- Freeze		Water	
																		Oil	Filter		Dilution
10/03/96	N	N	32803	5559	24	47	2	1	10	20	38	4	10	40	25	29	16	N	N	N	

Interpretation
The analysis of the oil sample taken from your Diesel Engine indicates that Copper and Lead are slightly high.

Recommendation
Continue to monitor compartment by sampling at recommended intervals.

TRENDING SAMPLE INFORMATION:					WEAR METALS ANALYSIS										INFRARED ANALYSIS PERCENT OF ALLOWABLE					PHYSICAL TESTS		
DATE SAMPLE TAKEN	CHANGED		QUARTS OIL ADDED	HOURS ON METER	HOURS ON OIL	CU Copper PPM	FE Iron PPM	CR Chromium PPM	AL Aluminum PPM	SI Silicon PPM	PB Lead PPM	NA Sodium PPM	MO Molybdenum PPM	SN Tin PPM	Soot %	Sulfation %	Oxidation %	Nitration %	Anti- Freeze Dilution	Fuel Dilution	Water	
	Oil	Filter																				
10/03/96	N	N		32803	5559	24	47	2	1	10	20	38	4	10	40	25	29	16	N	N	N	
4/29/96	N	N		29638	2394	20	31	1	1	7	10	35	1	5	14	14	19	5	N	N	N	

SEE REVERSE SIDE FOR TEST EXPLANATIONS

CURRENT SAMPLE IS INCLUDED IN TRENDING

THIS ANALYSIS IS INTENDED AS AN AID IN PREDICTING MECHANICAL WEAR, NO GUARANTEE, EXPRESSED OR IMPLIED, IS MADE AGAINST FAILURE OF THIS COMPONENT.

HENNEPIN COUNTY
JIM ALLEN
280 WASHINGTON AVENUE
HOPKINS MN 55343

ANALYSTS, INC.

2450 HASSELL ROAD
HOFFMAN ESTATES, IL 60195
(847) 884-7977
(800) 222-0071



STATUS WAS

Abnormal ON 08-FEB-96

UNIT ID: 3228
COMPONENT: ENGINE
COMP REF NO 249114
PO REF NO JCC-4-14245-01

WORKSITE	UNIT MANUFACTURER	OIL TYPE
COMPONENT TYPE	INTN'L HARVESTER PAYSTAR 500	MOBIL DELVAC SAE 40
ALCOHOL FUELED ENGINE	COMPONENT MANUFACTURER AND MODEL DETROIT DIESEL 6V92	COMPONENT SERIAL NUMBER 06VF200397

MAINTENANCE RECOMMENDATIONS FOR LAB NO 6335 Reported on 12-FEB-96

ANALYSIS INDICATES ABNORMAL COMPONENT CONDITIONS! Bearing overlay wear. CHANGE the OIL and FILTER(s) if not already performed. CHECK for proper start-up and operating oil pressures. RESAMPLE at 1/2 normal interval.

EVAL ID:

1289

SPECTROCHEMICAL ANALYSIS IN PARTS PER MILLION BY WEIGHT

LAB NO.	IRON	CHROMIUM	NICKEL	ALUMINUM	LEAD	COPPER	IN	SILICON	TITANIUM	SILICON	BORE	SODIUM	POTASSIUM	MAGNESIUM	PHOSPHORUS	ZINC	CA	BAR	MAGNESIUM	ALUMINUM	VANADIUM	SAMPLE DRAWN
8150	47	2	<1	1	31	31	17	<1	<1	17	2	11	<10	<5	507	628	41	<10	932	<1	<1	20-OCT-95
6335	76	2	2	<1	54	25	21	<1	<1	12	<1	41	<10	<5	550	624	59	<10	797	<1	<1	08-FEB-96

SAMPLE INFORMATION

PHYSICAL TEST RESULTS

LAB NO	WHR UNIT	WHR OIL	OIL ADD	T/O	WATER	VIS CS	SAE	TAN	TBN
				%VOL	% VOL	100°C	GRADE		
8150	21564.0	5441.0		0.5	< 0.5	15.7	40	3.09	2.81
6335	26740	10615.0		2.0	< 0.5	15.5	40	1.40	2.69

ANALYSTS, INC. IS NOT RESPONSIBLE FOR THE RESULTS OF THIS ANALYSIS. THE ANALYSTS, INC. IS NOT RESPONSIBLE FOR THE RESULTS OF THIS ANALYSIS. THE ANALYSTS, INC. IS NOT RESPONSIBLE FOR THE RESULTS OF THIS ANALYSIS.

FOR LEGEND AND EXPLANATION OF PHYSICAL PROPERTIES TESTS PLEASE SEE REVERSE SIDE. IF A TEST NOT PERFORMED.

Appendix 7
Summary of Emissions Testing

Emissions Testing of Hennepin County Snowplows

Nigel Clark, WVU, October 2, 1997

Two ethanol powered and one diesel powered snowplows were subjected to emissions testing by the West Virginia University Transportable Heavy-Duty Emissions Testing Laboratories. The Transportable Laboratories were originally constructed to satisfy the need to gather data on emissions from heavy-duty vehicles without the need to remove engines from the vehicles for testing. The laboratories are transportable to permit testing at the site of truck operation and to ensure that tested vehicles were out of service for as short a time as possible. The laboratory facility arrives on the test site pulled on two trailers, one being a box trailer containing equipment for emissions measurement, data acquisition and control, and the other, a flat bed semi-trailer carrying the power absorber unit. The flat bed is lowered to the ground to provide a chassis dynamometer platform.

The vehicle to be tested is driven onto the flat bed and the wheels of the vehicle are positioned on rollers set in the bed. The outer wheels of the dual wheel set on each side of the vehicle are connected to the drive shafts of the dynamometer units located on each side of the vehicle. Each dynamometer unit consists of speed increasing gearboxes with a power absorber and a flywheel set. The flywheel sets consist of a series of selectable discs to allow simulation of vehicle inertia. During the test cycle, torque cells and speed transducers in the power absorber drive train measure the actual vehicle load and speed.

The full exhaust from the tail pipe of the test vehicle was ducted to a 45 cm diameter dilution tunnel on top of the emissions trailer. The exhaust was mixed with dilution air and the flow was controlled using a blower with critical flow venturis. Heated sampling probes sent diluted exhaust to a number of different gas analysis instruments, via heated lines. Levels of carbon dioxide (CO_2), carbon monoxide (CO), oxides of nitrogen (NO_x), and hydrocarbons (HC) were measured continuously. A bulk measurement of particulate matter (PM) was obtained using 70 mm filters weighed after conditioning for temperature and humidity in an environmental chamber. Levels of alcohol and aldehydes were determined using impingers and cartridges, respectively, with subsequent laboratory analysis.

The Hennepin County snowplows had 10-speed unsynchronized transmissions and as such would have had difficulty in following the Central Business District speed-time test schedule that is commonly used for automatic transit buses. The bulk of the testing was therefore undertaken using the West Virginia University 5-peak truck cycle, which has a total distance of 5 miles, a time of 900 seconds, and five peaks, at 20, 25, 30, 35, and 40 miles per hour.

The plows were tested in March and April of 1994, and again in May of 1995. Table 1 provides the vehicle mileage at the time of testing.

Table 2 provides emissions data gathered in 1994, while Table 3 provides 1995 initial and repeat run data.

The hydrocarbons reported for the vehicles are direct readings from the flame ionization detector

(FID) of the HC analyzer, which is calibrated using propane. A more representative indication of the hydrocarbon emissions for ethanol vehicles is often expressed as the "organic material hydrocarbon equivalent" (OMHCE), which is calculated as follows to correct for species and to exclude weight of oxygen in the species, with suitable background corrections.

$$\text{OMHCE} = (\text{FIDHC}) - 0.768 (\text{CH}_3\text{OH}) + 0.4621 (\text{HCHO}) = 0.6298 (\text{CH}_3\text{CHO}) + 0.6023 (\text{C}_2\text{H}_5\text{OH}),$$

where $\text{C}_2\text{H}_5\text{OH}$ is ethanol, HCHO is formaldehyde, CH_3CHO is acetaldehyde, and CH_3OH is methanol. In essence, the FID reading is corrected for the calibration with respect to ethanol ($\text{C}_2\text{H}_5\text{OH}$), which is independently measured using impingers, and is increased by the level of formaldehyde (HCHO) and acetaldehyde (CH_3CHO) measured using cartridges, since these two species do not register with the FID.

The data generally show that oxides of nitrogen are slightly lower for the ethanol vehicles than the diesel vehicle, and that particulate matter levels are significantly lower for ethanol. The diesel emissions levels remained consistent from year to year, and offered lower carbon monoxide emissions than the ethanol trucks, whereas the carbon monoxide emissions from one vehicle (3228) rose by a factor of three between 1994 and 1995. It is possible that catalytic converter efficiency had degraded on this vehicle, because hydrocarbon emissions also rose. The diesel vehicle had lower hydrocarbon emissions than the ethanol vehicles and it was evident that unburned ethanol was present in the exhaust of the ethanol vehicles as a significant fraction of the total hydrocarbon emissions. However, since oxides of nitrogen and particulate matter may be considered the emissions of concern for the heavy-duty fleet, one must conclude that the ethanol powered vehicles offered a solution to emissions inventory reduction.

Table 1. Mileage as Received for the Three Snowplows

Unit No.	1994	1995
HC - 3221 Ethanol	8842	30,353
HC - 3228 Ethanol	5175	17,170
HC - 3220 Diesel	12,409	43,806

Table 2. Data from 5-Peak Cycle Runs Gathered in 1994

WVU Sequence #	Unit	CO	NO ₂	PM	FIDHC	OMHCE	HCHO	C ₂ H ₅ OH	CH ₃ CHO
261	HC-3221 Ethanol	7.4	12.3	0.30	4.98	4.33	0.11	2.41	0.56
259	HC-3228 Ethanol	9.0	14.8	0.45	5.69	5.21	0.15	3.37	0.66
258	HC-3220 Diesel	4.3	13.2	0.83	1.35	---	---	---	---

Table 3. Data from 5-Peak Cycle Runs Gathered in 1995

WVU Sequence #	Unit	CO	NO ₂	PM	FIDHC	OMHCE	HCHO	C ₂ H ₅ OH	CH ₃ CHO
431	HC- 3221Ethanol	5.1	11.8	0.35	3.86	2.81	0.08	0.62	0.43
434	HC-3228 Ethanol	26.2	12.0	0.56	7.07	6.73	0.29	3.74	1.88
436	HC-3220 Diesel	4.6	13.3	0.85	1.50	---	---	---	---
453	HC-3221 Repeat	7.7	11.3	0.39	4.02	2.88	0.08	0.74	0.54
454	HC-3228 Repeat	31.2	11.7	0.56	7.17	6.86	0.26	4.33	1.57
460	HC-3220 Repeat	5.8	13.0	0.88	1.38	---	---	---	---

Appendix 8
Details of Emissions Testing

WEST VIRGINIA UNIVERSITY
Transportable Heavy Duty Vehicle Emissions
Testing Laboratory

Test Results Report

Test Date: March, 1994 and May, 1995
Test Vehicles: Snow Plow 3220, 3221 and 3228
Fuel Type: E100 and Diesel
Engine Type: DDC 6V-92TA

Submitted to
Hennepin County

Department of Mechanical & Aerospace Engineering
West Virginia University
Morgantown, WV 26506-6106
Phone: (304) 293-3111
January 28, 1996

Contents

- Part I. Test Driving Cycles
- Part II. Test Circumstances
- Part III. Test Results
- Part IV. Emissions Comparison of Ethanol vs. Diesel

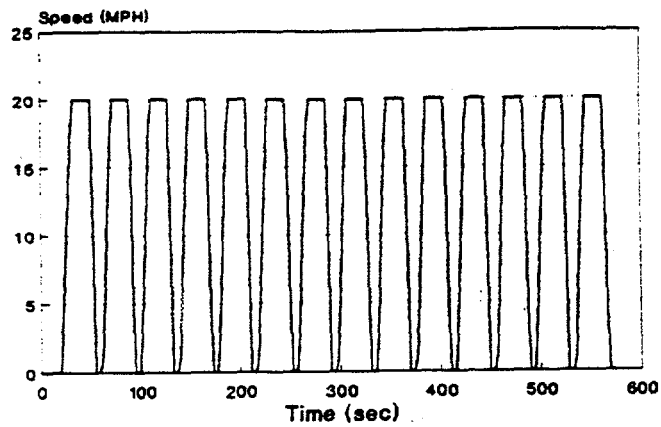
Part I

Test Driving Cycles

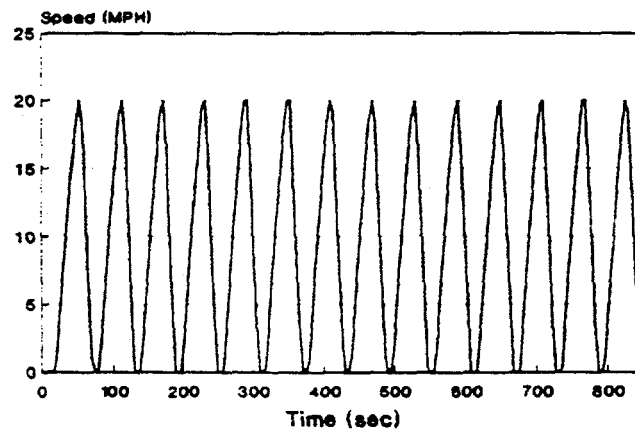
Three cycles were used for the tests: CBD cycle and Truck-CBD cycle and WVU-Truck cycle. The descriptions of the Cycles are as follows:

<u>Cycle Name</u>	<u>Descriptions of Test Cycles</u>
CBD	It is abbreviated from the Central Business District (CBD) phase of the Transit Coach Design Operation Profile Duty Cycle. It was developed by the Federal Transit Administration (FTA) and it was included in SAE Recommended Practice, SAE J1376 JUL82. The driving pattern in this cycle is a general representation of transit vehicle operation in a downtown business district. The cycle consists of fourteen identical segments. Each segment includes 10 seconds of acceleration, 18.5 seconds of 20 mph cruise, 4.5 seconds of deceleration and 7 seconds of idle. The total driving distance is 2 miles.
Truck-CBD	This cycle was modified from the Central Business District (CBD) cycle and was designed for heavy-duty truck testing. It was developed by West Virginia University faculty in 1992. The driving pattern in this cycle is a general representation of trucks operating in a downtown business district. The cycle consists of fourteen identical segments. The maximum speed of this cycle is 20 mph. The total duration of this cycle is 850 seconds. Each segment includes 30 seconds of acceleration, 5 seconds of 20 mph cruise, 15 seconds of deceleration and 10 seconds of idle. The total driving distance is 2.18 miles.
WVU-Truck	It is abbreviated from the West Virginia University Truck cycle. It was developed by West Virginia University faculty in 1994. More information can be found in SAE paper 951016. This cycle is designed for general truck chassis testing. The cycle consists of five segments. Each segment includes an acceleration to a certain speed and then keep this speed for a period and then a deceleration to idle. The acceleration and deceleration are constants for all 5 segments. The five constant speeds for the five segments are 20, 25, 30, 35, and 40 mph. The duration of this cycle is 900 seconds and the total driving distance is 5 miles.

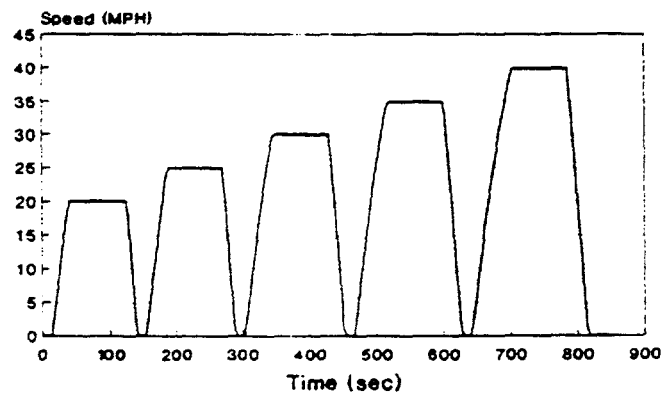
CBD Cycle



Truck-CBD Cycle



WVU-Truck Cycle (5-Peak Truck Cycle)



Part II

Test Circumstances

Eighteen tests were conducted for Hennepin County trucks. In order to obtain vehicle emissions data with various driving conditions, Each vehicle was tested with three driving cycles. The following tables show the general information of each test.

1. Tests for Truck 3220

Test ID	WVU Reference Number	Test Cycle	Test Date	Fuel	Vehicle Model Year
257	HC-3220-JA	CBD	03/28/94	Diesel	1993
435	HC-3220-D1-TCBD	Truck-CBD	05/10/95	Diesel	1993
248	HC-3220-D2	WVU-Truck	03/18/94	Diesel	1993
258	HC-3220-JA-TRK	WVU-Truck	03/28/94	Diesel	1993
436	HC-3220-D1-TRK	WVU-Truck	05/09/95	Diesel	1993
453	HC-3220-D1-TRK-R	WVU-Truck	05/20/95	Diesel	1993

2. Tests for Truck 3221

Test ID	WVU Reference Number	Test Cycle	Test Date	Fuel	Vehicle Model Year
262	HC-3221-E100	CBD	03/30/94	Ethanol	1993
432	HC-3221-E100-TCBD	Truck-CBD	05/05/95	Ethanol	1993
250	HC-3221-E100	WVU-Truck	03/19/94	Ethanol	1993
261	HC-3221-E100-TRK	WVU-Truck	03/30/94	Ethanol	1993
431	HC-3221-E100-TRK	WVU-Truck	05/05/95	Ethanol	1993
454	HC-3221-E100-TRK-R	WVU-Truck	05/21/95	Ethanol	1993

3. Tests for Truck 3228

Test ID	WVU Reference Number	Test Cycle	Test Date	Fuel	Vehicle Model Year
260	HC-3228-E100	CBD	03/29/94	Ethanol	1993
433	HC-3228-E100-TCBD	Truck-CBD	05/06/95	Ethanol	1993
251	HC-3228-E100	WVU-Truck	03/21/94	Ethanol	1993
259	HC-3228-E100-TRK	WVU-Truck	03/29/94	Ethanol	1993
434	HC-3228-E100-TRK	WVU-Truck	05/06/95	Ethanol	1993
460	HC-3228-E100-TRK-R	WVU-Truck	05/23/95	Ethanol	1993

Part III

Test Results

Eighteen sheets of the test results are included in this part. This contains vehicle and engine information, vehicle emissions rates and fuel economy of each individual run. Explanations of the emissions constituents are also included. The WVU Transportable Heavy-Duty Vehicle Emissions Testing Laboratory can simulate the on-road operation of the tested vehicle. The trucks driven on the chassis dynamometer were under the actual driving conditions which include the vehicle's inertial resistance, tire rolling resistance and air resistance on road. The actual driving speed was measured and the driving distance of each test run was calculated. Emissions data were based on 10-hz continuous measurements during the test runs. The mass of each pollutant was calculated from integration of the instantaneous concentration over the whole test cycle. The reported emissions rate is the emissions constituent mass over the actual driving distance of the test run. The test results are the summary of the data obtained from several repeat runs conducted for each test set-up.

Description of component codes

CO: carbon monoxide
 CO₂: carbon dioxide
 NO_x: oxides of nitrogen
 FIDHC: total hydrocarbon measured by HFID. For CNG vehicles, unburned methane is included. For alcohol vehicles, unburned methanol or ethanol and formaldehyde are included.
 PM: particulate matter
 CH₃OH: unburned methanol
 C₂H₅OH: unburned ethanol
 HCHO: formaldehyde
 CH₃CHO: acetaldehyde
 RHC: calculated residual hydrocarbon for alcohol fueled vehicles. The amount (in gram/mile) of RHC can be calculated from the concentration (in ppm) of C_{RHC} which is obtained from the following equation:

$$C_{RHC} = C_{FIDHC} - r_1 \times C_{CH_3OH} \quad \text{for methanol or}$$

$$C_{RHC} = C_{FIDHC} - r_2 \times C_{C_2H_5OH} - r_3 \times C_{CH_3CHO} \quad \text{for ethanol}$$

C_{FIDHC} represents the measured concentration (in ppm) by Heated FID

r₁, r₂, r₃ are the HFID response factors to methanol, ethanol and acetaldehyde, respectively. For the WVU lab,

r₁ = 0.73, r₂ = 0.73, r₃ = 0.473 from the HFID calibration

C_{CH₃OH} and C_{C₂H₅OH} represent the measured concentration (in ppm) of methanol and ethanol, respectively.

OMHCE: calculated amount (in gram/mile) of organic material hydrocarbon equivalent. Two different equations with methanol and ethanol are used as following:

For methanol:

$$OMHCE = RHC + \frac{13.8756}{32.042} \times Meth_{mass} + \frac{13.8756}{30.0262} \times Form_{mass}$$

For ethanol:

$$OMHCE = RHC + \frac{13.8756}{23.034} \times Eth_{mass} + \frac{13.8756}{30.0262} \times Form_{mass} + \frac{13.8756}{22.03} \times Acet_{mass}$$

where, Meth_{mass}: unburned methanol emissions in gram/mile;
 Eth_{mass}: unburned ethanol emissions in gram/mile;
 Form_{mass}: unburned formaldehyde emissions in gram/mile;
 Acet_{mass}: unburned acetaldehyde emissions in gram/mile.

MPG: calculated fuel economy (in mile/gallon).

BTU: calculated fuel energy used by the vehicle.



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 257

WVU Test Reference Number HC-3220-JA

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDVT1PC069272
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	38568
Odometer Reading (mile)	Not Available
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 10-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF199374
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	JETA
Primary Fuel Sample ID	N-WV-1152
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	Not Applicable
Test Cycle	CBD
Test Date	3/28/94

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/Mile
257- 1	17.2	20.1	2.35	2.55	4273	2.22	56720
257- 2	19.7	20.8	2.10	2.78	4368	2.17	57966
257- 3	18.2	20.8	2.33	2.72	4461	2.13	59106
257- 4	21.1	21.2	2.02	2.81	4537	2.09	60287
Average	19.0	20.7	2.20	2.72	4409	2.15	58520
Std. Dev.	1.7	0.4	0.17	0.12	114	0.06	1529
CV %	8.93	2.11	7.62	4.35	2.59	2.62	2.61



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 435

WVU Test Reference Number HC-3220-D1-TCBD

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDVT1PC069272
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	38575
Odometer Reading (mile)	43806
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 10-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF199374
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	D1
Primary Fuel Sample ID	95-04
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	Not Applicable
Test Cycle	Truck-CBD
Test Date	5/10/95

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/Mile
435- 1	11.0	22.0	2.56	1.92	4096	2.34	53867
435- 2		21.9	2.92	1.94	3929	2.44	51654
435- 3	13.8	22.8	2.83	2.33	4200	2.28	55295
435- 4	13.7	22.3	2.78	2.40	4088	2.34	53823
435- 5		22.2	2.70	2.32	4124	2.32	54308
435- 6	10.1	21.2	2.96	1.86	4068	2.36	53491
435- 7	10.8	21.0	2.84	2.13	4053	2.36	53310
Average	11.9	21.9	2.80	2.13	4080	2.35	53678
Std. Dev.	1.8	0.6	0.14	0.23	82	0.05	1106
CV %	14.81	2.86	4.83	10.57	2.01	2.08	2.06



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 248

WVU Test Reference Number HC-3220-D2

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDVT1PC069272 32 ²⁵
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	27721
Odometer Reading (mile)	12409
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 10-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF199374
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	D2
Primary Fuel Sample ID	N-WV-1148
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	Not Applicable
Test Cycle	WVU-Trk
Test Date	3/18/94

Emissions Results (g/mile)

Fuel Economy

Test #	CO	NOx	HC	PM	CO2	MPG	BTU/Mile
248-1	4.7	15.9	1.26	0.81	2423	4.16	31237
248-2	4.4	14.5	1.29	0.68	2287	4.40	29524
248-3	3.2	14.5	1.18	0.61	2027	4.97	26157
248-4	4.9	15.0	1.20	0.81	1955	5.14	25282
248-5	3.6	14.0	1.27	0.65	1982	5.08	25591
248-6	3.4	14.4	1.24	0.58	1926	5.22	24885
Average	4.1	14.7	1.24	0.69	2100	4.83	27113
Std. Dev.	0.7	0.7	0.04	0.10	205	0.44	2622
CV %	17.85	4.50	3.63	14.27	9.75	9.09	9.67



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 258

WVU Test Reference Number HC-3220-JA-TRK

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDVT1PC069272
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	38568
Odometer Reading (mile)	Not Available
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 10-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF199374
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	JETA
Primary Fuel Sample ID	N-WV-1152
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	Not Applicable
Test Cycle	WVU-Trk
Test Date	3/28/94

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/Mile
258-1	4.3	13.1	1.40	0.85	2451	3.90	32334
258-2	4.1	13.7	1.40	0.84	2397	3.98	31631
258-3	4.8	13.1	1.25	0.83	2279	4.19	30041
258-4	3.9	12.6	1.31	0.78	2317	4.13	30533
Average	4.3	13.1	1.34	0.82	2361	4.05	31135
Std. Dev.	0.4	0.4	0.07	0.03	77	0.13	1040
CV %	9.33	3.26	5.51	4.02	3.28	3.33	3.34



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 436

WVU Test Reference Number HC-3220-D1-5PK

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDTV1PC069272
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	38575
Odometer Reading (mile)	43751
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 10-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF199374
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	D1
Primary Fuel Sample ID	95-04
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	Not Applicable
Test Cycle	WVU-Trk
Test Date	5/9/95

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/Mile
436- 1	5.2	13.9	1.43	0.90	2529	3.79	33219
436- 2	4.4	13.5	1.55	0.78	2525	3.80	33158
436- 3	4.5	13.2	1.50	0.85	2529	3.79	33204
436- 4	4.3	13.2	1.52	0.86	2504	3.83	32870
436- 5	4.6	12.6	1.50	0.86	2475	3.88	32506
Average	4.6	13.3	1.50	0.85	2512	3.82	32992
Std. Dev.	0.4	0.5	0.04	0.04	23	0.04	306
CV %	7.67	3.58	2.96	5.08	0.93	0.93	0.93



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 453

WVU Test Reference Number HC-3220-D1-5PK-R

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDVT1PC069272
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	34499
Odometer Reading (mile)	44349
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 10-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF199374
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	D1
Primary Fuel Sample ID	95-04
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	Not Applicable
Test Cycle	WVU-Trk
Test Date	5/20/95

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/Mile
453- 1	5.7	13.4	1.39	0.79	2411	3.98	31686
453- 2	5.6	13.1	1.39	0.88	2380	4.03	31281
453- 3	6.1	12.9	1.30	0.94	2351	4.08	30908
453- 4	5.8	12.8	1.45	0.91	2319	4.13	30492
Average	5.8	13.0	1.38	0.88	2366	4.05	31092
Std. Dev.	0.2	0.3	0.06	0.07	39	0.07	511
CV %	3.34	2.27	4.59	7.48	1.66	1.64	1.64



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 262

WVU Test Reference Number HC-3221-E100

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDVTXPC069271 3221
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	38422
Odometer Reading (mile)	8859
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 10-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF200396
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	E100
Primary Fuel Sample ID	N-WV-1154
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	Not Applicable
Test Cycle	CBD
Test Date	3/30/94

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/mile
262- 1	82.6	13.1	11.90	1.05	4427	1.24	61231
262- 2	87.3	13.1	12.29	1.10	4367	1.25	60823
262- 3	86.6	13.9	12.52	1.13	4462	1.23	61849
Average	85.5	13.4	12.24	1.09	4419	1.24	61301
Std. Dev.	2.5	0.5	0.31	0.04	48	0.01	516
CV %	2.95	3.59	2.54	3.53	1.08	0.84	0.84



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 432

WVU Test Reference Number HC-3221-E100-TCBD

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDVTXPC069271 324
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	38575
Odometer Reading (mile)	30373
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 10-Spd
Number Of Axles	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF200396
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	E100
Primary Fuel Sample ID	95-03
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	N/A
Test Cycle	Truck-CBD
Test Date	5/5/95

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/Mile
432-1		14.3	6.49	0.58	3687	1.53	49596
432-2	10.2	13.9	6.02	0.66	3797	1.49	50990
432-3	9.1	14.0	5.50	0.67	3804	1.49	51040
432-4	10.9	13.8	5.30	0.73	3796	1.49	50964
432-5	10.3	13.8		0.73	3796	1.50	50809
432-6	8.6	14.1	7.74	0.78	3699	1.53	49687
Average	9.8	14.0	6.21	0.69	3763	1.50	50514
Std. Dev.	1.0	0.2	0.97	0.07	55	0.02	681
CV %	9.83	1.54	15.68	10.39	1.45	1.36	1.35

Test ID	C2H5OH	HCHO	CH3CHO	RHC	OMHC
432-1	0.81	0.18			
432-2	0.79	0.15	0.91		4.45
432-3	0.69	0.14	0.92		4.09
432-4	0.61	0.15	0.82		3.90
432-5	0.65	0.14	0.80		
432-6	0.67	0.14	0.78		5.37
Average	0.70	0.15	0.85		4.45
Std. Dev.	0.08	0.01	0.07		0.65
CV%	11.40	10.07	7.74		14.67



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 250

WVU Test Reference Number HC-3221-E100

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDVTXPC069271
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	27672
Odometer Reading (mile)	8842
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 10-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF200396
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	E100
Primary Fuel Sample ID	N-WV-1154
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	Not Applicable
Test Cycle	WVU-Trk
Test Date	3/19/94

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/mile
250- 1	8.8	11.1	4.13	0.10	1975	2.83	26823
250- 2	8.0	10.9	4.06	0.11	1939	2.89	26327
250- 3	8.2	10.9	3.76	0.11	1896	2.95	25733
250- 4	11.3	10.9	3.98	0.13	1869	2.99	25432
250- 5	8.2	10.8	3.76	0.09	1890	2.97	25614
Average	8.9	10.9	3.94	0.11	1914	2.93	25986
Std. Dev.	1.4	0.1	0.17	0.01	43	0.06	576
CV %	15.42	0.93	4.36	12.35	2.23	2.19	2.22



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 261

WVU Test Reference Number HC-3221-E100-TRK

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDVTPC069271
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	38422
Odometer Reading (mile)	Not Available
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 10-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF200396
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	E100
Primary Fuel Sample ID	N-WV-1154
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	Not Applicable
Test Cycle	WVU-Trk
Test Date	3/30/94

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/Mile
261-1	8.3	12.2	4.97	0.32	2493	2.26	33664
261-2	6.2	12.5	5.10	0.30	2432	2.32	32805
261-3	6.7	12.3	4.87	0.29	2405	2.34	32416
261-4		12.4	4.97	0.29	2347	2.40	31616
261-5	8.1	12.1	4.93	0.28	2367	2.38	31949
Average	7.3	12.3	4.97	0.30	2409	2.34	32490
Std. Dev.	1.0	0.2	0.08	0.02	58	0.06	797
CV %	13.76	1.30	1.70	5.45	2.39	2.43	2.45

Test ID	C2H5OH	HCHO	CH3CHO	RHC	OMHC
261-1	2.48	0.11	0.50		4.31
261-2	2.54	0.12	0.61		4.49
261-3	2.42	0.10	0.52		4.25
261-4	2.45	0.11	0.60		4.36
261-5	2.12	0.12	0.59		4.21
Average	2.40	0.11	0.56		4.32
Std. Dev.	0.16	0.01	0.05		0.11
CV%	6.87	7.43	8.72		2.52



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 431

WVU Test Reference Number HC-3221-E100-5PK

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDVTXPC069271
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	38575
Odometer Reading (mile)	30353
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 10-Spd
Number Of Axles	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF200396
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	E100
Primary Fuel Sample ID	95-03
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	N/A
Test Cycle	WVU-Trk
Test Date	5/5/95

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/Mile
431-1		12.1	4.32	0.42	2444	2.31	32920
431-2		12.0	4.12	0.39	2353	2.40	31667
431-3		11.7	4.13	0.37	2341	2.41	31477
431-4	5.9	11.7	3.92	0.37	2363	2.40	31732
431-5	5.7	11.7	3.73	0.39	2363	2.40	31721
431-6	6.4	11.8	3.54	0.31	2311	2.45	31037
431-7	4.2	11.8	3.51	0.32	2295	2.47	30772
431-8	4.6	11.6	3.72	0.30	2279	2.49	30574
431-9	3.6	11.9	3.71	0.31	2343	2.42	31403
Average	5.1	11.8	3.86	0.35	2344	2.42	31478
Std. Dev.	1.1	0.2	0.28	0.04	48	0.05	685
CV %	21.37	1.32	7.28	12.08	2.06	2.15	2.18

Test ID	C2H5OH	HCHO	CH3CHO	RHC	OMHC
431-1	0.59	0.08	0.22		2.97
431-2	0.66	0.09	0.37		2.96
431-3	0.61	0.08	0.41		2.96
431-4	0.55	0.08	0.42		2.82
431-5	0.66	0.08	0.45		2.76
431-6	0.66	0.07	0.45		2.64
431-7	0.58	0.07	0.50		2.62
431-8	0.64	0.08	0.53		2.78
431-9	0.62	0.08	0.48		2.74
Average	0.62	0.08	0.43		2.81
Std. Dev.	0.04	0.01	0.09		0.13



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 454

WVU Test Reference Number HC-3221-E100-5PK-R

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDTVXPC069271
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	38575
Odometer Reading (mile)	31054
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 10-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF200396
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	E100
Primary Fuel Sample ID	95-03
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	Not Applicable
Test Cycle	WVU-Trk
Test Date	5/21/95

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/Mile
454- 1	8.9	11.6	4.30	0.44	2596	2.18	34908
454- 2	7.9	11.4	4.00	0.37	2530	2.24	33999
454- 3	8.4	11.2	4.12	0.35	2500	2.26	33613
454- 4	6.0	11.2	3.85	0.42	2471	2.29	33171
454- 5	7.3	11.0	3.81	0.36	2445	2.31	32847
Average	7.7	11.3	4.02	0.39	2508	2.26	33707
Std. Dev.	1.1	0.2	0.20	0.04	58	0.05	801
CV %	14.29	2.01	5.04	10.01	2.33	2.35	2.38

Test ID	C2H5OH	HCHO	CH3CHO	RHC	OMHC
454- 1	0.78	0.09	0.45		3.15
454- 2	0.82	0.09	0.51		3.01
454- 3	0.81	0.08	0.47		3.07
454- 4	0.82	0.09	0.56		2.94
454- 5	0.74	0.08	0.54		2.88
Average	0.80	0.08	0.51		3.01
Std. Dev.	0.03	0.00	0.05		0.11
CV%	4.25	3.08	9.15		3.53



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 260

WVU Test Reference Number HC-3228-E100

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDVT8PC069270
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	38422
Odometer Reading (mile)	5367
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 9-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF200397
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	E100
Primary Fuel Sample ID	N-WV-1154
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	Not Applicable
Test Cycle	CBD
Test Date	3/29/94

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/Mile
260- 1	92.8	15.1	15.38	0.87	4570	1.19	63744
260- 2	82.2	15.2	12.89	0.89	4647	1.18	64248
260- 3	84.6	15.3	11.66	1.06	4792	1.15	66103
260- 4	73.3	15.3	13.15	0.89	4725	1.16	65375
Average	83.2	15.2	13.27	0.93	4684	1.17	64867
Std. Dev.	8.0	0.1	1.55	0.09	96	0.02	1069
CV %	9.62	0.78	11.67	9.45	2.05	1.65	1.65



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 251

WVU Test Reference Number HC-3228-E100

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDVT8PC069270
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	27672
Odometer Reading (mile)	5175
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 9-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF200397
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	E100
Primary Fuel Sample ID	N-WV-1154
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	ACDELCO
Test Cycle	WVU-Trk
Test Date	3/21/94

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/mile
251-1		14.0	4.96	0.24	2160	2.59	29355
251-2	8.5	14.0	5.04	0.25	2164	2.59	29298
251-3	4.4	13.0	4.76	0.22	2140	2.63	28881
251-4	6.1	12.7	4.27	0.21	1965	2.86	26580
251-5	4.1	12.7	4.78	0.20	1939	2.90	26230
251-6	3.9	13.4	4.49	0.21	1940	2.90	26180
251-7	4.3	12.6	4.33	0.22	1956	2.87	26439
Average	5.2	13.2	4.66	0.22	2038	2.76	27566
Std. Dev.	1.8	0.6	0.31	0.02	110	0.15	1521
CV %	34.47	4.55	6.55	7.54	5.40	5.44	5.52



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 433

WVU Test Reference Number HC-3228-E100-TCBD

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDDVT8PC069270
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	38575
Odometer Reading (mile)	17170
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 9-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF200397
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	E100
Primary Fuel Sample ID	95-03
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	N/A
Test Cycle	Truck-CBD
Test Date	5/6/95

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/Mile
433- 1	122.7	15.2	17.58	1.35	4112	1.31	57940
433- 2	121.5	15.0	16.94	1.44	4119	1.31	57976
433- 3	113.5	14.6	15.38	1.56	4156	1.30	58254
433- 4	111.7	14.6	16.57	1.42	4115	1.32	57713
433- 5	111.5	14.8	16.12	1.38	4168	1.30	58401
Average	116.2	14.8	16.52	1.43	4134	1.31	58057
Std. Dev.	5.5	0.3	0.83	0.08	26	0.01	272
CV %	4.70	1.84	5.02	5.77	0.63	0.47	0.47

Test ID	C2H6/COH	HCHO	CH3CHO	RHC	OMHC
433- 1	6.53	0.88	3.88		15.38
433- 2	5.51	0.90	3.48		14.42
433- 3	5.50	0.84	3.31		13.37
433- 4	5.50	0.89	3.44		14.17
433- 5	5.51	0.86	3.38		13.86
Average	5.71	0.88	3.50		14.24
Std. Dev.	0.46	0.02	0.23		0.75
CV%	8.01	2.85	6.44		5.26



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 434

WVU Test Reference Number HC-3228-E100-5PK

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDTV8PC069270
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	38575
Odometer Reading (mile)	17200
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 9-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF200397
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	E100
Primary Fuel Sample ID	95-03
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	Not Applicable
Test Cycle	WVU-Trk
Test Date	5/6/95

Emissions Results (g/mile)

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/Mile
434-1	28.1	12.2	7.23	0.60	2474	2.25	33801
434-2	25.7	12.1	6.80	0.54	2422	2.30	33059
434-3	26.3	12.0	6.95	0.58	2457	2.27	33538
434-4	24.8	11.9	7.30	0.55	2482	2.25	33849
Average	26.2	12.0	7.07	0.56	2459	2.26	33562
Std. Dev.	1.4	0.1	0.24	0.03	27	0.02	362
CV %	5.22	1.18	3.33	4.90	1.09	1.09	1.08

Fuel Economy

Test ID	C2H6OH	HCHO	CH3CHO	RHC	OMHC
434-1	3.40	0.27	1.84		6.68
434-2	4.27	0.26	1.85		6.75
434-3	3.45	0.29	1.94		6.57
434-4	3.86	0.28	1.88		6.92
Average	3.74	0.28	1.88		6.73
Std. Dev.	0.41	0.01	0.04		0.14
CV%	10.83	3.75	2.21		2.14



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 259

WVU Test Reference Number HC-3228-E100-TRK

Fleet Owner Full Name Hennepin County
Fleet Address 320 Washington Ave.
Fleet Address (City, State, Zip Code) Hopkins, MN 55343
Vehicle Type Snow Plow
Vehicle ID Number (VIN) 2HTTGDDVT8PC069270
Vehicle Manufacturer NVSTR
Vehicle Model Year 1993
Gross Vehicle Weight (GVW) (lb) 55020
Vehicle Total Curb Weight (lb) 27510
Vehicle Simulated Weight (lb) 38422
Odometer Reading (mile) 5349
Vehicle Transmission Type Manual
Vehicle Transmission Configuration Fuller RTX-11708LL 9-Spd
Number Of Axes 3
Engine Type DDC 6V-92TA DDEC II
Engine ID Number 06VF200397
Engine Displacement (liter) 9.05
Number Of Cylinders 6
Engine Rated Power (hp) 277
Primary Fuel E100
Primary Fuel Sample ID N-WV-1154
Secondary Fuel Not Applicable
Secondary Fuel Sample ID Not Applicable
Particulate Trap Manufacturer Not Applicable
Catalytic Converter Manufacturer Not Applicable
Test Cycle WVU-Trk
Test Date 3/29/94

Emissions Results (g/mile)

Fuel Economy

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/mile
259- 1		13.7	5.63	0.30	2508	2.23	34006
259- 2		14.9	6.73	0.32	2506	2.24	33870
259- 3	10.3	14.4	5.47	0.58	2750	2.05	37128
259- 4	7.9	15.9	5.67	0.65	2934	1.92	39576
259- 5	7.3	14.8	5.51	0.44	2545	2.21	34354
259- 6	10.3	15.2	5.15	0.52	3081	1.83	41564
259- 7	9.0	14.2	5.57	0.34	2750	2.04	37177
Average	9.0	14.7	5.68	0.45	2725	2.08	36811
Std. Dev.	1.4	0.7	0.49	0.14	223	0.16	2973
CV %	15.39	4.77	8.72	30.06	8.20	7.85	8.08



WVU Transportable Heavy Duty Vehicle Emissions Testing Laboratory

Department of Mechanical and aerospace Engineering, West Virginia University, Morgantown, WV 26506

Tel: (304) 293-3111 FAX: (304) 293-8832

Test Sequence Number: 460

WVU Test Reference Number HC-3228-E100-5PK-R

Fleet Owner Full Name	Hennepin County
Fleet Address	320 Washington Ave.
Fleet Address (City, State, Zip Code)	Hopkins, MN 55343
Vehicle Type	Snow Plow
Vehicle ID Number (VIN)	2HTTGDTV8PC069270
Vehicle Manufacturer	NVSTR
Vehicle Model Year	1993
Gross Vehicle Weight (GVW) (lb)	55020
Vehicle Total Curb Weight (lb)	27510
Vehicle Simulated Weight (lb)	38575
Odometer Reading (mile)	17603
Vehicle Transmission Type	Manual
Vehicle Transmission Configuration	Fuller RTX-11708LL 9-Spd
Number Of Axes	3
Engine Type	DDC 6V-92TA DDEC II
Engine ID Number	06VF200397
Engine Displacement (liter)	9.05
Number Of Cylinders	6
Engine Rated Power (hp)	277
Primary Fuel	E100
Primary Fuel Sample ID	95-03
Secondary Fuel	Not Applicable
Secondary Fuel Sample ID	Not Applicable
Particulate Trap Manufacturer	Not Applicable
Catalytic Converter Manufacturer	Not Applicable
Test Cycle	WVU-Trk
Test Date	5/23/95

Emissions Results (g/mile)

Test ID	CO	NOx	HC	PM	CO2	MPG	BTU/Mile
460- 1	34.7	12.1	8.41	0.64	2643	2.10	36246
460- 2	32.6	12.2	7.87	0.56	2526	2.19	34632
460- 3	32.0	11.7	7.61	0.52	2582	2.15	35354
460- 4	30.2	11.6	7.34	0.57	2590	2.15	35415
460- 5	28.3	11.5	7.11	0.51	2529	2.20	34554
460- 6	29.1	11.4	7.17	0.54	2474	2.25	33839
Average	31.2	11.7	7.59	0.56	2557	2.17	35007
Std. Dev.	2.4	0.3	0.49	0.04	60	0.05	840
CV %	7.64	2.74	6.52	8.03	2.33	2.40	2.40

Fuel Economy

Test ID	C2H5OH	HCHO	CH3CHO	RHC	OMHC
460- 1	4.74	0.26	1.57		7.77
460- 2	4.74	0.26	1.54		7.42
460- 3	4.49	0.24	1.34		7.07
460- 4	4.78	0.22	1.37		7.02
460- 5	4.54	0.24	1.48		6.85
460- 6	4.33	0.26	1.57		6.86
Average	4.60	0.25	1.48		7.16
Std. Dev.	0.18	0.01	0.10		0.36
CV%	3.88	5.99	6.90		5.04

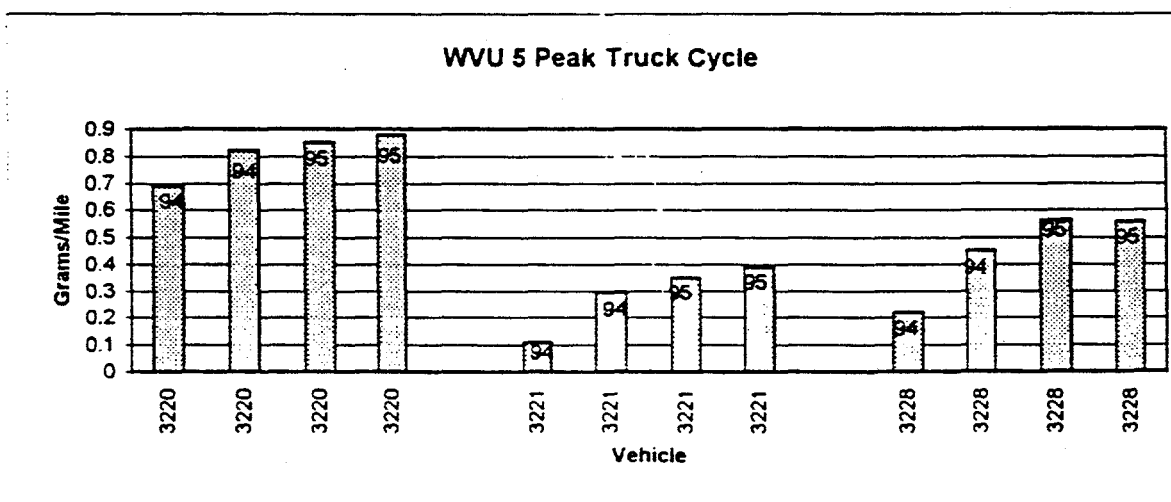
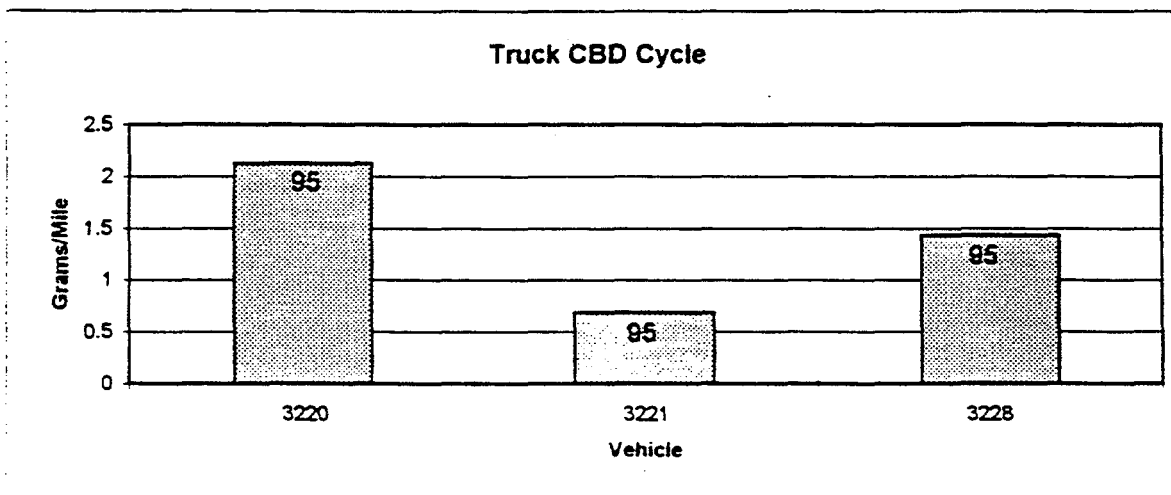
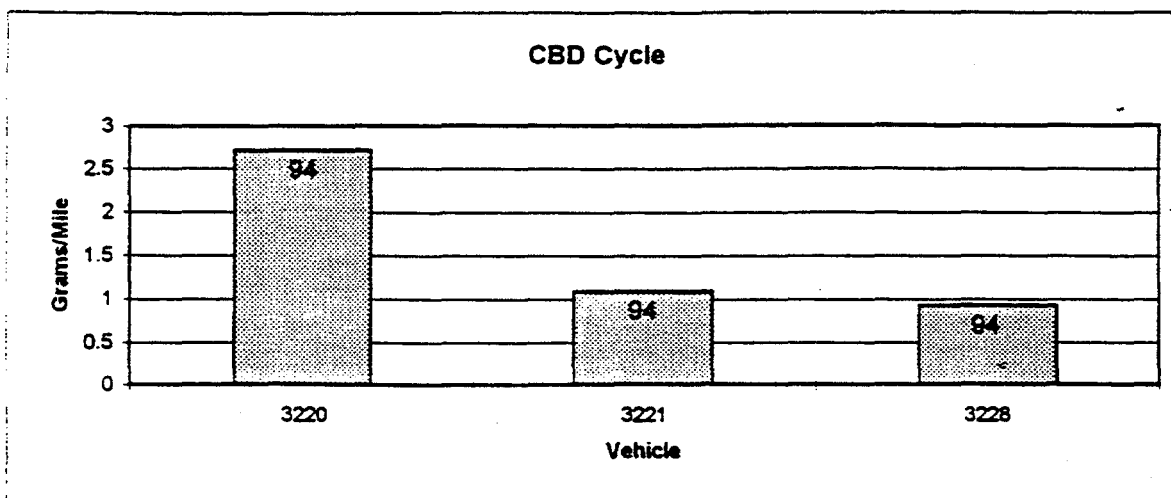
Part IV

Emissions Comparison of Ethanol vs. Diesel

Six-page figures are provided in this package. The figures in 5 page are the components of emissions in 3 different driving cycles and in the 2-year tests. One page contains the tested fuel economy for the 3 trucks. The average values were plotted in the figures.

Hennepin County Comparison of Particulate Matter (PM) Emissions for Diesel and Ethanol
Fueled Vehicles For Different Test Cycles

1/29/96



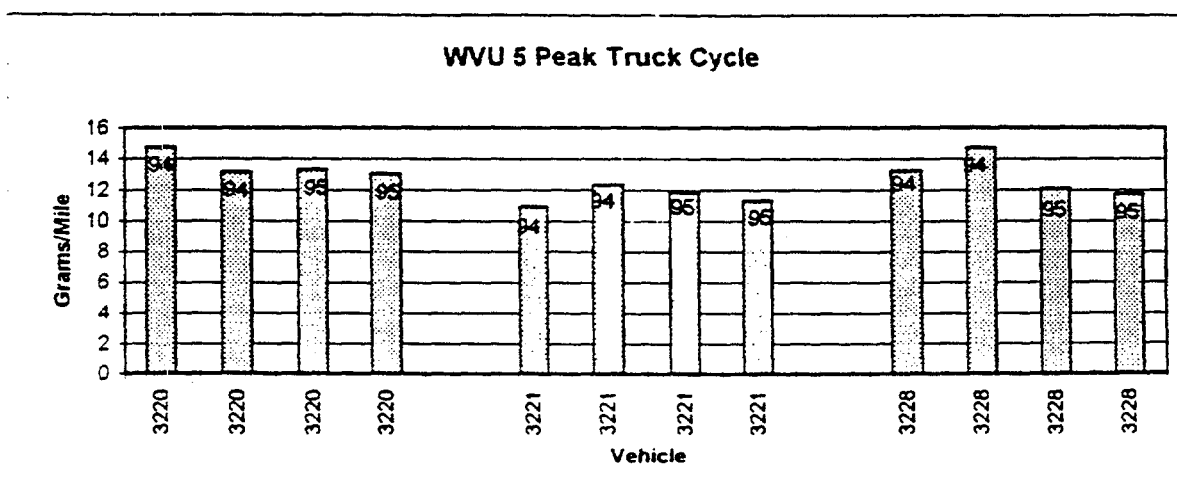
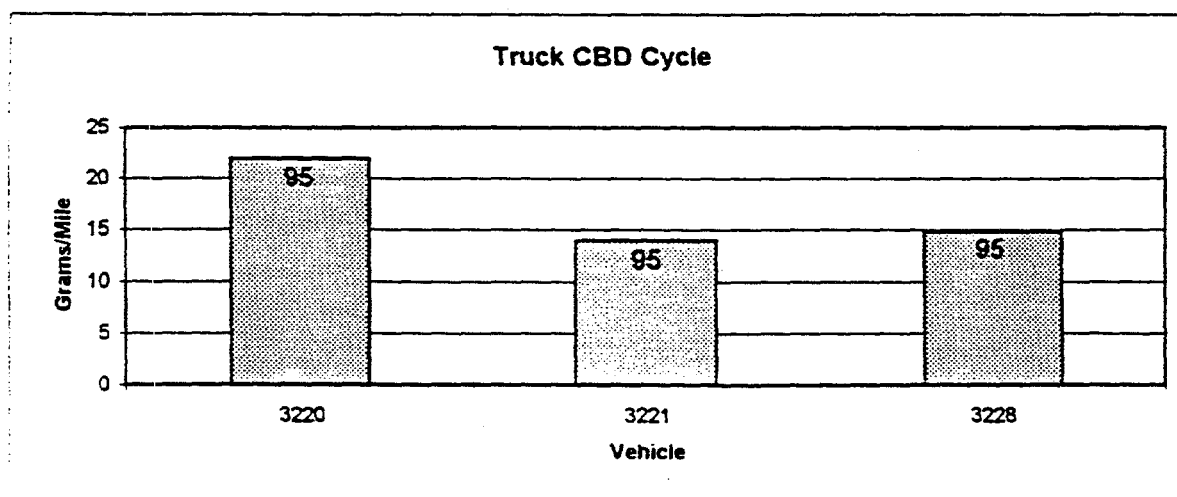
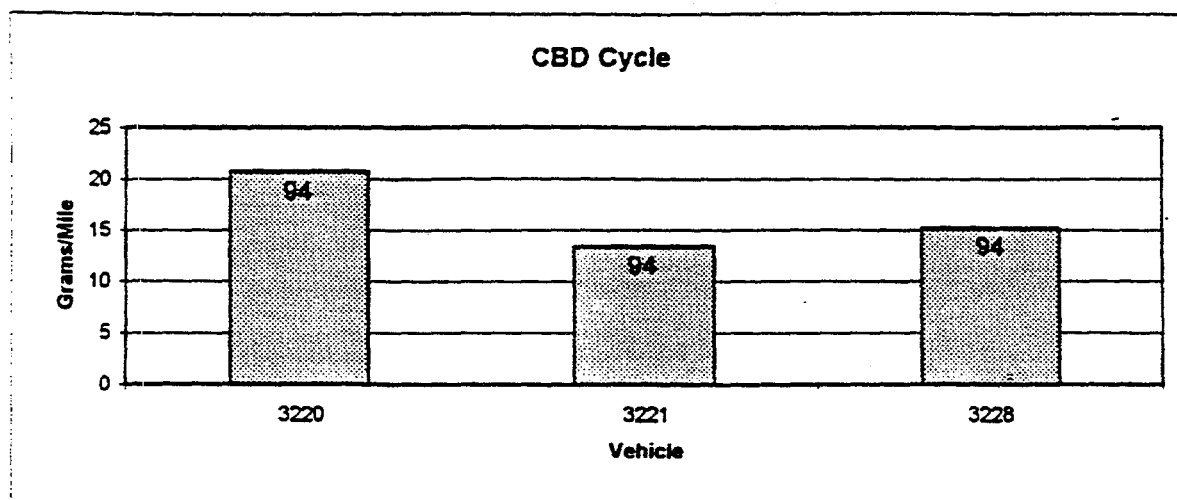
Vehicle 3220 = Diesel

Vehicle 3221 = Ethanol

Vehicle 3228 = Ethanol

Hennepin County Comparison of Oxides of Nitrogen (NOx) Emissions for Diesel and Ethanol
Fueled Vehicles For Different Test Cycles

1/29/96



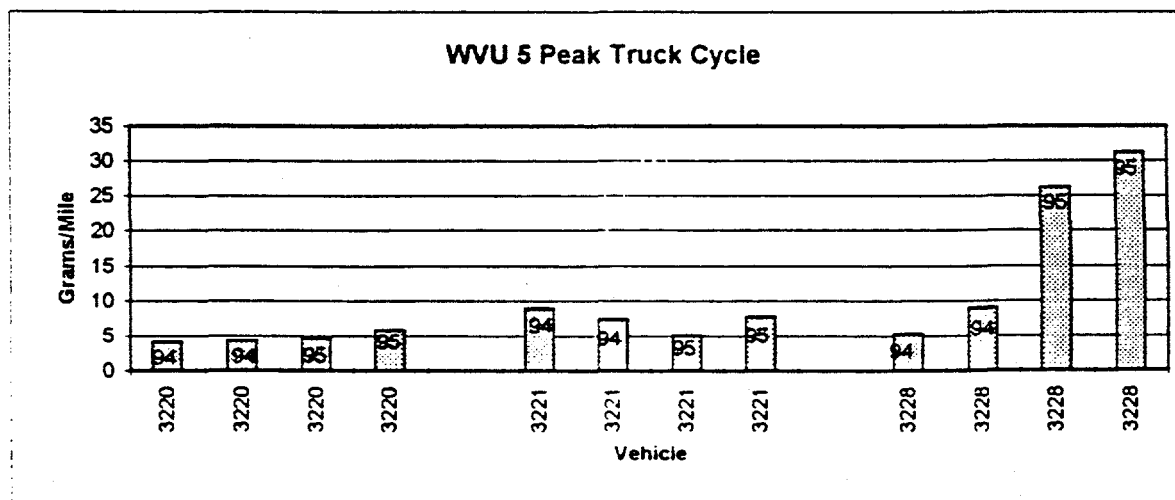
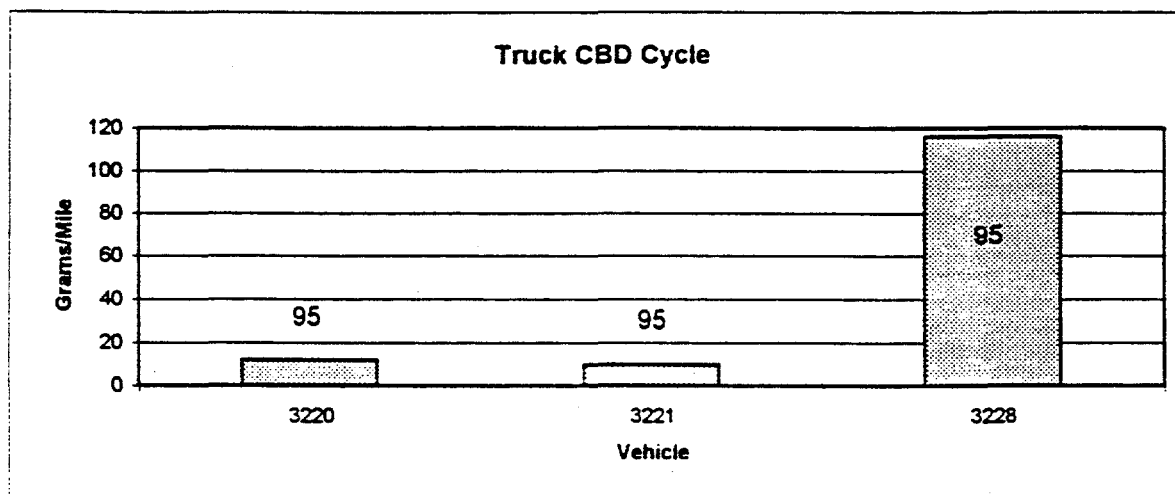
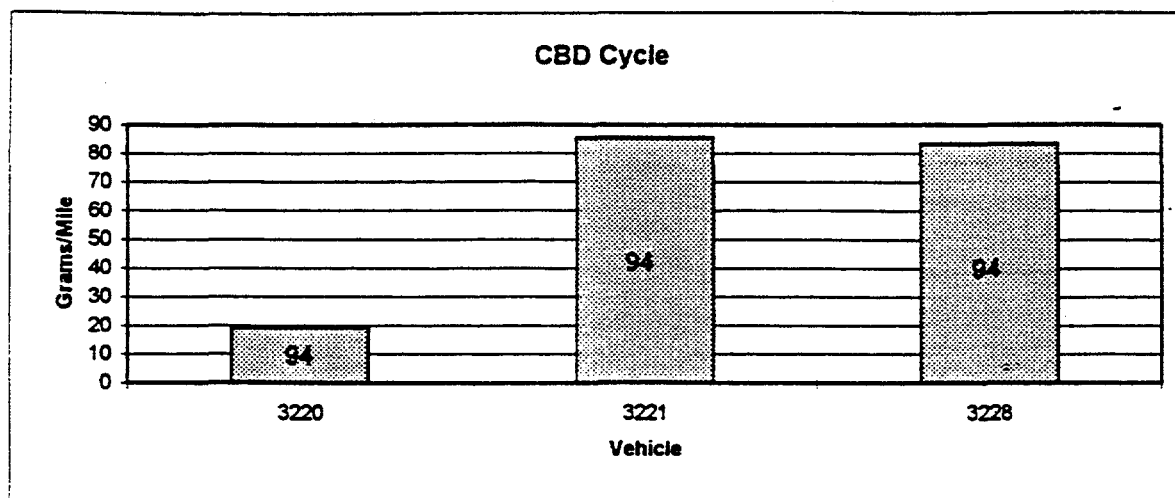
Vehicle 3220 = Diesel

Vehicle 3221 = Ethanol

Vehicle 3228 = Ethanol

Hennepin County Comparison of Carbon Monoxide (CO) Emissions for Diesel and Ethanol
Fueled Vehicles For Different Test Cycles

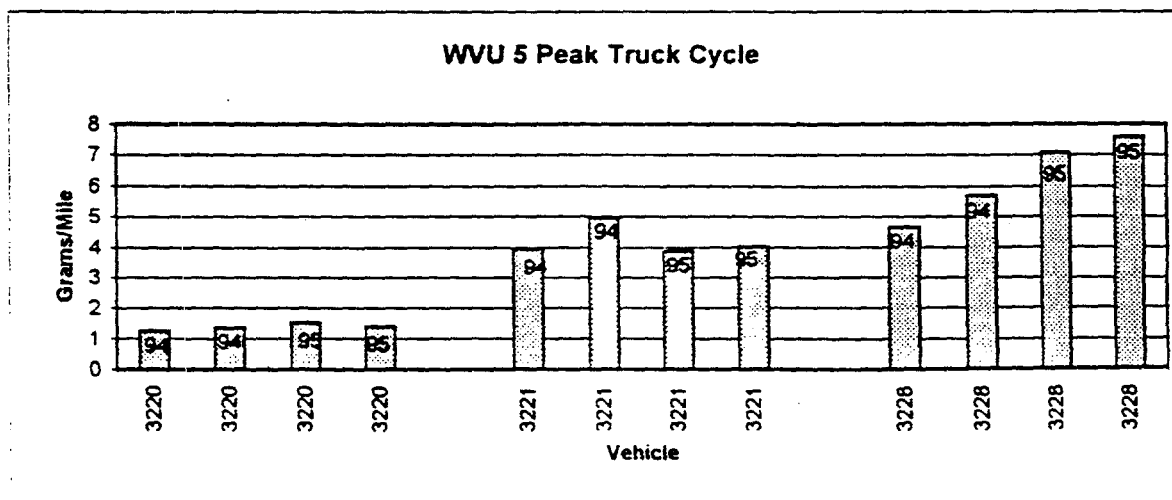
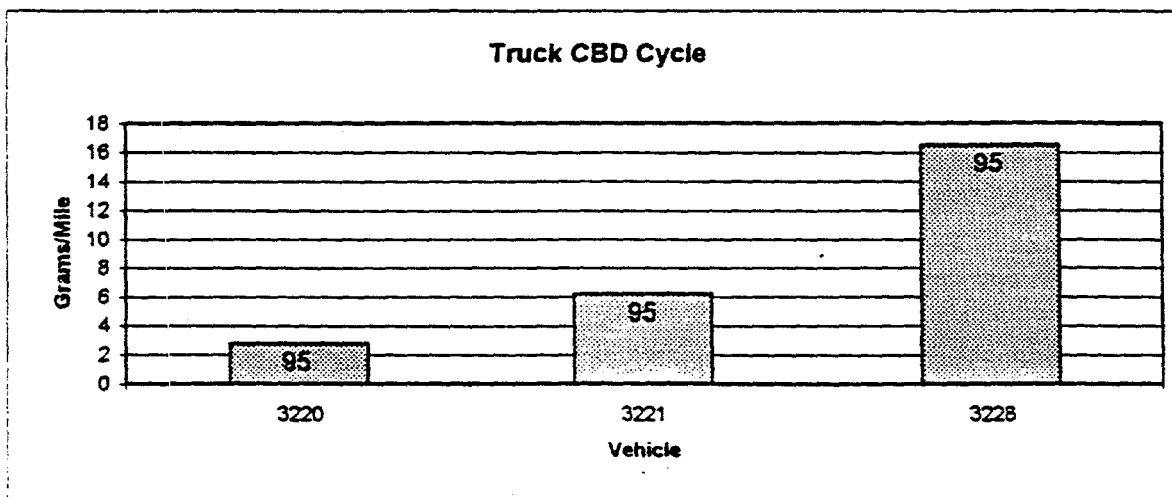
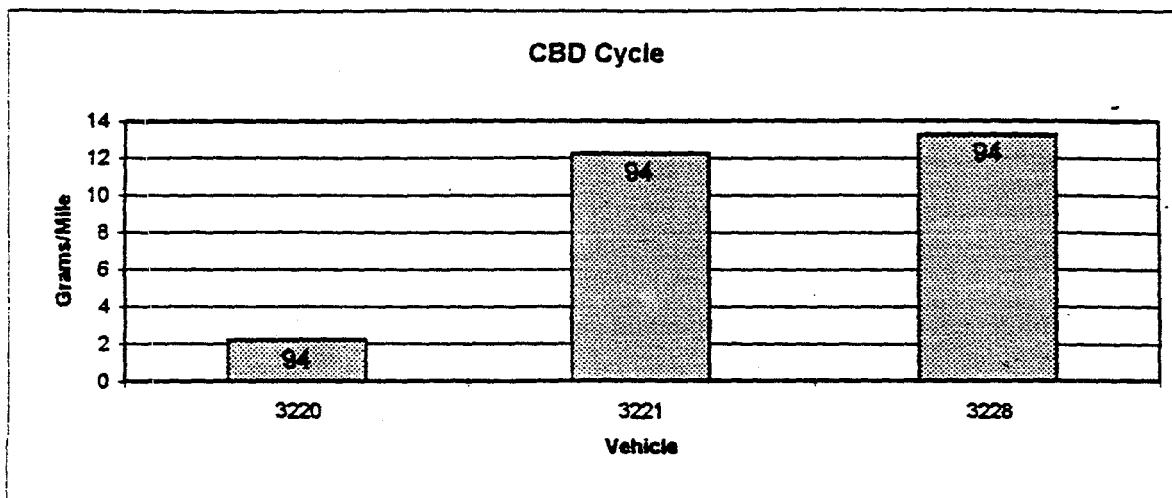
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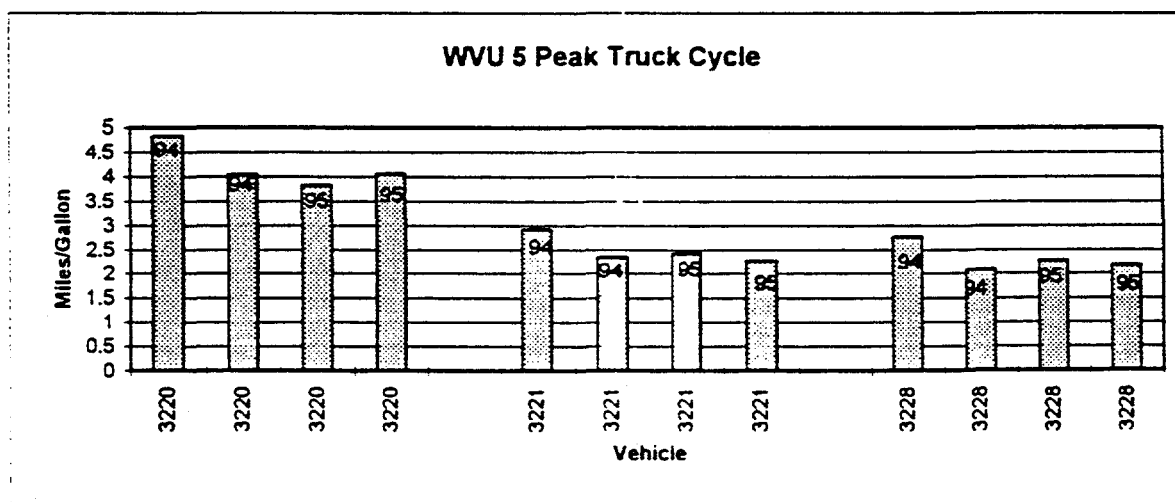
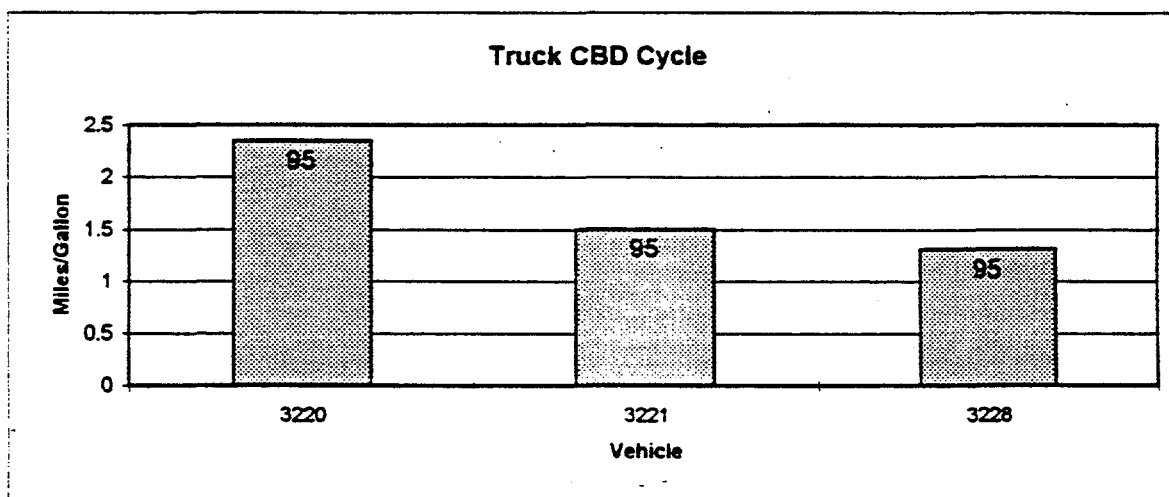
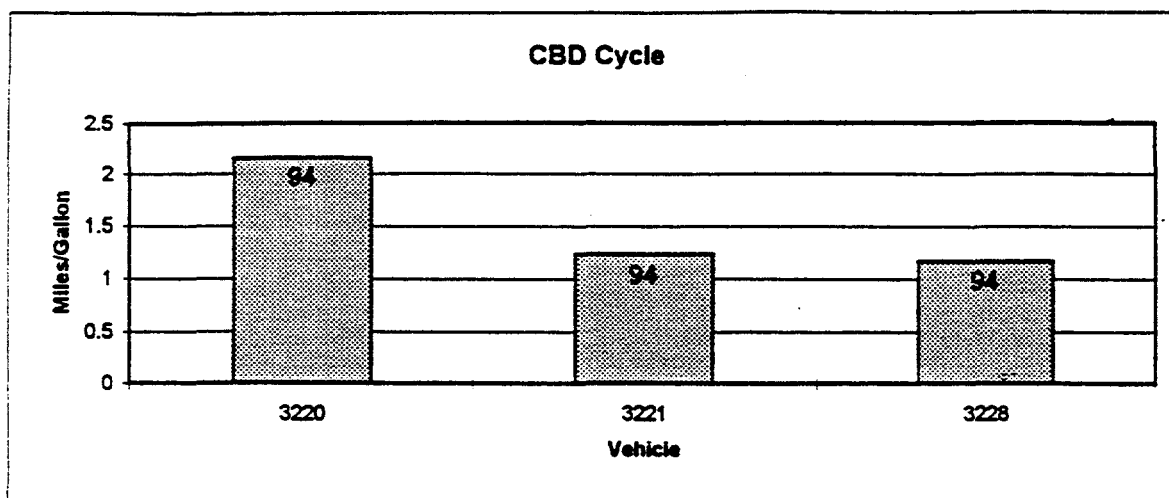


Vehicle 3220 = Diesel

Vehicle 3221 = Ethanol

Vehicle 3228 = Ethanol





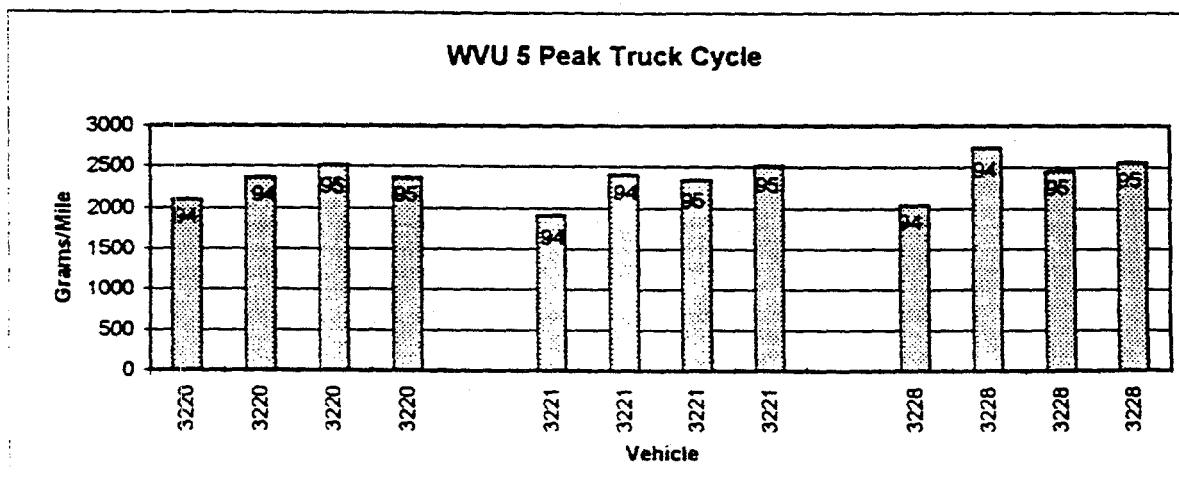
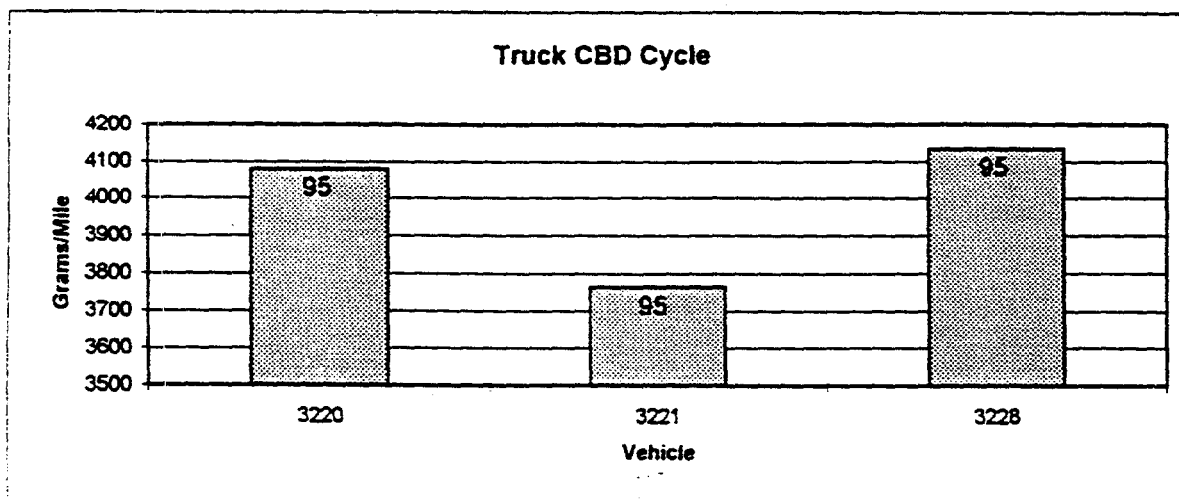
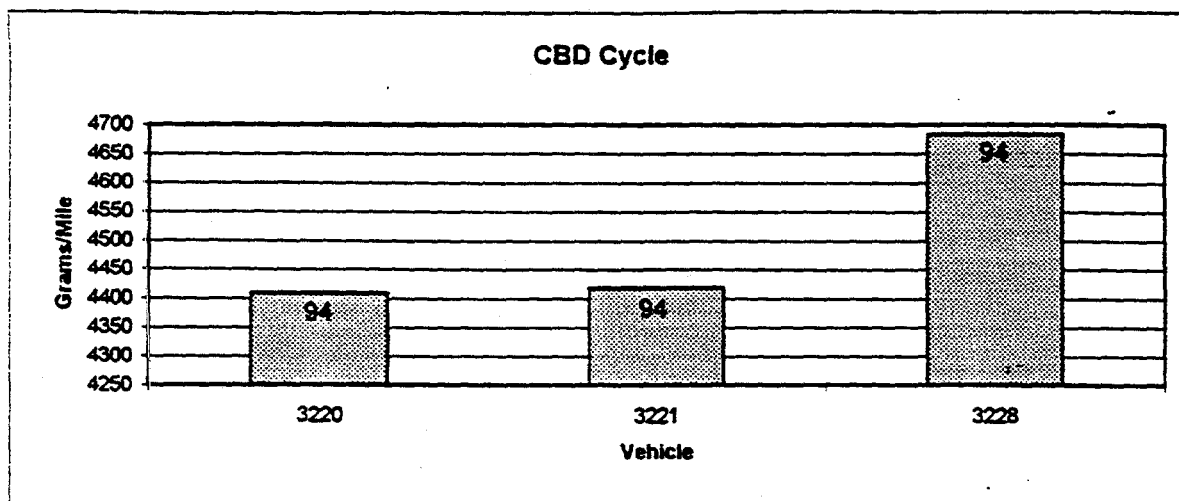
Vehicle 3220 = Diesel

Vehicle 3221 = Ethanol

Vehicle 3228 = Ethanol

Hennepin County Comparison of Carbon Dioxide (CO₂) Emissions for Diesel and Ethanol Fueled Vehicles For Different Test Cycles

1/29/96



Vehicle 3220 = Diesel

Vehicle 3221 = Ethanol

Vehicle 3228 = Ethanol

REPORT DOCUMENTATION PAGE

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