Fifth Quarter
CTTRANSIT

Demonstration and Evaluation of Hybrid Diesel Electric Transit Buses

July, August, September 2004

Report No. CT-170-1884-05-04-12

PROGRAM PARTNERS

CTTRANSIT
Allison Transmission
Horiba Instruments Inc.
New Flyer Bus Industries
University of Connecticut
CDOT Division of Research
The East Coast Hybrid Consortium
CDOT Bureau of Public Transportation
Connecticut Academy of Science and Engineering

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Technical Report Documentation Page

1.Report No. CT-170-1884-05-04-12	**2. Government Accession No.**	**3. Recipients Catalog No.**
4. Title and Subtitle CTTransit Demonstration and Evaluation of Hybrid Diesel Electric Transit Buses – Interim Report 5		**5. Report Date** October, 2004 **6. Performing Organization Code**
7. Author(s) Stephen W. Warren		**8. Performing Organization Report No.**
9. Performing Organization Name and Address CTTransit 100 Leibert Road Hartford, CT 06141		**10. Work Unit No. (TRIS)** **11. Contract or Grant No.** CM-005984 **13. Type of Report and Period Covered** Quarterly Interim July, August & September 2004
12. Sponsoring Agency Name and Address Connecticut Department of Transportation 2800 Berlin Turnpike Newington, CT 06131-7546		**14. Sponsoring Agency Code** 170-1884

15. Supplementary Notes
This project is being funded by a Congestion Mitigation Air Quality grant (CM-005984). The project partners are: CTTransit, Allison Transmission, Horiba Instruments, Inc., New Flyer Bus Industries, University of Connecticut, ConnDOT Bureau of Public Transportation, ConnDOT Division of Research, The East Coast Hybrid Consortium, and the Connecticut Academy of Science and Engineering.

16. Abstract
The project goal is to identify the next generation of transit vehicles for future fleet replacement that are cost effective, reliable, produce fewer emissions, and have improved fuel economy compared to the standard heavy-duty diesel powered bus. Data are being collected to produce an estimated life-cycle cost analysis, using emissions information, mileage, fuel economy, power production, brake pad wear, maintenance & repair costs. Driver & customer surveys are also being performed.

Two 2003 model year 40 ft low floor New Flyer Allison hybrid diesel electric buses were placed into service in June 2003. Performance data collection began on July 1, 2003 on these buses as well as two virtually identical 2002 model year 40 ft low floor New Flyer standard diesel buses. The hybrids and base buses operate in virtually identical conditions on equivalent routes each day.

17. Key Words Hybrid diesel electric, fuel economy, bus performance	**18. Distribution Statement** No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (Of this report) Unclassified	**20. Security Classif.(Of this page)** Unclassified	**21. No. of Pages** 54	**20. Price**

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

Fifth Quarter
CTTRANSIT
Demonstration and Evaluation of
Hybrid Diesel Electric Transit Buses

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This project was sponsored by the Connecticut Department of Transportation in Cooperation with the U.S. Department of Transportation, Federal Highway Administration. This is an interim report for this project and the reader should be cautioned that the data has not yet been fully analyzed.

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Summary of Activities and Findings

- Two 2003 model year 40' low floor New Flyer Allison hybrid diesel electric buses were placed into revenue service in mid-June, 2003. Performance data collection began on July 1st, 2003, on these buses as well as two virtually identical 2002 model year 40' low floor New Flyer standard diesel buses.
- The test buses were randomly assigned to operate on every route in the system in order to test their capability and versatility in different operating conditions. These routes vary in passenger loads, operating speed and terrain. In order to make the test data as comparable as possible a standard base diesel bus was assigned to "shadow" a hybrid bus on following trips each day as much as possible. The hybrids and base buses therefore should operate in virtually identical conditions each day.
- Performance data collected included route and driver assigned, noon temperature and weather, miles operated, fuel and oil consumed, road calls, trouble codes, maintenance performed and cost of maintenance and repair.
- To date the new hybrid buses have operated very well. Only one hybrid system related road call has been experienced. The other road calls have been attributed to oil cooler and engine harness issues which are not related to the hybrid bus design.
- The hybrid buses have been popular with our customers and Drivers. A survey of Drivers was conducted and documented in the third quarter report. A passenger survey was conducted last quarter with very favorable results summarized.
- The hybrids are in great demand for demonstrations by various groups and special events. The only downside is that this has reduced their in-service testing time.
- To date the hybrids demonstrated good reliability and low maintenance costs. They have shown to average about 10% to 15% better fuel economy than their peer test diesel buses and 35% better than the fleet average.
- The emissions testing component of the test program began in the third quarter. Some emissions testing delays were experienced by very cold weather and snow conditions.
- Three standard bus routes are utilized for emission tests. The E-Farmington Avenue service is our heaviest ridership route and is representative of a common transit route with frequent stops to board and alight passengers. The Enfield express is a high speed park and ride which uses the HOV lanes on the interstate highway and has only one initial pickup and one final destination stop. The Avon Express is a route which traverses a very steep grade over Avon Mountain.
- The test buses were transferred to the **CT**TRANSIT Stamford division in mid-June, 2004, for emissions testing on ultra low sulfur diesel fuel.
- Diesel particulate filters were installed at the end of September to allow for this emission component testing during the last quarter of this year.
- Our hybrid bus testing program was featured at the National AASHTO Research Advisory Committee (RAC) meeting that was hosted by the Connecticut Department of Transportation in July. A **CT**TRANSIT hybrid bus was also demonstrated at the University of Connecticut Technology Expo in September.

CT TRANSIT GAS EMISSIONS MEASUREMENTS - QUATERLY REPORT
OCTOBER 12, 2004 [Data in preliminary form, not to be used for external publication]

Project Objective:

Measure the emission concentrations of CO, CO_2, NO_x and UHC (unburned hydrocarbons) of 2 Hybrid Diesel-Electric buses and 2 conventional Diesel buses under regular operation conditions employing an on-road emission measurement equipment (Horiba 1000). These measurements will be used to:

- Compare fuel consumption and exhaust gas emissions characteristics of the Hybrid Diesel-Electric buses with the conventional Diesel buses
- Test the reliability of the Hybrid Diesel-Electric buses under regular daily operation conditions

This information will be used to qualitatively evaluate the reliability, fuel consumption and emissions reduction of the Hybrid Diesel-Electric bus in comparison with conventional Diesel transportation. It will also become a decision maker tool for future investments in alternative energies at CT Transit.

Driving Cycles

1. Enfield Outbound: Highway driving cycle (16.7 miles)
2. Enfield Inbound: Highway driving cycle (16.7 miles)
3. Farmington Avenue Outbound city route: City driving cycle (5.6 miles)
4. Avon mountain Outbound route driving cycle (8.2 miles)
5. Avon mountain Inbound route driving cycle (8.2 miles)
6. Farmington Avenue Inbound city route: City driving cycle (5.6 miles)

Data Gathered

For each one of the driving cycles we have recorded the following data:

1. CO, CO_2, NO_x, UHC emissions and Air Fuel Ratio (AFR)
2. Speed and Location (longitude, altitude and latitude)
3. Ambient Pressure, Temperature and Humidity
4. Exhaust Flow Rate, Pressure and Temperature
5. State of Charge (SOC)

Testing Current Status

	Conventional Diesel		Hybrid Bus	
Date	201	202	301	302
6-Jan			X	
21-Jan			X	
23-Jan	X			
30-Jan	X			
11-Feb		X		
13-Feb		X		
18-Feb		X		
27-Feb				X
16-Apr			X	
21-Apr			X	
23-Apr	X			
27-Apr		X		
30-Apr				X
26-May		X		
28-May		X		
29-Jun		X		
29-Jul			X	
3-Aug			X	
4-Aug			X	
6-Aug	X			
10-Aug	X			
25-Aug				X
26-Aug				X
20-Sep		X		
21-Sep		X		

Without Modifications #1 Diesel Low Sulfur Diesel

Testing has been performed on 2 conventional diesel buses (201 and 202) and 2 hybrid buses (301 and 302). Two types of fuel have been employed for the emission measurements: The first fuel type was #1 Diesel used during the months of January till May and represented by the green shading in the table above. The second fuel type is the low sulfur Diesel used during the period from June until now represented by pale blue shading. Measurements taken for the months of January and February are not considered in the data analysis as these data were taken during the shakedown period. During this period, several issues were identified and corrected in the Horiba equipment and the process used to take the emissions measurements (difficulties on data acquisition synchronization, presence of negative exhaust flow and hydrocarbons readings and NO_x sensor calibration issues) was modified to rectify these issues. In the following, we present a summary of gas emission results from the experiments.

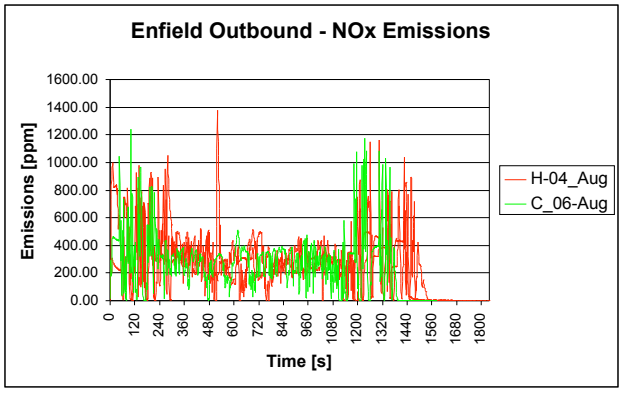
Emission Measurements Results:

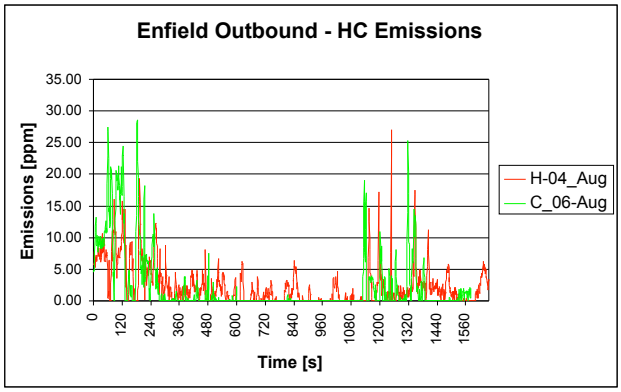
The gas emission results are shown below for selected dates:

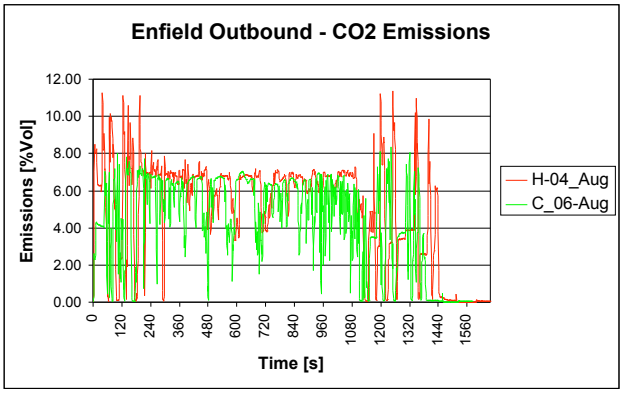
1. Comparison of low sulfur Diesel performance of conventional and hybrid buses
2. Comparison of hybrid bus performance for #1 Diesel and low sulfur Diesel fuels
3. Comparison of conventional bus performance for #1 Diesel and low sulfur Diesel fuels
4. Summary of route-averaged emission indices for conventional and hybrid buses operating on low sulfur Diesel
5. Summary of route-averaged emission indices for conventional and hybrid buses operating on # 1 Diesel and low sulfur Diesel

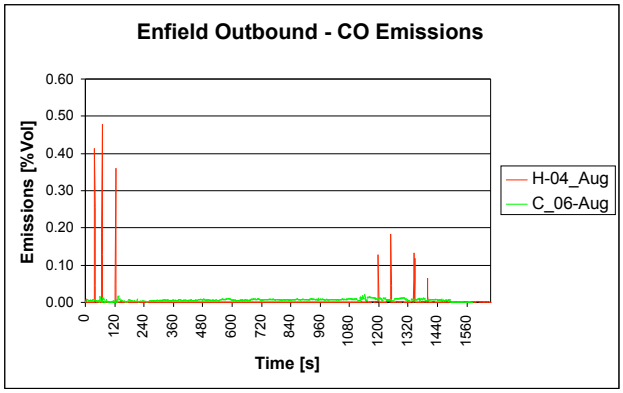
1. Emission measurements comparison between a conventional diesel bus and a hybrid electric bus using Low Sulfur Diesel at different driving cycles for 2 testing days:

1.1. Enfield Outbound

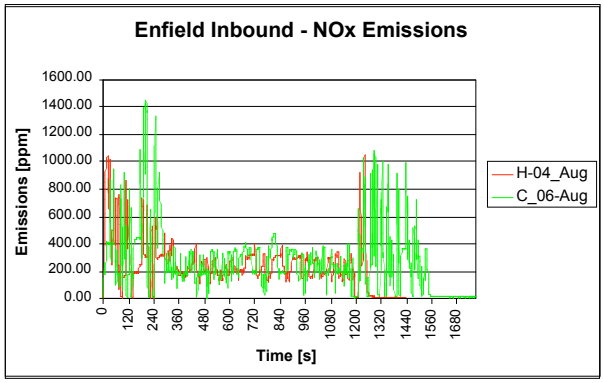


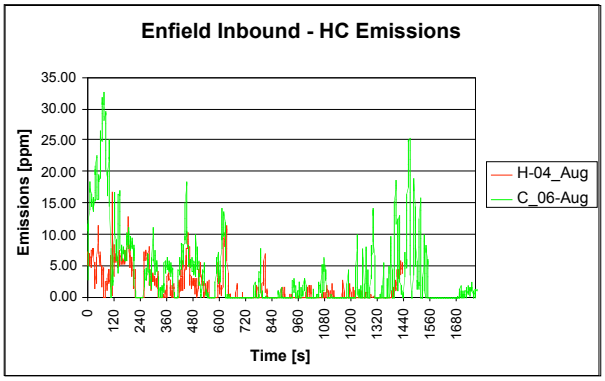


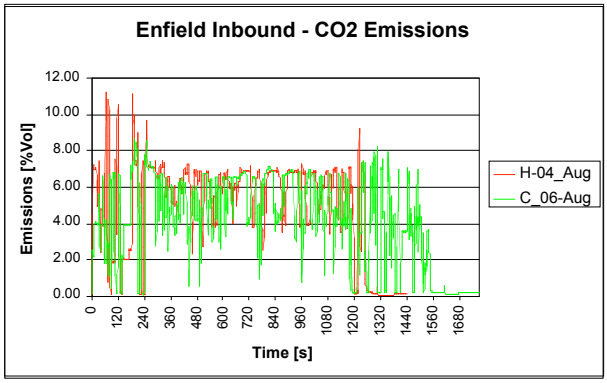


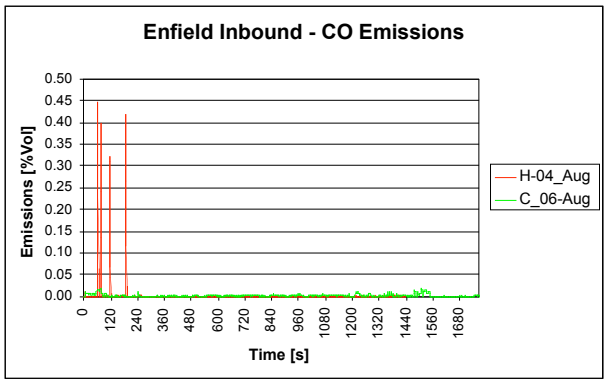


1.2. Enfield Inbound

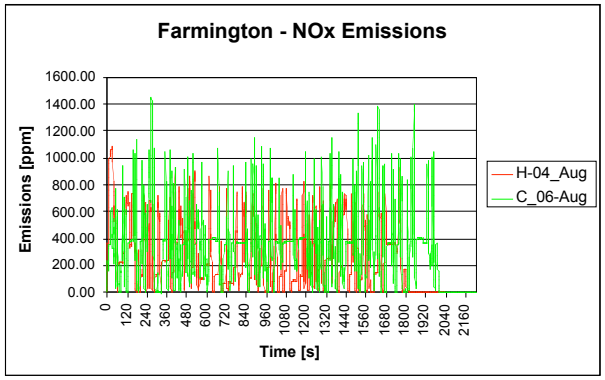


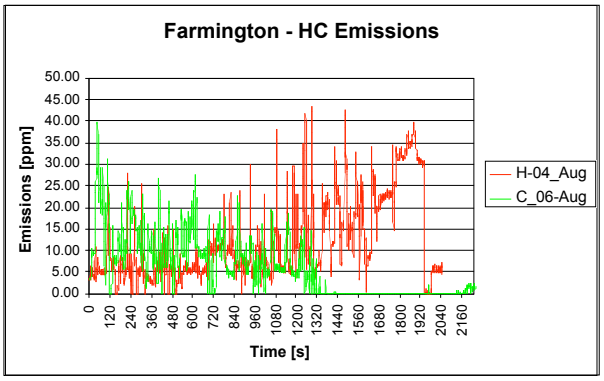


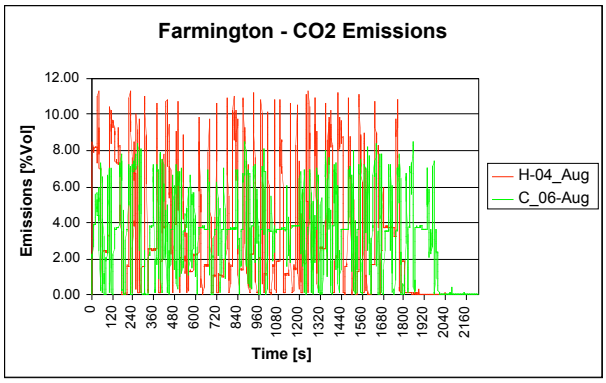


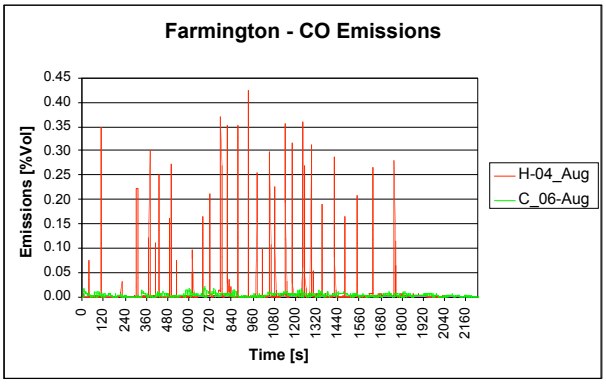


1.3. Farmington Outbound

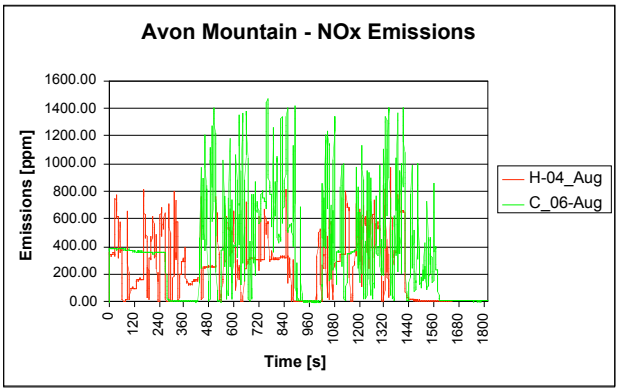


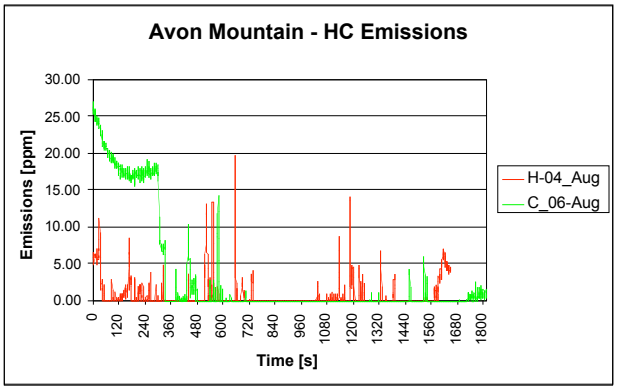


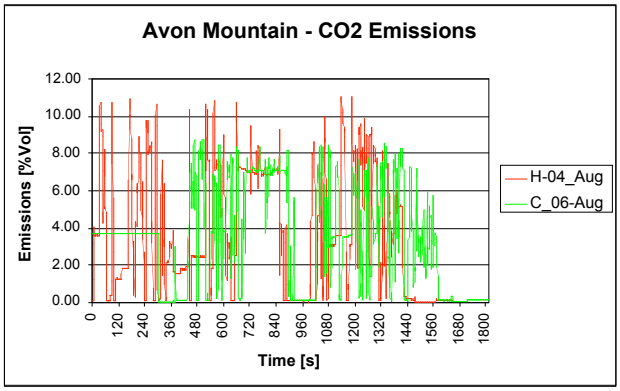


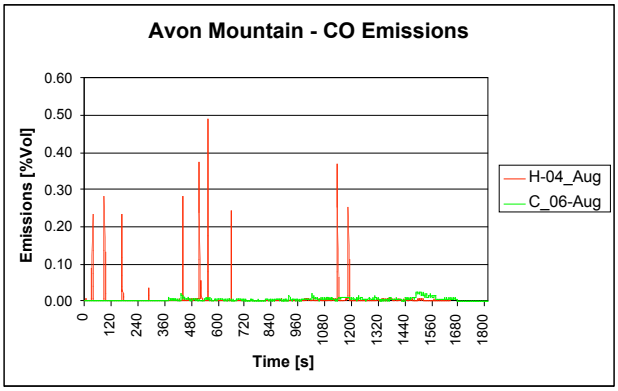


1.4. Avon Outbound









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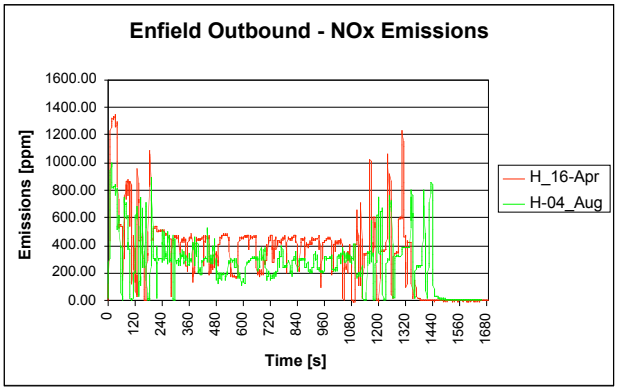

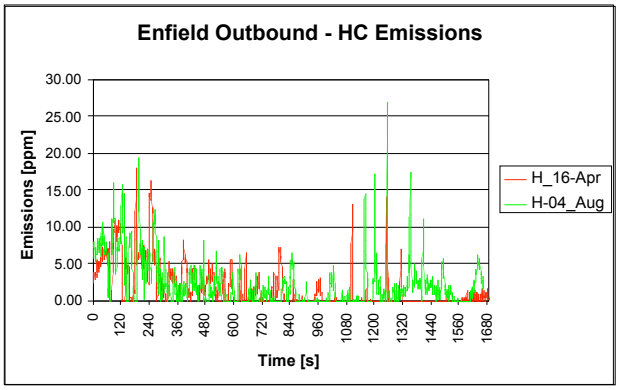

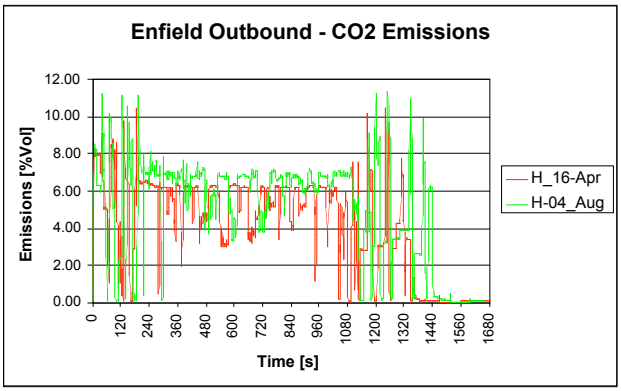

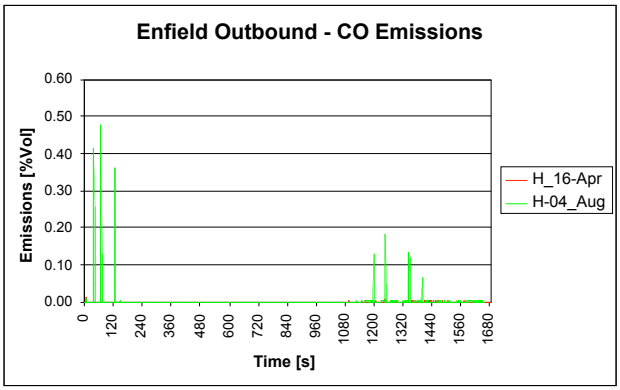

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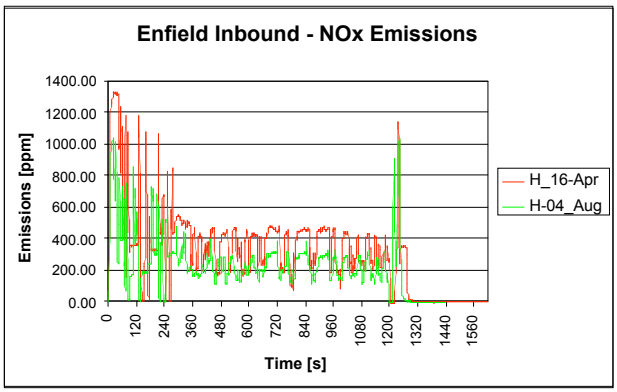
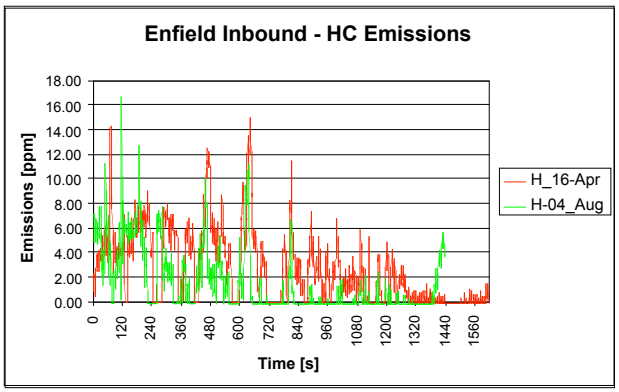
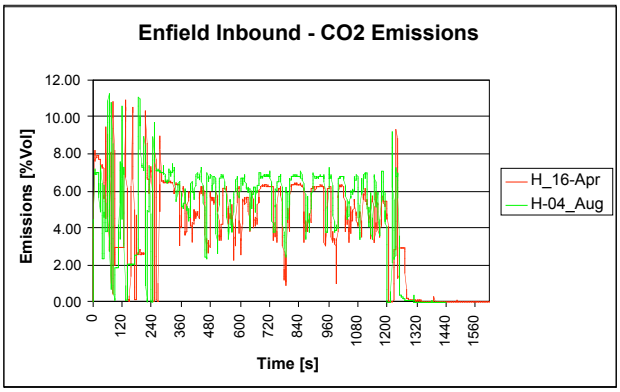
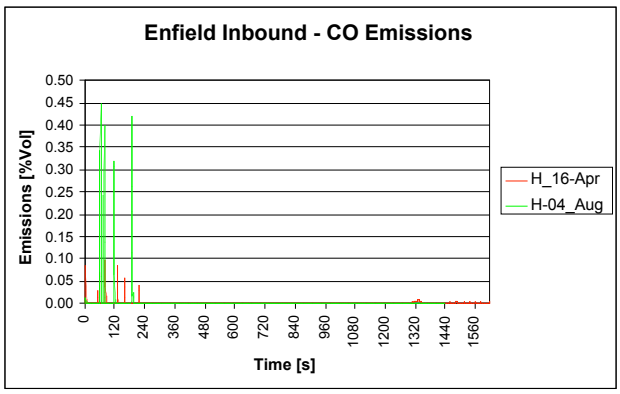
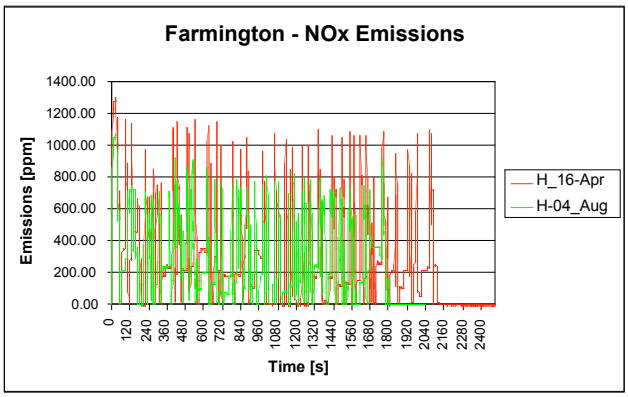


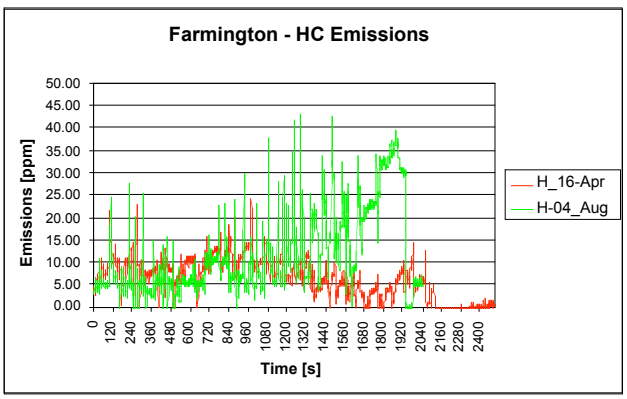


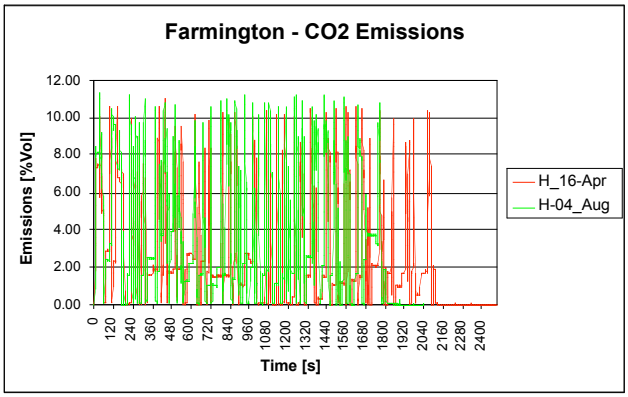


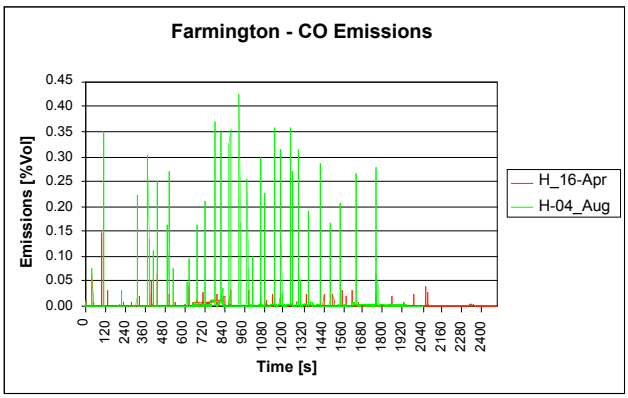


2.3. Farmington Outbound









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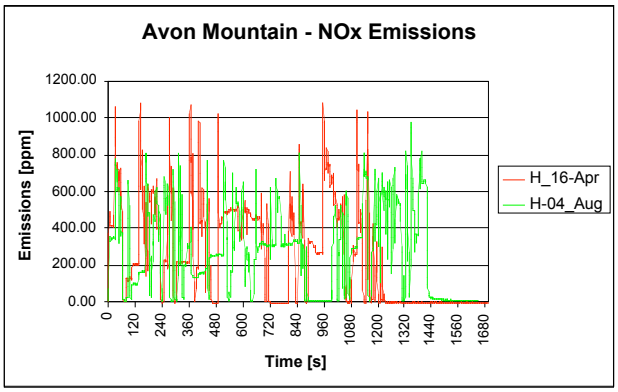

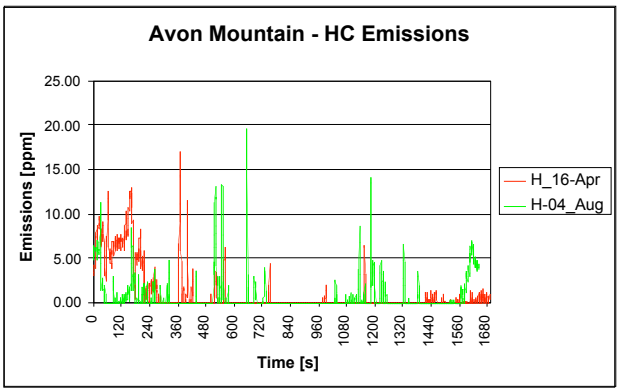

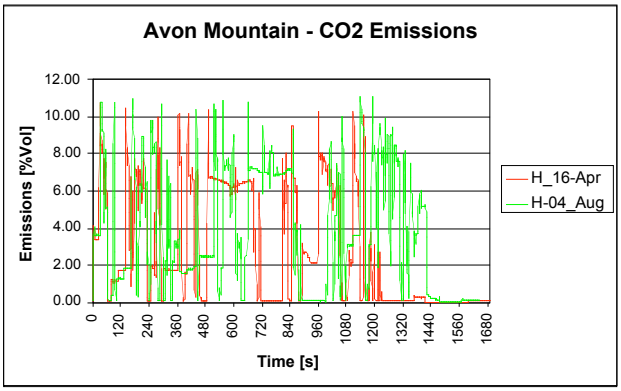

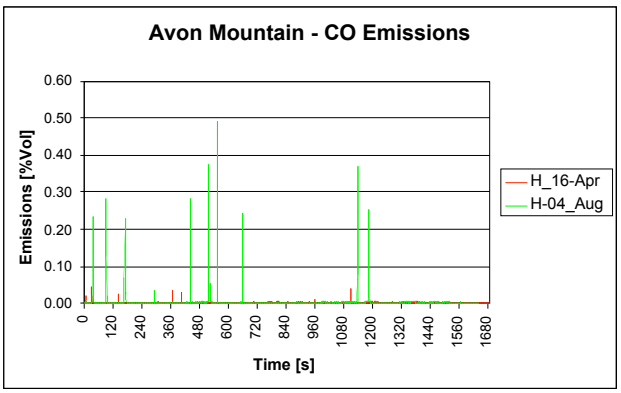

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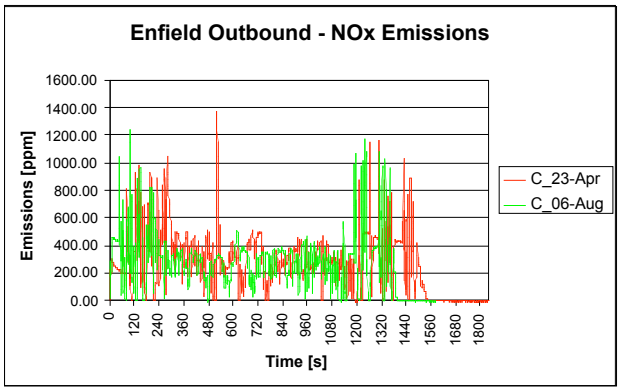
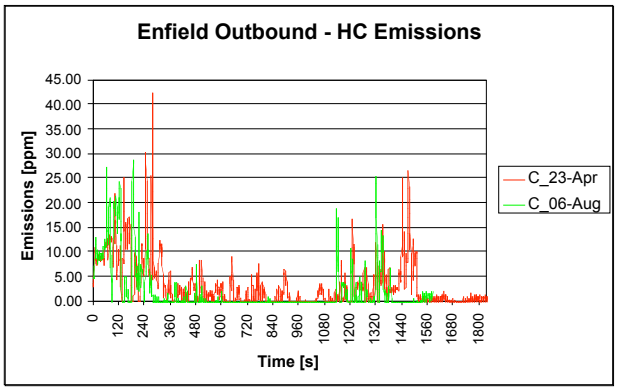
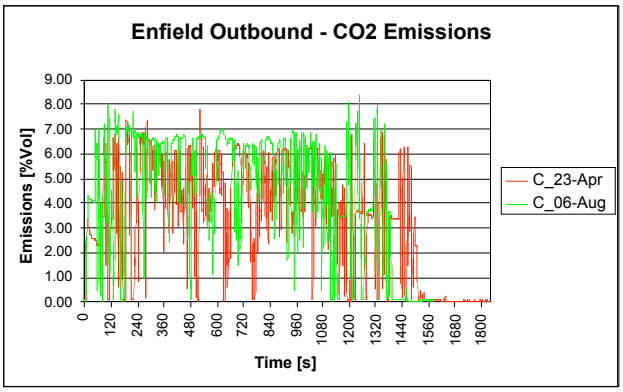
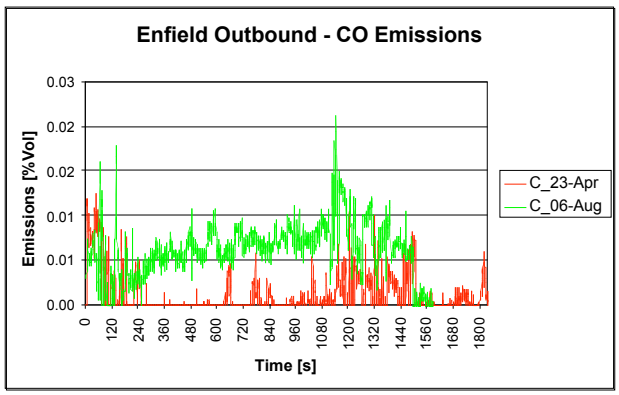
3.1. Enfield Outbound









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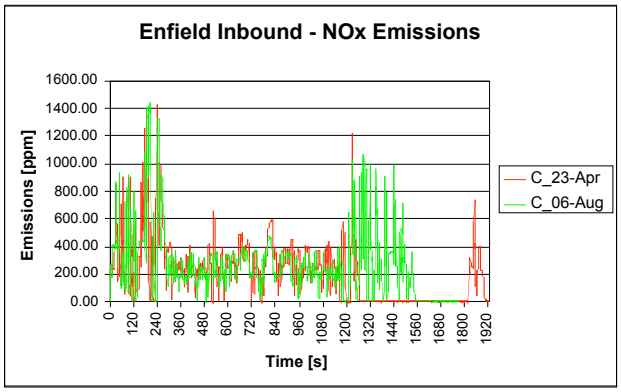
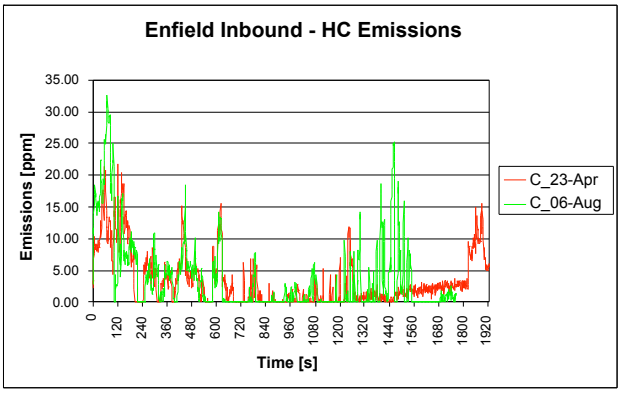
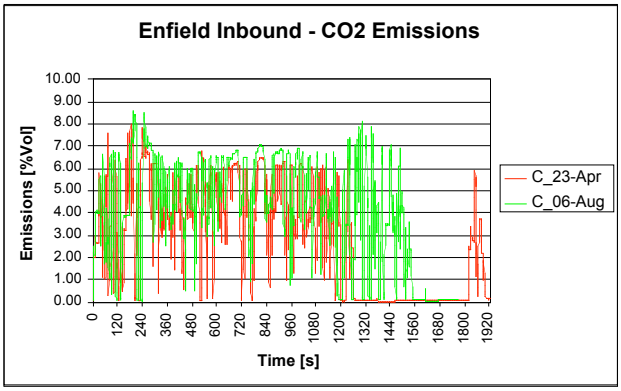
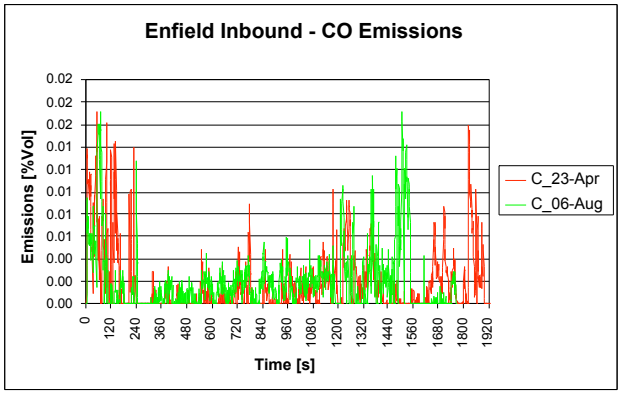
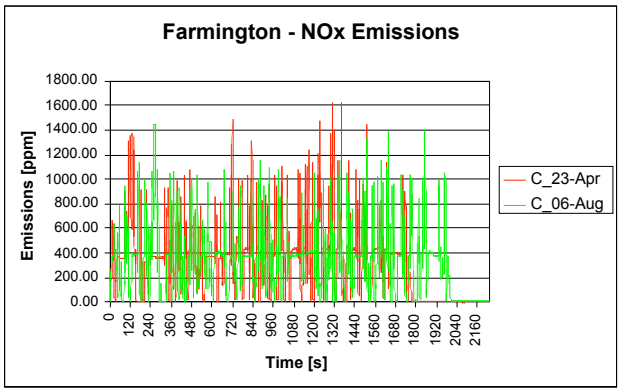


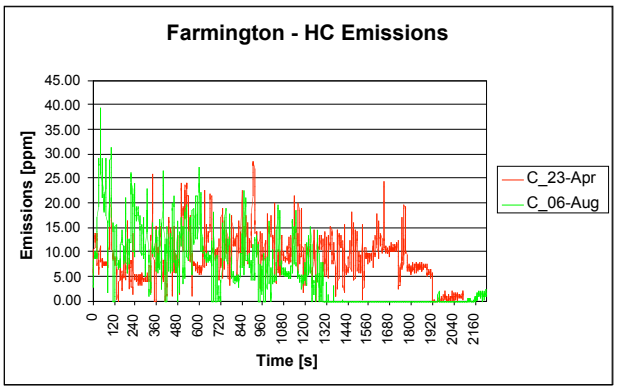


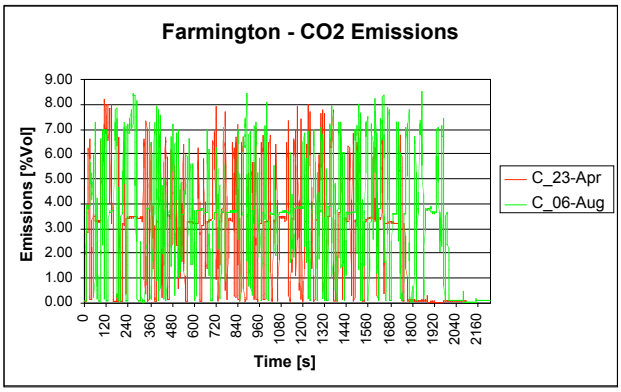


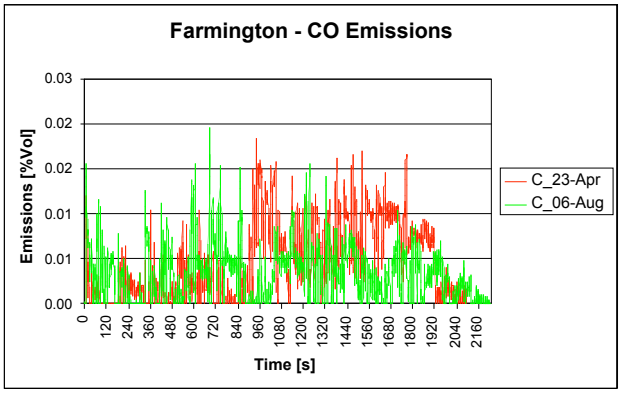


3.3. Farmington Outbound

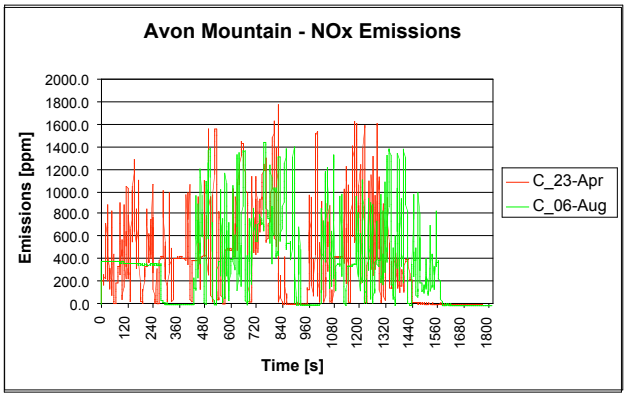


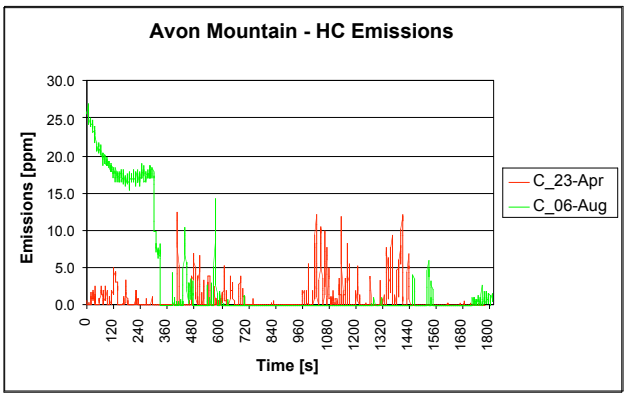


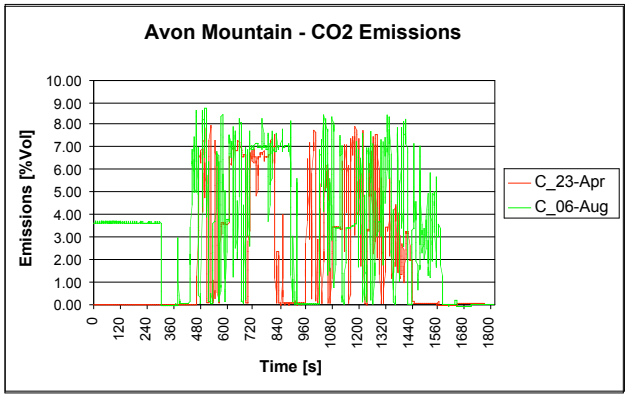


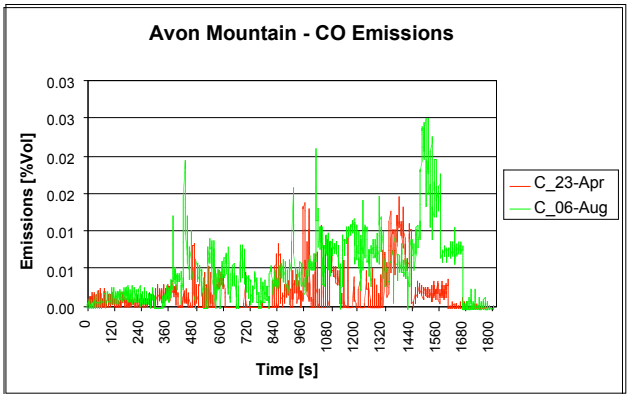


3.4. Avon Outbound

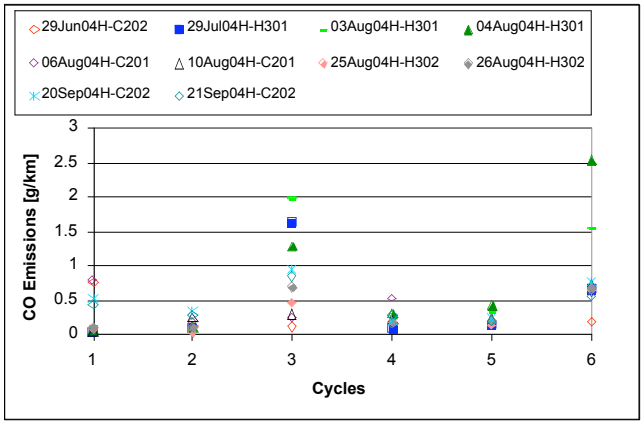


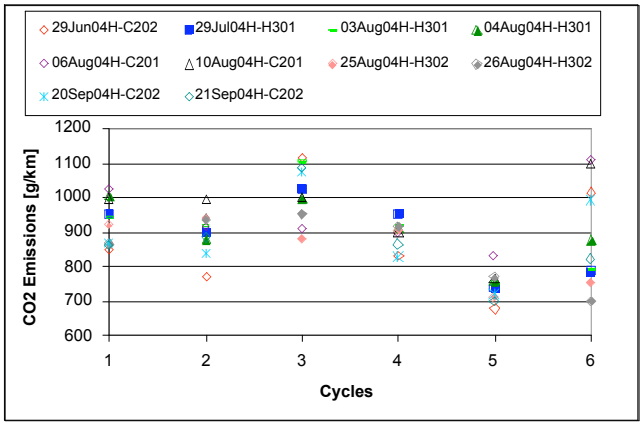


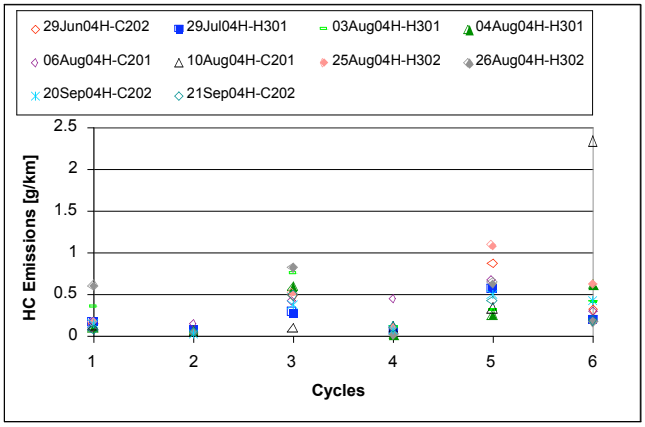


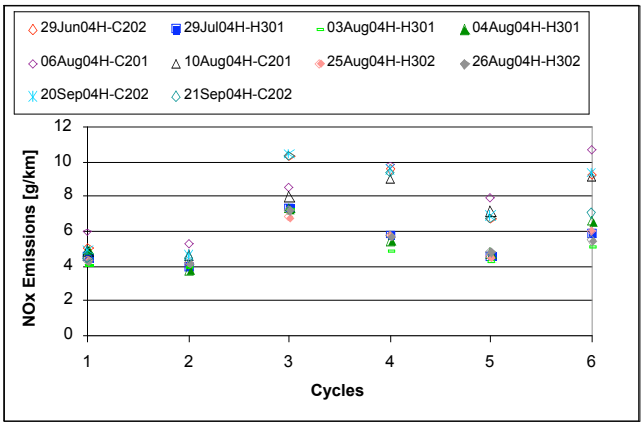


4. Emission measurements and fuel consumption comparison between conventional buses and hybrid buses using Low Sulfur Diesel fuel for all testing days and driving cycles

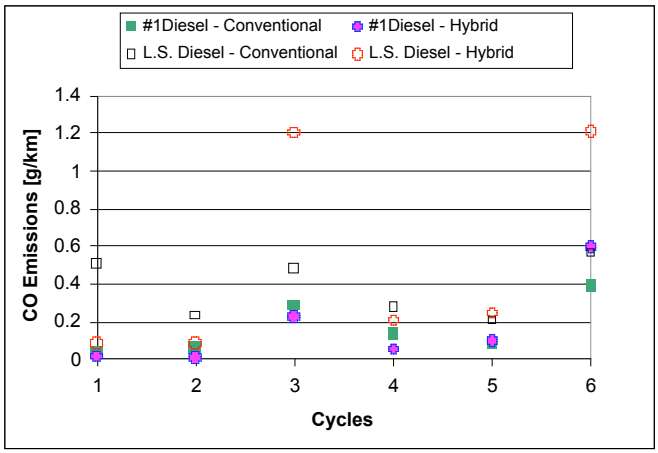


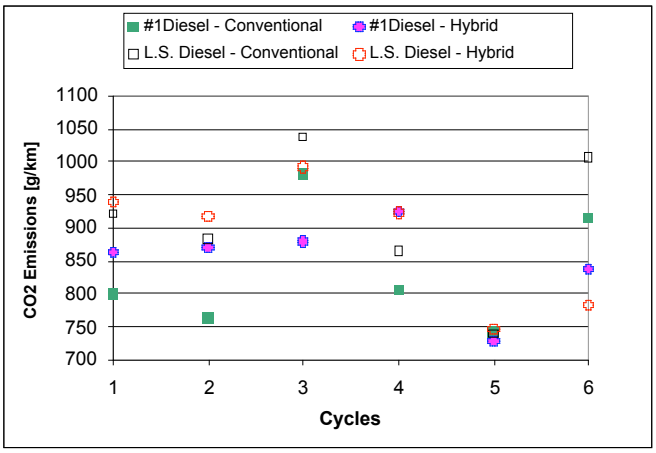


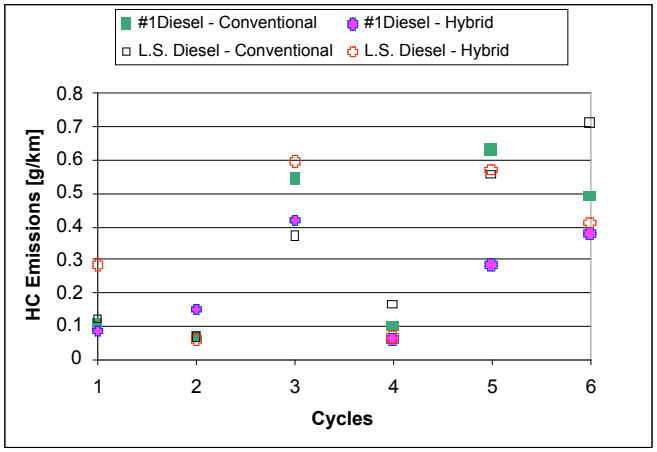


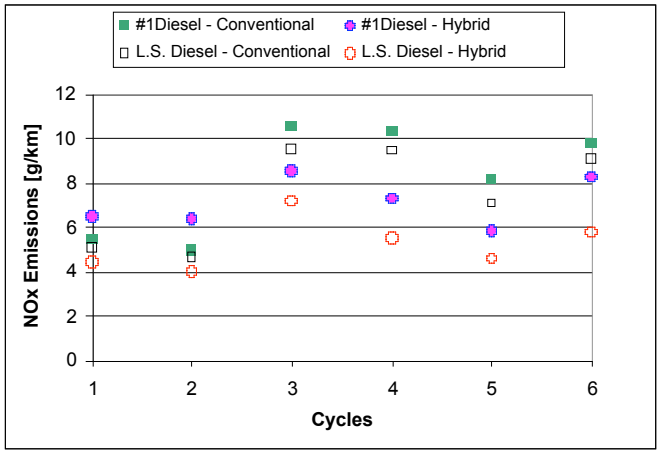


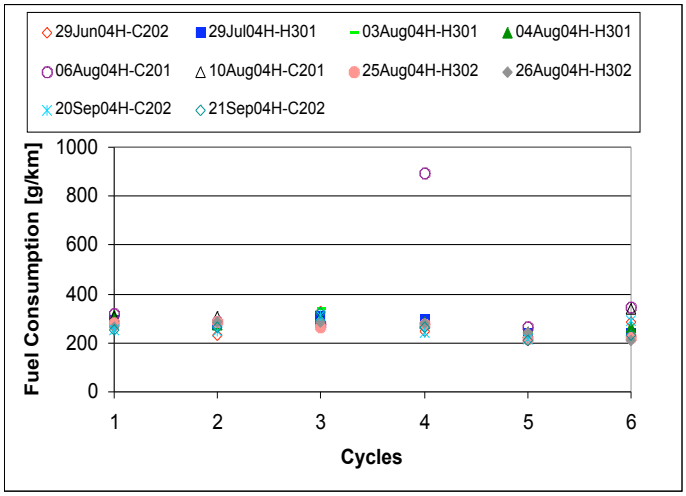
5. Averages of emission measurements and fuel consumption comparison between conventional buses and hybrid buses using #1 Diesel fuel and Low Sulfur Diesel fuel for all testing days and driving cycles

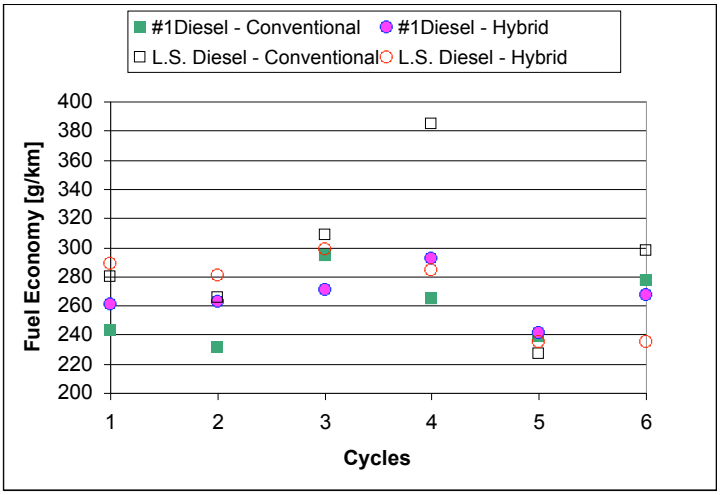












Connecticut Transit Hybrid Bus Project
5th Quarter Progress Report
Particulate Matter Emissions

July1, 2004 - September 30, 2004

Principal Investigator: *Britt A. Holmén*

Research Objective(s):
This research aims to compare the available engine, fuel and aftertreatment configurations available to the CT Transit fleet in terms of ultrafine particulate matter number and mass emissions in order to determine the combination that will best meet current and likely future particulate matter emission standards. Specifically, Table 1 defines the six different engine-fuel- aftertreatment combinations that will be tested and compared.

Table 1. Project Transit Bus Configurations for Emissions Comparison*

Standard **Diesel Bus** configurations:	(D1) #1 diesel fuel, no aftertreatment.
	(D2) ULSF, no aftertreatment.
	(D3) ULSF + diesel particulate filter/trap.
Hybrid Diesel-Electric Bus configurations:	(H1) #1 diesel fuel, no aftertreatment.
	(H2) ULSF, no aftertreatment.
	(H3) ULSF + diesel particulate filter/trap.

*ULSF = ultralow sulfur fuel with S < 15ppm.

The project objectives are being addressed using "on-board" emissions testing. This new approach involved significant research challenges and appreciable changes in instrumentation and testing protocols compared to dynamometer testing, but provides unique opportunities for evaluating the real-world emissions of in-service transit buses.

Accomplishments This Quarter:

1. Collected emissions measurements on *July 29, August 3, 4, 6, 10, 25, and 26* and *September 20, 21*, as indicated in updated Table 2.

Table 2. On-Road Tests of Commuter, Local and Mountain Routes

Date	Bus	Comments
21Jan04	H301	Mass flowmeters operational, but noisy. ELPI ch12 = extreme currents. ELPI no initial TB. Roof hatch insulation added.
23Jan04	201	New RS-232 cables for mass flowmeters to reduce noise. ELPI flange fitting missing – Ruben jury-rigged w/washers. Trouble w/Prolink's connection— scantool was bad on Warmup run only. Computer clock offsets measured periodically throughout day. (Driver = Al).
30Jan04	201	Low noise Labview readings for first time. JW logging voltage from socket (Scopeview). JW trouble with Prolink communication (13:27).
11Feb04	202	Two erratic t/c readings (ch0 and ch2) JW has new laptop for logging. New procedure – stop and open doors every third bus stop.
13Feb04	202	Replace t/c ch 2 connector – no noise. AC changed NOx analyzer output signal range to 2000 ppm (was 1000 ppm). Failure of compressor joint at 11:19am – test series collected after joint repaired until second failure at 14:20 (Avon

		Mountain return).
18Feb04	202	Logsheets for intersection crossings and magnehelics added to protocols. Replicate sets of 3 bus routes collected.
27Feb04	H302	New SS swagelok for flowmeter A to replace copper. First hybrid current probe measurements. Larry Oeler (EPA NTE group) visiting.
16Apr04	H301	New VANSCO Data Link Adapter (USB model) for scantool testing – hexadecimal and log formatted data recovered. Jimmy Dowd = Driver. No Tunnel Blank #2 today for PM mass.
21Apr04	H301	Garmin GPS and Fugawi software to synch all laptop clocks to GPS time. DayHill Road HOV lane entrance closed today—took Jennings Rd. exit on 91S.
23Apr04	201	Diluter A 0-6" magnehelic problem – no response after 12:10pm (warm-up)
28Apr04	202	VANSCO collecting with CANsniff software. New Horiba zeroing and pitot calibration routine started.
30Apr04	H302	New dessicant. Sears air compressor (5.5hp, 22gal) not filling; purchase new Husky compressor (5hp, 26 gal) and run with it – Husky does not cycle off at all.
26May04	202	CPC fuse replaced; BNC cable provided by Jimmy. SMPS cannot maintain aerosol flow rate – constantly cycling to + flow. High HEPA counts for SMPS (8/cm^3) and liquid level light on w/o BtOH connection (off at 12:04). ELPI AUX button OFF, Trav = 0V. Prolink parameters changed - %load, RPM, speed, engine time (no coolant temp). Many ELPI vibration spikes on warm-up.
27May04	202	(no BH) All OK.
28May04	H301	(no BH) Diluter B magnehelic problem. First notice water in air compressor line.
02Jun04	H301	JHRAC visitors. Enfield run only due to water in compressor line to silica dryer. ELPI counts high (100k fA range).
29Jun04	202	East Coast Hybrid Consortium visitors, Art Vatsky and Russ Owens. Repaired Sears compressor is back. New "de-aqua-vator" system between air compressor and silica gel – Never got water in first collection vessel, only compressor tubing line. *First runs on ultralow sulfur diesel fuel.*
29Jul04	**H301**	ELPI pump failed, had to use MOUDI pump, but it could not maintain vacuum needed for ELPI operation.
03Aug04	**H301**	(no BH) First runs with new ELPI pump, model SV25B. It could not pull full 100 mbar vacuum (was 108-118), but Dekati says OK to 140mbar.
04Aug04	**H301**	(no BH) All reported OK.
06Aug04	**201**	(no BH) All reported OK.
10Aug04	**201**	(no BH) All reported OK.
25Aug04	**H302**	All OK. MJ Bradley remote sensing equipment was not functional so emissions comparison between analytical techniques could not be conducted.
26Aug04	**H302**	(no BH) All reported OK.
20Sep04	**202**	(no BH) First early morning runs due to classes; Traffic reported much lighter.
21Sep04	**202**	(no BH) Magnehelic readings on minidiluter sample lines increased at ~ 9:30am – cause unknown, continued running.

Work Plan:

While continuing to collect emissions data from the diesel and hybrid buses, the following data analysis tasks will also be conducted.

1. Analyze particle number distribution data to compare vehicle configurations.
2. Quantify ultrafine particle emissions as a function of engine operating parameters.
3. Write final report summarizing project research methods and findings.

CTTRANSIT'S HYBRID & CONVENTIONAL DIESEL EMISSIONS MEASURMENT PROJECT
October 14, 2004

Principle Investigator: *John D. Warhola*

Project Objective:

To measure both gas and particulate emissions simultaneously from each of the two identical Diesel Electric Hybrid buses and two conventionally powered buses. Data obtained from this project will be evaluated and utilized to choose the best configuration producing the best performance and least amount of emissions in CTTRANST'S "real world" bus routes.

Project Direction:

As of June 2004 all four test buses have been transferred to the Stamford Division for revenue service and to operate on Ultra-Low Diesel fuel. This is the second of three stages of testing. The last stage of testing will include not only Ultra-Low Diesel, but will include the installation of particulate filters on all four-test buses for emissions comparison.

Note: All four buses in the testing program are fueled in Stamford with Ultra – Low Diesel. They are then driven to the Hartford facility. The buses have the capacity to travel between divisions and undergo emissions testing without any refueling.

Project Changes & Modifications:

- Calibration of the Horiba OBS – 1000's NOX sensor at 2000ppm. now takes place every time it is moved to a different bus and or every two weeks with a three-point calibration gas. Vapor pressure & Temperature correction is utilized on all three gases.

- Vapor pressure & Temperature correction is utilized on all the other gases involving calibration.

- A two-minute data logging prior to and after sampling has been adopted on the Horiba side as per their recommendations.

- Clock synchronization of all data logging equipment occurs before and after each leg of a run. Approximately 30 minutes between checks.

- On May 4th, a test involving the Horiba system only was run. It involved the thermal insulation of the exhaust sampling pipe system from where the exhaust pipe exited the bus roof all the way up to and including the Horiba tailpipe adapter where all Horiba sensors are mounted.

- Testing concluded there was no significant benefit to insulating the exhaust-sampling pipe to reduce exhaust flow measurement issues. In other words thermal loss from air flowing over the exterior of the sampling exhaust pipe with a 6" diameter did not generate additional turbulence within the exhaust stream and affect low flow exhaust measurements.

- As of 4-16-04 per Horiba's instructions, a six-inch exhaust pipe extension was installed onto the end of the Horiba tail pipe adapter, which all sensors are mounted in. This extension was recommended to improve low exhaust flow accuracy.

- The baffle plate located forward of the end of the exhaust sampling pipe has been enlarged and lengthened to accommodate and protect the end of the exhaust from siphoning effects at high speeds which could affect emissions readings.

- Horiba recommended expediting quickly the re-zero process of the exhaust flow calibration to avoid large temperature swings in the exhaust pipe and pitot tube, which may be introducing errors. This has been adopted.

- As of 4-16-04 a prototype data logging tool built by Vansco has been acquired on a trail bases. Its capacity to capture all data messages transmitted on the J1939/1708 communication network is beneficial overall. The one time challenge to isolate only the messages required for emissions testing is time consuming but will be an asset to all future testing of buses for emissions or performance.

- On the 4-30-04 run Professor Holmen's [oilless air compressor] failed. A new one was acquired and the test was fully completed the same day without further complications. The temporary replacement air compressor ran hot the entire emissions testing and was never able to cycle off.

- NOTE: The swing of outside ambient temperatures from extreme cold to well into the 80's will bring about new issues. All equipment operating parameters will be checked to see if cooling may be necessary in the upcoming months.

- Up until May 28, 2004 humidity collecting in the compressed air system used for particulate measurement has not posed a significant problem or has been anything of an issue. On the 28th. weather was medium rain. Moisture caused a measurement failure involving a magnehelic during the inbound run to Enfield. Particulate

measurement was cancelled at the end of the outbound run from Enfield due to saturation of desiccant dryer. Water was collecting and leaking out of the base of the desiccant dryer tube.

- To eliminate contamination and the passage of saturated air through to Professor Holmen's desiccant dryer/filter system a water extraction device was built by Technical Services & CTTRANSIT personnel. It is referred to as the de-aqua-vator and is mounted in the bus. This system has two stages, which have not allowed moisture in visible form to pass or collect in the second stage as of yet. Further testing in the upcoming months of August and September will challenge the de-auqa-vator.

- Protocol involving draining & purging of water extraction system at various points on a 30-minute interval has been set and will insure proper equipment operation and integrity.

- On the next test setup, the compressed air line, which runs from the trailer into the bus, will be installed to facilitate the drainage of water into the de-auqa-vator. This will help to avoid condensation collecting in the hose and causing a bubbling action. Also the least amount of compressed air line will be left outside of the bus. With a majority of hose inside of the bus it should act as a cooling line to drop out as much moisture as possible prior to the de-aqua vator.

- As of test date June 29th. a new NOX sensor has been calibrated and will be in use marked along with the change in emissions testing with the test buses **burning Ultra-Low Diesel.** A degradation chart is being generated through the calibration process of the NOX sensor to keep tabs on the life of the sensor. Horiba gave this sensor to CTTRANSIT. Horiba requests that we supply the degradation chart for their analysis on the performance of this expendable sensor, which normally costs $2500.00.

Continuation of Emissions Testing:

Including April 16th. up to June 29th. 2004 there has been 11 test days.

On May 4th. a thermal insulation test took place involving the Horiba Gas Emissions analyzer system only.

On June 2nd. members of the JHRAC were given full emissions testing demonstration aboard H301. Professor Holmen and John Warhola were in attendance to explain procedures and processes.

On June 29th. Art Vatsky & Russ Owens from the East Coast Hybrid Consortium accompanied the emissions team with Professor Holmen and John Warhola aboard Bus 202 for the entire test. The processes & procedures were witnessed first hand by both Mr. Vatsky and Mr. Owens.

On June 29th. John Warhola meet with Art Vatsky & Russ Owens for a short period of time while Bus 202 was being prepared & emissions equipment was being calibrated prior to emissions testing which they were scheduled to attended on behalf of the East Coast Hybrid Consortium.

The June 29th. test is the first test involving the test vehicles running on Ultra – Low Diesel fuel.

Immediate Project tasks to be accomplished

- Have just received another Cummins Software Update. This update is supposed to contain the control of data logging frequency. This must be verified.

- CTTRANSIT has purchased the SAE J1939 document package, which contain information to decipher the engine data stream output by the ECM for data logging with the newly acquired Vansco data logger. Specific data points to log must be identified and verified prior to our next scheduled test.

- Request operators of all testing equipment to check temperature-operating parameters and supply them to John Warhola for consideration of cooling issues.

- John Warhola to contact Stamford for repair of boost leak on test Bus 202 which occurs on the Avon Mountain run.

Future concerns to be considered

- As far as oilless compressed air supply, the duty cycle on the air compressor is high. Purchase of a single stand-alone oilless air compressor without a holding tank, which can deliver 75% or more of the volume of compressed air needed, should be investigated. This would insure steady volume & psi. This would also avoid running the main air compressor at 100% duty cycle, which does not allow it to shut off for more than two minutes.

- John Warhola needs to check on installation of particulate filter. Does it increase backpressure and what affect in the category of turbulence.

- John Warhola is to provide information requested by Art Vansky and Russ Owens of the East Cost Hybrid Consortium.

- Discuss with team about running Delta P. across existing filters on the two different engines:

@ IDLE
50 % load
100 % load

- Compare above Delta P. after installing the particulate filter if exhaust flow measurements are significantly different.

John D. Warhola
7-12-04

Continuation of Emissions Testing 4th. Quarter Report

Including July 1st. through September 30th. there has been 9 test days.

Bus H302 now running on Ultra-Low Diesel was scheduled for testing on July 28th. Fuel was inadvertently contaminated with # 1 diesel and the test was cancelled. Safeguards were installed to prevent further occurrences.

On July 29th. Bus H301 was tested. Installation of coiled compressed air hose to reduce moisture was installed ahead of DeAuqavator.

During July 29th. warm-up test exhaust flow readings were completely out of range. Upon examination of pitot tube at end of warm-up run it was discovered to be 45 degrees off. Tube was readjusted and readings returned to normal.

Checking alignment of pitot tube has been added to protocol upon installation of sampling exhaust system.

During the July 29th. test on the particulate side the vacuum pump failed. A supplemental pump was inadequate.

On August 25th. arrangements were made with M.J. Bradley Assoc. to compare their infarred sensing technology against our lab grade mobile emissions equipment for comparison. They encountered equipment failure and comparison testing of H302 did not take place.

On August 25th. jdw made an observation of current draw increase during climbing portions of Avon Mountain. On the downhill portion, regenerative charging current doesn't seem to exceed 100 Amps very often as was noticed in the past visually.

A separate run for recording this observation was done. Both CTTRANSIT'S current transformer and Allison's software were recording during the test. Data has not been compared yet.

Allison has not formally acknowledged changes in the battery software. Discussion with technical services has indicated a change to amp-hour target of battery pack. John Warhola & Steve Warren are pursuing a formal answer.

During a hybrid training session for the project graduate students, Professor Cetegen's assistant Andres Chaparro observed use of current during idle. This discovery will lead to quantifying its value during testing operation as a loss due to inherent operation of the Allison Electric Drive. The operation of the electric motor was pointed out in formal training but the principle of actual use of electrical energy during idling was never pointed out or recognized until now. This could be one of possibly other reasons mpg is not what has been expected from regenerative braking. This is only an opinion I share without having gone through the electrical use data at this time.

On September 16th. particulate filters were installed on Bus H301, H302 & 201.

On September 29th. a particulate filter was installed on Bus 202.

Mileage on the Hybrids are low per month in comparison to Hartford due to limitations by height. New Flyer engineering is working on feasibility of lowering the battery pack roof. Consequences to lowering of roof will cost the hybrid to take on an extra load of A/C, which will be forced automatically during high temperatures.

As it stands, the bus is at the edge of design temperatures not to have forced A/C installed.

I have no data to predict the loss on mpg during summer months if modification takes place at this time. I have yet to encounter an over-temperature trouble code from the system on either buses.

Immediate Project tasks to be accomplished

- **Differences in conventional particulate filters versus hybrid particulate filters. Will efficiency introduce a correction factor in results?**

- **Differences in engine emissions performance specifications between the Series 40 E and the Cummins ISL 270. Will better emissions performance by one engine before PF produce inaccurate final emissions conditioning measured after PF?**

- **Horiba has a software upgrade addressing timing. The software has not been tested yet. To change the software at this point may skew data. Discussion with emissions team to stay with the current software needs to be confirmed.**

- **Data logging of hybrid P.F. is possible for pressure and temperature. Emissions team must decide if data is useful to pursue installation.**

Information related to project and equipment

- **Horiba has informed me they have an Alpha unit similar to our OBS 1003. They have changed to a Flame Ionization Detector (FID) and chemolumenesence detection.**

- **With approval I would like to see if Horiba would let us use their Alpha unit and run a side by side comparison?**

- **Question to the emission team if Horiba agrees, what would the benefits be if any at this time and if the unit is available.**

NOTE: EPA and CARB are doing a large test running against other analyzers. The EPA has been pushing Horiba to loan them their FID alpha unit to test.

John D. Warhola

October 14, 2004

hybrid bus *vs. standard bus* facts

	HYBRID BUS	STANDARD BUS
WEIGHT (EMPTY)	29,360 lbs.	28,850 lbs.
HEIGHT	131"	111"
WIDTH x LENGTH	102" x 40'	102" x 40'
SEATS	38	38
FUEL ECONOMY	10%-15% Improvement—Expected 4.0 mpg transit duty cycle	
RANGE	550 miles	440 miles
EMISSIONS	50%-90% Improvement (ultralow & PM Filter) PM=.05, HC=1.3, CO=15.5, NOx=.4	
TOP SPEED	68mph	68mph
BRAKE LIFE	25% Improvement—Expected 30,000 miles	
REGENERATIVE BRAKING	Electric Motors become Generators on Braking	
ENGINE	Cummins ISL @280hp	Detroit Diesel Series 40 @280hp
TRANSMISSION	Allison EP 40 Electric Drive	Allison B400R Automatic
ELECTRIC MOTORS	(2) Concentric AC Induction Motors	None
TRACTION BATTERIES	Sealed Nickel-Metal Hydride	None
ACCELERATION	Up to 50% Improvement—31 sec. to 40mph at gross weight	
COST	$500,000	$270,000
LIFE CYCLE COST	To be determined—Expected to be about equal due to hybrid fuel economy and extended brake and engine life.	

CTTRANSIT Hybrid Diesel-Electric Bus
Evaluation Program
July 1, 2003 through December 31, 2004

Goals

- Identify the next generation of transit vehicles for future fleet replacement;
- Find a vehicle that is cost effective, reliable, produces fewer emissions, and operates with improved fuel economy when compared to the standard heavy-duty diesel powered bus;
- Collect data to produce an estimated life cycle cost analysis to determine the above.

Cleaner air. Brighter future.

Project Description

Two New Flyer 40-foot 2003 model low floor Allison hybrid diesel-electric powered buses were purchased in June 2003. **CT**TRANSIT is operating the vehicles in normal revenue service and is comparing their operating characteristics to a set of virtually identical New Flyer 2002 model year low floor standard 40-foot heavy duty clean diesel buses. The vehicles are operated for scheduled and controlled periods of time in local, slow average speed, high stop-and-go service, and higher speed commuter express operations. They are also being evaluated under light and heavy loads and for their ability to climb and descend steep roads.

Data on mileage, fuel economy and other consumable fluids used are collected daily via the automated TRAK and Ultramain maintenance management computer systems. Emissions information is collected utilizing mobile exhaust gas analyzer (EGA) equipment. Brake pad wear, battery condition and fault codes are checked on a regular and continuing basis. All maintenance and repair labor and parts costs are documented by vehicle utilizing the Ultramain computer work order and maintenance management system. Bus Operator and customer input about the vehicles' operating characteristics has also been obtained via surveys.

Program Funding

This project has been funded by a Congestion Mitigation Air Quality grant CM-005984, Project 170-1884 for a total of $1,485,000.00. An additional capital grant CT-90-X250 provided funding of $119,000.00 to purchase new mobile exhaust gas analyzer equipment. Finally, the East Coast Hybrid Consortium has provided $100,000 in additional project funding.

Program Partners

Allison Electric Drive Transmissions
Connecticut Academy of Science & Engineering
Connecticut Department of Transportation Bureau of Public Transportation
Connecticut Department of Transportation Division of Research
CTTRANSIT
Horiba Instruments, Inc.
New Flyer Industries
The East Coast Hybrid Consortium
University of Connecticut

Vehicles to be Tested

Two 2003 New Flyer Hybrid Diesel-Electric Buses
Two 2002 New Flyer Diesel Buses

Data Collection on Each Vehicle

Daily Data Collection
Route operated (from Dispatcher)
Temperature and weather (from Dispatcher)
Vehicle mileage (from TRAK and Ultramain)
Vehicle fuel and fluids used (from TRAK and Ultramain)
All maintenance done on the vehicle (Ultramain)

Monthly Data Collection
CO, HC, NOx, PM (Mobile EGA, Particulate Matter (PM) Measuring Equipment)

Bus Operator & Passenger Surveys
Bus operators have been surveyed to get their input about the operating characteristics of the hybrid bus as compared to the standard diesel bus. They indicated by over a 90% margin that they preferred driving the hybrid bus due to its great acceleration.

The passengers were also surveyed and they had a very favorable impression of the hybrid bus. They especially liked that it was an environmentally friendly vehicle.

EGA & PM Monthly Emissions Testing (First Eight Months)
(2) Hybrid diesel-electric buses (#1 diesel)
(2) Identical diesel buses (#1 diesel)

EGA & PM Monthly Emissions Testing (Next Four Months)
(2) Hybrid diesel-electric buses (Ultralow sulfur fuel no PM Filter)
(2) Identical diesel buses (Ultralow sulfur fuel no PM Filter)

EGA & PM Monthly Emissions Testing (Last Four Months)
(2) Hybrid diesel-electric buses (Ultralow sulfur fuel & PM Filter)
(2) Identical diesel buses (Ultralow sulfur fuel & PM Filter)

Advanced Electricity Energy Storage Module

Contains sealed nickel-metal hydride batteries that provide power to the electric drive motors. The batteries also store electricity, which is produced when the motors turn into generators as they help to brake the bus.

Connecticut's First Hybrid Electric Bus

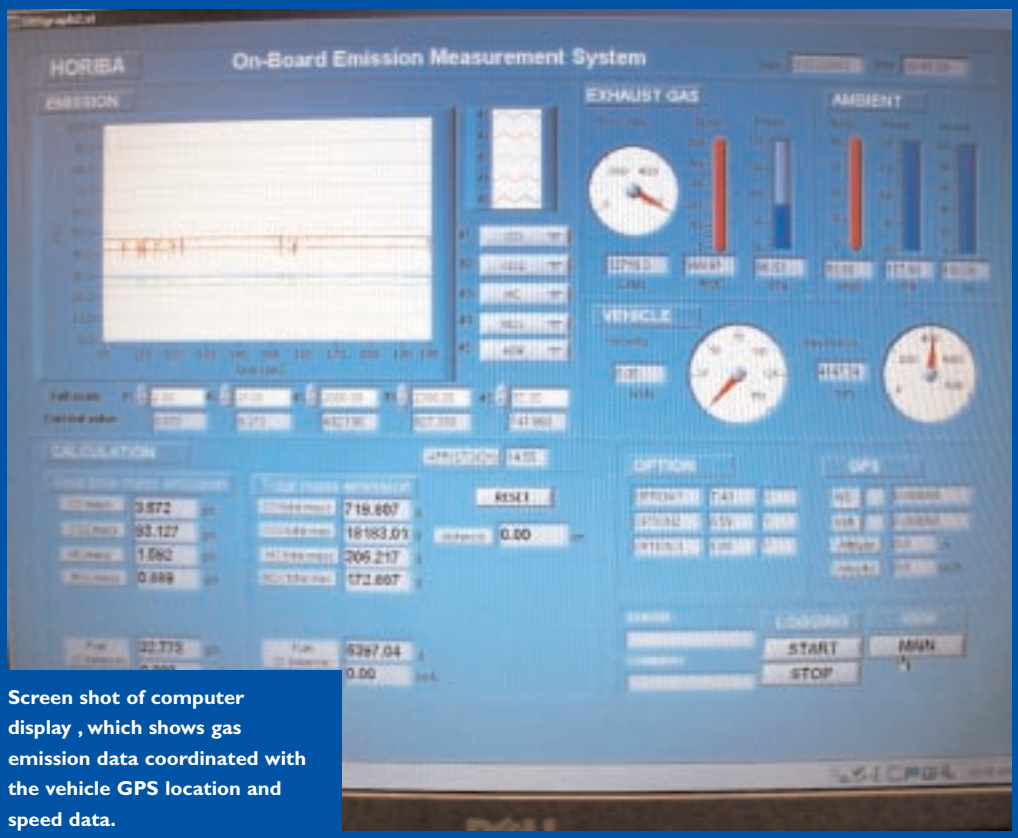
40-foot New Flyer low-floor bus with hybrid parallel Allison electric drive.

An electrical generator and air compressor are installed on a trailer to provide the electricity and clean compressed air for the sophisticated emissions test equipment located inside the bus.

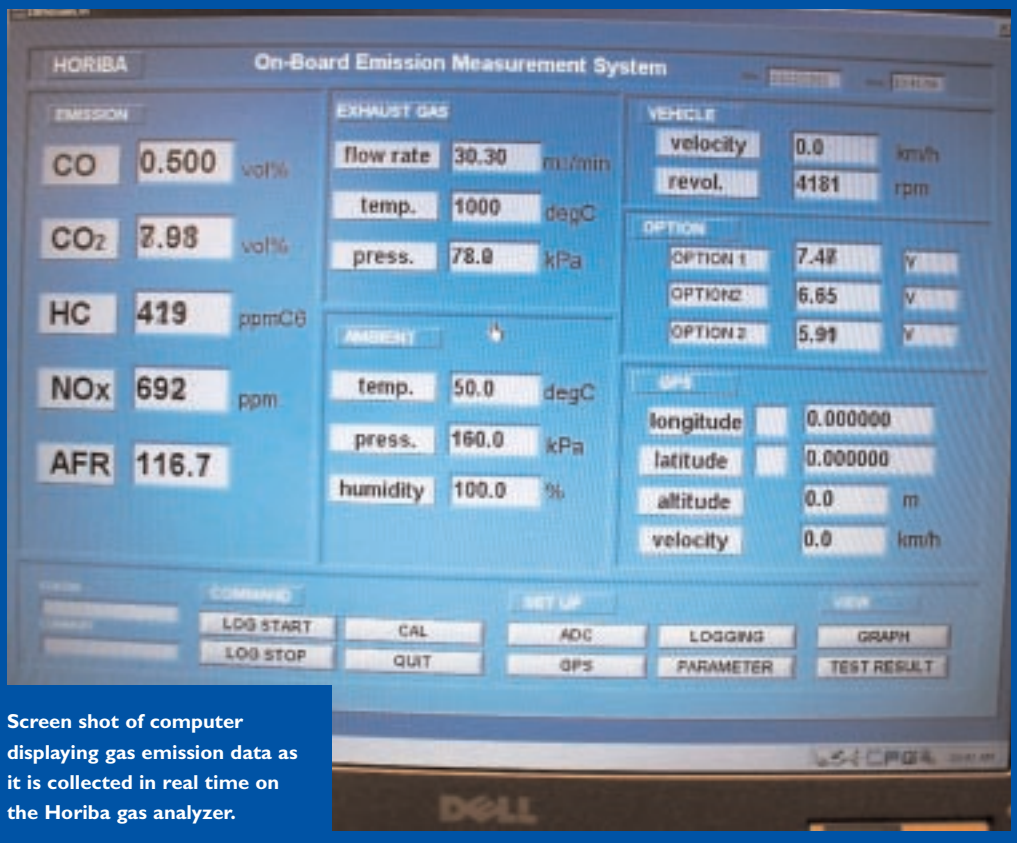
Emissions tests are collected on three different route types: low speed/frequent stops; high speed highway; and steep grade roadways. Testing is also done on #1 diesel, ultralow sulfur diesel, and ultralow sulfur diesel with a particulate filter.

University of Connecticut graduate students operate and monitor the particulate matter mass and particle size measurement equipment.

A University of Connecticut graduate student calibrates the lab emissions test equipment using known calibration gas before each test is run.



Screen shot of computer display , which shows gas emission data coordinated with the vehicle GPS location and speed data.



Screen shot of computer displaying gas emission data as it is collected in real time on the Horiba gas analyzer.

CT TRANSIT

The Clean Fuel Solution Hybrid Diesel Electric

- Hybrid electric buses combine a diesel engine and electric drive components
- Improved performance
  - Significant emissions reduction
  - Increased fuel economy
  - Smooth & quiet operation
- Avoids the infrastructure costs of CNG; no special fuel handling is required

CTTRANSIT Hybrid Project

- $1,275,513 FHWA Grant
- $100,000 TECHC Grant
- Eight project partners:

  Allison Electric Drive Transmission
  CT Academy of Science & Engineering
  CDOT Bureau of Public Transportation
  CDOT Division of Research
  CTTRANSIT
  Horiba Instruments, Inc.
  New Flyer Bus Industries
  The East Coast Hybrid Consortium
  University of Connecticut

- 24-month project
- Innovative & unique mobile emissions test

Hybrid bus project reports can be found at: www.ct.gov/dot/LIB/documents/dresearch/CT-170-1884-3-04-5.pdf

CTTRANSIT
JULY, 2004 HYBRID BUS TEST PROGRAM DATA

Total Fleet	*Fleet Total*	*Fleet Avg*
Miles	984,675.00	2492.8
Fuel - Gallons	290,569.00	735.6
Oil - Quarts	1,361.00	3.4
Road Calls	317	0.8
Maintenance Parts Cost	$178,350.92	$451.52
Maintenance Labor Cost	$114,743.89	$290.49
Total Maintenance Cost	$293,094.81	$742.01
Total Cost/Mile	$0.30	$0.30
Miles/Gallon Fuel	3.39	3.39
Miles/Quart Oil	723.5	723.5
Miles/Road Call	3,106.2	3,106.2

Base Comparison Buses	*201*	*202*	*201 & 202*	*Base Avg*	*Hybrid vs Base*
Miles	2,828	3,702	6,530	3,265	-1846
Fuel - Gallons	786.0	1,009.7	1,795.7	897.9	-542.7
Oil - Quarts	6.0	2.0	8.0	4.0	-2.5
Road Calls	2	0	2	1	-1.0
Maintenance Parts Cost	$114.37	$3,002.77	$3,117.14	$1,558.57	-$1,558.57
Maintenance Labor Cost	$336.89	$469.90	$806.79	$403.40	-$270.59
Total Maintenance Cost	$451.26	$3,472.67	$3,923.93	$1,961.97	-$1,829.16
Total Cost/Mile	$0.16	$0.94	$0.60	$0.60	-$0.51
Miles/Gallon Fuel	3.60	3.67	3.64	3.64	9.87%
Miles/Quart Oil	471	1,851.00	816.25	816.25	15.9%
Miles/Road Call	1,414.00	N/A	3,265	3,265	-427.00

Hybrid Buses	*H301*	*H302*	*H301 & H302*	*Hybrid Avg*	*Hybrid vs Fleet*
Miles	1,389	1,449	2,838	1,419	-1,074
Fuel - Gallons	370.5	339.8	710.3	355.2	-380.5
Oil - Quarts	3.0	0.0	3.0	1.5	-1.9
Road Calls - Hybrid Related	0	0	0	0	-0.80
Road Calls	0	0	0	0	-0.80
Maintenance Parts Cost	$0.00	$0.00	$0.00	$0.00	-$451.52
Maintenance Labor Cost	$265.62	$0.00	$265.62	$132.81	-$157.68
Total Maintenance Cost	$265.62	$0.00	$265.62	$132.81	-$609.20
Total Cost/Mile	$0.19	$0.00	$0.09	$0.09	-$0.20
Miles/Gallon Fuel	3.75	4.26	4.00	4.00	17.90%
Miles/Quart Oil	463.00	N/A	946.00	946.00	23.52%
Miles/Road Call - Hybrid Related	N/A	N/A	N/A	N/A	N/A
Miles/ Road Call Total	N/A	N/A	N/A	N/A	N/A

CTTRANSIT
H301 and 201 BUS TEST DATA
JULY, 2004

			H301						201						
	NOON														% MPG
DATE	TEMP.	CONDITIONS	RUN NO.	BLOCK #	BADGE #	FUEL	MILES	MPG	RUN NO.	BLOCK#	BADGE #	FUEL	MILES	MPG	CHANGE
07/01/04	80°	clear	19/43	104/H101	1966/1948	17.8	65	3.65	30/2	502	1920/1963	56.6	175	3.09	18.11%
07/02/04	78°	clear	19/43	104/H101	1966/1948	17.8	65	3.65	49	520	1909	3.8	13	3.42	6.74%
07/03/04	79°	clear													
07/04/04	82°	clear													
07/05/04	77°	rain													
07/06/04	83°	cloudy	24/12	504	1923/1907	38.8	144	3.71	38	305	1937	18.3	61	3.33	11.34%
07/07/04	81°	clear	22/6	511	1922/1904	36.9	133	3.60	45/14/25	503	1951/1933/1910	42.7	144	3.37	6.88%
07/08/04	79°	clear	22/6	511	1922/1984	37.2	134	3.60	49/16/33	520	1985/1949/1930	52.4	163	3.11	15.80%
07/09/04	82°	cloudy	14/43	113/H101	1933/1948	16.4	64	3.90	43/39	S101/H203	1948/1924	23.2	72	3.10	25.75%
07/10/04															
07/11/04															
07/12/04	79°	rain	22	109	1904	20.9	74	3.54	13/39	102/H203	1927/1924	20.7	75	3.62	-2.28%
07/13/04	81°	clear	43	S101/H101	1948	18.7	74	3.96	6	511	1922	28.3	100	3.53	11.99%
07/14/04	82°	clear	22/6	511	1922/1904	33.9	132	3.89	2739	110/H203	1975/1924	15.3	59	3.86	0.97%
07/15/04	81°	clear	19/IO5	104/IO5	1953/1949	22.4	91	4.06	32/7	513	1928/1913	54.1	191	3.53	15.07%
07/16/04	83°	clear	22/6	511	1922/1904	15.9	70	4.40	Tripper			39.9	156	3.91	12.60%
07/17/04	80°	clear							21/804	503	1946/1985	63	241	3.83	
07/18/04															
07/19/04	81°	cloudy							25	505	1910	23.6	75	3.18	
07/20/04	79°	cloudy							32/7	513	1928/1913	25	111	4.44	
07/21/04	78°	clear							38/37	512	1937/1957	51.6	196	3.80	
07/22/04	79°	clear													
07/23/04	81°	cloudy	40	306	1901	38	138	3.63	32/7	513	1928/1913	72.6	286	3.94	-7.81%
07/24/04									Tripper			10	37	3.70	
07/25/04															
07/26/04	82°	clear	26/20	518	1906/1961	27.6	92	3.33	45/14/25	503	1951/1978/1910	38.8	135	3.48	-4.20%
07/27/04	79°	cloudy	26/20	518	1906/1961	28.2	113	4.01				23.9	108	4.52	-11.32%
07/28/04	78°	clear							34/1	501	1926/1967	49.3	176	3.57	
07/29/04	80°	clear							27	110	1983	15.8	53	3.35	
07/30/04	81°	cloudy							31/3	507	1954/1960	57.1	201	3.52	
07/31/04															
Totals						370.5	1389.0	3.75				786.0	2828.0	3.60	4.20%

CTTRANSIT
H302 and 202 BUS TEST DATA
JULY, 2004

			H302						202						
	NOON														% MPG
DATE	TEMP.	CONDITIONS	RUN NO.	BLOCK #	BADGE #	FUEL	MILES	MPG	RUN NO.	BLOCK#	BADGE #	FUEL	MILES	MPG	CHANGE
07/01/04	80°	clear							21/10	519	1917/1943	30.3	128	4.22	
07/02/04	78°	clear							45/14/25	503	1951/1933/1980	40.2	142	3.53	
07/03/04	79°	clear													
07/04/04	82°	clear							28/802	506	1934/1980	40.9	164	4.01	
07/05/04	77°	rain													
07/06/04	83°	cloudy							43/24	S101/S203	1948/1923	24.2	89	3.68	
07/07/04	81°	clear							32/7	513	1928/1913	51.7	179	3.46	
07/08/04	79°	clear							32/7	513	1928/1913	53.4	188	3.52	
07/09/04	82°	cloudy							38/37	512	1937/1957	48	173	3.60	
07/10/04															
07/11/04															
07/12/04	79°	rain							19/27	104/303	1966/1975	31.6	111	3.51	
07/13/04	81°	clear	24	S203	1949	6.2	27	4.35	45/13/25	503	951/1933/191	35.8	142	3.97	9.79%
07/14/04	82°	clear	13/44	102/S202	1953/1968	17.6	81	4.60	32/7	513	1928/1913	47.4	179	3.78	21.87%
07/15/04	81°	clear	50/40	CC2/306	1959/1901	15.9	67	4.21	14/22	113/511	1933/1985	40.3	149	3.70	13.97%
07/16/04	83°	clear							35/4	509	1902/1986/1955	59.2	211	3.56	
07/17/04	80°	clear													
07/18/04															
07/19/04	81°	cloudy	Tripper			36.5	171	4.68	21/10	519	1917/1943	48	197	4.10	14.15%
07/20/04	79°	cloudy	13	102	1953	17.5	72	4.11	36/9	517	1916/1921	61.8	215	3.48	18.26%
07/21/04	78°	clear	34/1	501	1926/1967	47.6	190	3.99	48/49	516	1964/1909	48.2	171	3.55	12.51%
07/22/04	79°	clear	24/12	504	1923/1907	39.3	164	4.17	32/7	513	1928/1913	52.7	182	3.45	20.83%
07/23/04	81°	cloudy	24/12	504	1923/1907	34.1	141	4.13	49/16/33	520	1909/1977/1930	47.9	145	3.03	36.59%
07/24/04															
07/25/04															
07/26/04	82°	clear	Tripper			16.8	79	4.70	22/6	511	1922/1904	51.7	182	3.52	33.58%
07/27/04	79°	cloudy							21/10	519	1917/1949	46.5	195	4.19	
07/28/04	78°	clear	Tripper			20.7	97	4.69	32/7	513	1928/1913	46	179	3.89	20.42%
07/29/04	80°	clear	34/1	1926/1967	501	43.2	180	4.17	24/12	504	1923/1907	43.1	149	3.46	20.53%
07/30/04	81°	cloudy	34/1	1986/1967	501	44.4	180	4.05	44	S202	1968	14.7	53	3.61	12.44%
07/31/04									26/17	504	1906/1965	46.1	179	3.88	
Totals						339.8	1,449.0	4.26				1,009.7	3,702.0	3.67	16.31%

CTTRANSIT
AUGUST, 2004 HYBRID BUS TEST PROGRAM DATA

Total Fleet	*Fleet Total*	*Fleet Avg*
Miles	1,001,781.00	2536.2
Fuel - Gallons	294,498.00	745.6
Oil - Quarts	1,453.00	3.7
Road Calls	289	0.7
Maintenance Parts Cost	$265,781.42	$672.86
Maintenance Labor Cost	$129,116.21	$326.88
Total Maintenance Cost	$394,897.63	$999.74
Total Cost/Mile	$0.39	$0.39
Miles/Gallon Fuel	3.40	3.40
Miles/Quart Oil	689.5	689.5
Miles/Road Call	3,466.4	3,466.4

Base Comparison Buses	*201*	*202*	*201 & 202*	*Base Avg*	*Hybrid vs Base*
Miles	2,210	3,204	5,414	2,707	-666.5
Fuel - Gallons	612.8	897.5	1,510.3	755.2	-227.35
Oil - Quarts	0.0	2.0	2.0	1.0	1.5
Road Calls	0	1	1	0.5	-0.5
Maintenance Parts Cost	$141.75	$141.75	$283.50	$141.75	-$41.02
Maintenance Labor Cost	$235.51	$297.76	$533.27	$266.64	$211.98
Total Maintenance Cost	$377.26	$439.51	$816.77	$408.39	$170.96
Total Cost/Mile	$0.17	$0.14	$0.15	$0.15	$0.13
Miles/Gallon Fuel	3.61	3.57	3.58	3.58	7.85%
Miles/Quart Oil	2210.00	1,602.00	2,707.00	2,707.00	-69.8%
Miles/Road Call	2,210.00	3,204.00	5,414	5,414	-1333.00

Hybrid Buses	*H301*	*H302*	*H301 & H302*	*Hybrid Avg*	*Hybrid vs Fleet*
Miles	2,024	2,057	4,081	2,041	-496
Fuel - Gallons	509.3	546.3	1055.6	527.8	-217.8
Oil - Quarts	5.0	0.0	5.0	2.5	-1.2
Road Calls - Hybrid Related	0	0	0	0	N/A
Road Calls	0	0	0	0	N/A
Maintenance Parts Cost	$51.52	$149.94	$201.46	$100.73	-$572.13
Maintenance Labor Cost	$186.94	$770.29	$957.23	$478.62	$151.74
Total Maintenance Cost	$238.46	$920.23	$1,158.69	$579.35	-$420.40
Total Cost/Mile	$0.12	$0.45	$0.28	$0.28	-$0.11
Miles/Gallon Fuel	3.97	3.77	3.87	3.87	13.65%
Miles/Quart Oil	404.80	2057.00	816.20	816.20	15.53%
Miles/Road Call - Hybrid Related	N/A	N/A	N/A	N/A	N/A
Miles/ Road Call Total	N/A	N/A	N/A	N/A	N/A

CTTRANSIT
H301 and 201 BUS TEST DATA
AUGUST, 2004

			H301						201						
	NOON														% MPG
DATE	TEMP.	CONDITIONS	RUN NO.	BLOCK #	BADGE #	FUEL	MILES	MPG	RUN NO.	BLOCK#	BADGE #	FUEL	MILES	MPG	CHANGE
8/1/2004	80°	CLOUDY													
8/2/2004	79°	CLEAR							26/20	518	1906/1961	40.4	136	3.37	
8/3/2004	81°	CLEAR							18/5	510	1984/1914	43.7	135	3.09	
8/4/2004	82°	CLOUDY							45/14/25	503	910/1951/193	46.1	147	3.19	
8/5/2004	80°	CLOUDY	Tripper			6.8	25	3.68							
8/6/2004	78°	RAIN	40	306	1946	8.9	38	4.27							
8/7/2004	77°	CLOUDY													
8/8/2004	79°	CLEAR													
8/9/2004	81°	CLOUDY	22/6	511	1922/1904	34.4	152	4.42							
8/10/2004	76°	CLEAR	14/43	113/H101	1933/1948	18.4	74	4.02							
8/11/2004	78°	RAIN	24/12	504	1923/1907	35.7	144	4.03	Tripper			64.3	222	3.45	16.83%
8/12/2004	80°	CLEAR	24/12	504	1923/1907	34.6	145	4.19	9&34	517/501	1916/1967	28.9	197	6.82	-38.52%
8/13/2004	81°	CLEAR	24	S203	1985	17.5	75	4.29	20	105	1961	1.8	7	3.89	10.20%
8/14/2004	77°	CLEAR													
8/15/2004	79°	CLOUDY													
8/16/2004	77°	CLOUDY	5 & 18	510	1929/1923	29.2	129	4.42	Tripper			3.3	13	3.94	12.14%
8/17/2004	80°	CLEAR	6&22	511	1922/1963	35.7	133	3.73	Tripper			2.7	12	4.44	-16.18%
8/18/2004	79°	CLEAR	14	113	1974	15.4	60	3.90	45/14/25	503	1951/1974/1925	37.4	142	3.80	2.62%
8/19/2004	80°	CLOUDY	1&34	501	1926/1967	43.9	170	3.87	20/39	105/203	1961/1924	25.5	77	3.02	28.24%
8/20/2004	78°	RAIN	24/12	504	1975/1907	38.4	144	3.75	43	101	1948	11.2	31	2.77	35.48%
8/21/2004	80°	CLEAR							28/15/804	A01	1979/1977/1934	37.5	118	3.15	
8/22/2004	80°	CLEAR													
8/23/2004	77°	CLEAR	24	504	1966	27.3	113	4.14	10&21	519	1917/1971	42.2	165	3.91	5.86%
8/24/2004	80°	CLEAR	43	101	1948	19.1	66	3.46	45/14/25	503	1951/1943/1910	41.1	143	3.48	-0.68%
8/25/2004	81°	CLEAR	6&22	511	1922/1963	32.3	132	4.09	7&32	513	1928/1913	52.5	179	3.41	19.86%
8/26/2004	79	CLEAR	6&22	511	1922/1963	34	133	3.91	38	305	1938	17	59	3.47	12.71%
8/27/2004	80°	CLEAR	Tripper			21.3	72	3.38	43	101	1948	33.1	152	4.59	-26.39%
8/28/2004	82°	CLEAR													
8/29/2004	79°	CLEAR													
8/30/2004	82°	CLOUDY	14&24	113/203	1983/1966	17.4	68	3.91	21/39	107/203	1971/1924	24.8	77	3.10	25.87%
8/31/2004	81°	CLEAR	6&22	511	1922/1963	39	151	3.87	3&31	507	1954/1960	59.3	198	3.34	15.96%
Totals						509.3	2024.0	3.97				612.8	2210.0	3.61	10.20%

CTTRANSIT
H302 and 202 BUS TEST DATA
AUGUST, 2004

			H302						202						
	NOON														% MPG
DATE	TEMP.	CONDITIONS	RUN NO.	BLOCK #	BADGE #	FUEL	MILES	MPG	RUN NO.	BLOCK#	BADGE #	FUEL	MILES	MPG	CHANGE
8/1/2004	80°	CLOUDY													
8/2/2004	79°	CLEAR							15	301	1985	15.3	50	3.27	
8/3/2004	81°	CLEAR							48/49/28	516	1964/1909/1934	49.5	152	3.07	
8/4/2004	82°	CLOUDY	44/40	106/306	1968/1946	55.3	189	3.42	46	508	1941	21.5	71	3.30	3.49%
8/5/2004	80°	CLOUDY	40	306	1946	71.8	249	3.47	10&21	519	1917/1920	50.5	214	4.24	-18.16%
8/6/2004	78°	RAIN				1.6	7	4.38	37/28	101/516	1957/1978	27	91	3.37	29.81%
8/7/2004	77°	CLOUDY							18	F03	1971	4.2	14	3.33	
8/8/2004	79°	CLEAR													
8/9/2004	81°	CLOUDY	14&24	113/203	1978/1923	16.1	67	4.16	26/20	518	1906/1961	35.1	135	3.85	8.20%
8/10/2004	76°	CLEAR	24&12	504	1923/1907	37.5	139	3.71	3&31	507	1954/1960	54.8	196	3.58	3.64%
8/11/2004	78°	RAIN	40	306	1901	17.7	67	3.79	7&32	513	1928/1913	50.5	178	3.52	7.39%
8/12/2004	80°	CLEAR	14/40	113/306	1933/1949	18.8	77	4.10							
8/13/2004	81°	CLEAR	6&22	511	1922/1920	36.7	142	3.87	10&21	519	1938/1943	64.3	243	3.78	2.38%
8/14/2004	77°	CLEAR													
8/15/2004	79°	CLOUDY													
8/16/2004	77°	CLOUDY	6&22	511	1922/63	34.6	132	3.82	8&42	515	1908/1920	44.4	149	3.36	13.68%
8/17/2004	80°	CLEAR	1&34	501	1926/1962	52.3	179	3.42	9&36	517	1916/1967	58.6	215	3.67	-6.72%
8/18/2004	79°	CLEAR	43	S101/H101	1948	20.4	73	3.58	27/24	110/203	1920/1966	15.6	57	3.65	-2.06%
8/19/2004	80°	CLOUDY	6&22	511	1922/1920	40.5	151	3.73	7&32	513	1947/1913	49.7	178	3.58	4.10%
8/20/2004	78°	RAIN	6&22	511	1922/1963	43.6	162	3.72	20/27	105/303	1961/1982	24.2	81	3.35	11.01%
8/21/2004	80°	CLEAR													
8/22/2004	80°	CLEAR													
8/23/2004	77°	CLEAR							3&31	507	1949/1960	55.5	197	3.55	
8/24/2004	80°	CLEAR							3&31	507	1954/1960	50.8	198	3.90	
8/25/2004	81°	CLEAR							9&36	517	1916/1967	57	216	3.79	
8/26/2004	79	CLEAR							20/44	105/202	1961/1968	14.7	51	3.47	
8/27/2004	80°	CLEAR	40	306	1901	76.9	329	4.28	9&36	517	1916/1967	60.6	216	3.56	20.03%
8/28/2004	82°	CLEAR													
8/29/2004	79°	CLEAR													
8/30/2004	82°	CLOUDY	19	104	1904	12	51	4.25	1&34	501	1926/1962	54.2	171	3.15	34.71%
8/31/2004	81°	CLEAR	40	306	1901	10.5	43	4.10	5&18	510	1914/1980	39.5	131	3.32	23.48%
Totals						546.3	2,057.0	3.77				897.5	3,204.0	3.57	5.47%

CTTRANSIT
SEPTEMBER, 2004 HYBRID BUS TEST PROGRAM DATA

Total Fleet	*Fleet Total*	*Fleet Avg*
Miles	964,551.00	2441.9
Fuel - Gallons	276,364.00	699.7
Oil - Quarts	1,410.00	3.6
Road Calls	246	0.6
Maintenance Parts Cost	$299,404.74	$757.99
Maintenance Labor Cost	$144,053.65	$364.69
Total Maintenance Cost	$443,458.39	$1,122.68
Total Cost/Mile	$0.46	$0.46
Miles/Gallon Fuel	3.49	3.49
Miles/Quart Oil	684.1	684.1
Miles/Road Call	3,920.9	3,920.9

Base Comparison Buses	*201*	*202*	*201 & 202*	*Base Avg*	*Hybrid vs Base*
Miles	3,406	2,675	6,081	3,041	-629
Fuel - Gallons	936.8	710.8	1,647.6	823.8	-241.95
Oil - Quarts	4.0	0.0	4.0	2.0	-0.4
Road Calls	0	0	0	0	0.0
Maintenance Parts Cost	$6,081.95	$752.84	$6,834.79	$3,417.40	-$3,353.05
Maintenance Labor Cost	$427.02	$259.97	$686.99	$343.50	-$166.00
Total Maintenance Cost	$6,508.97	$1,012.81	$7,521.78	$3,760.89	-$3,519.05
Total Cost/Mile	$1.91	$0.38	$1.24	$1.24	-$1.14
Miles/Gallon Fuel	3.64	3.76	3.69	3.69	12.29%
Miles/Quart Oil	2210.00	N/A	1,520.25	1,520.25	-20.7%
Miles/Road Call	N/A	N/A	N/A	N/A	N/A

Hybrid Buses	*H301*	*H302*	*H301 & H302*	*Hybrid Avg*	*Hybrid vs Fleet*
Miles	2,460	2,363	4,823	2,412	-30
Fuel - Gallons	572.3	591.4	1163.7	581.9	-117.8
Oil - Quarts	0.0	4.0	4.0	2.0	-1.6
Road Calls - Hybrid Related	0	0	0	0	N/A
Road Calls	0	0	0	0	N/A
Maintenance Parts Cost	$118.34	$10.35	$128.69	$64.35	-$693.64
Maintenance Labor Cost	$168.54	$186.46	$355.00	$177.50	-$187.19
Total Maintenance Cost	$286.88	$196.81	$483.69	$241.85	-$880.83
Total Cost/Mile	$0.12	$0.08	$0.10	$0.10	-$0.36
Miles/Gallon Fuel	4.30	4.00	4.14	4.14	18.75%
Miles/Quart Oil	N/A	590.75	1205.75	1205.75	43.27%
Miles/Road Call - Hybrid Related	N/A	N/A	N/A	N/A	N/A
Miles/ Road Call Total	N/A	N/A	N/A	N/A	N/A

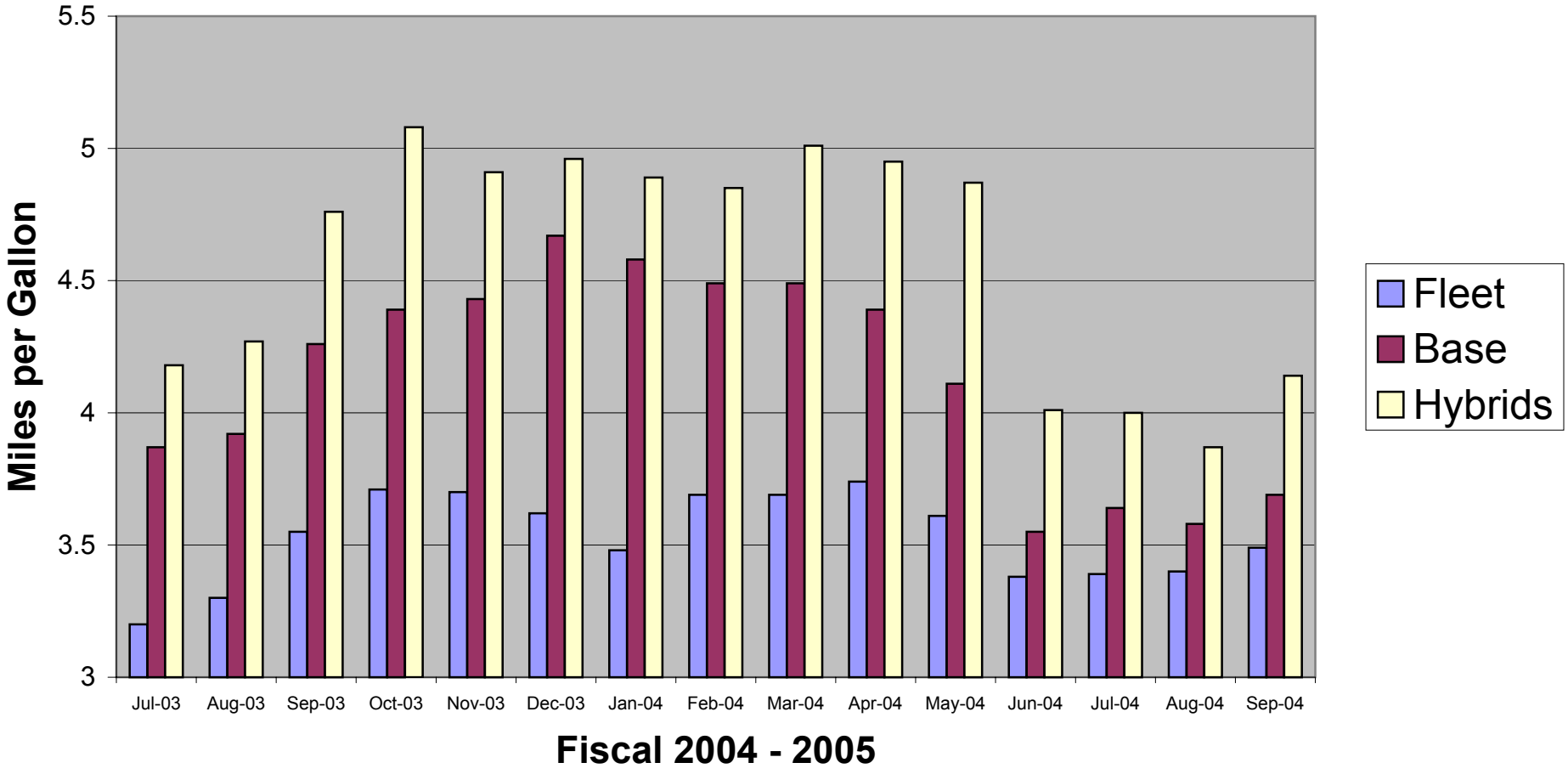
CTTRANSIT
H301 and 201 BUS TEST DATA
September, 2004

			H301						201						
	NOON														% MPG
DATE	TEMP.	CONDITIONS	RUN NO.	BLOCK #	BADGE #	FUEL	MILES	MPG	RUN NO.	BLOCK#	BADGE #	FUEL	MILES	MPG	CHANGE
9/1/2004	80°	Clear	34/1	501	1926/1962	23.2	104	4.48	20/27	105/303	1927/1975	24.8	82	3.31	35.58%
9/2/2004	78°	Cloudy	13/40	102/306	1953/1901	18.2	81	4.45	24/12	504	1966/1907	45.9	146	3.18	39.92%
9/3/2004	80°	Clear	22	109	1980	12	52	4.33	14	113	1943	48.1	211	4.39	-1.22%
9/4/2004	79°	Clear													
9/5/2004															
9/6/2004															
9/7/2004	82°	Rain	22/6	511	1922/1963	33.6	137	4.08	22	109	1963	67	281	4.19	-2.78%
9/8/2004	79°	Clear	14	113	1974	40.7	177	4.35	18/5	510	1914/1923	37.8	132	3.49	24.54%
9/9/2004	82°	Cloudy	42	101	1957	8.1	36	4.44	45/14/25	503	1951/1974/1920	41.8	142	3.40	30.83%
9/10/2004	80°	Cloudy	13/44	102/S202	1953/1929	23.2	94	4.05	31	507	1960	56.9	193	3.39	19.45%
9/11/2004	77°	Rain							21/804	503	1943/1984	58	249	4.29	
9/12/2004															
9/13/2004	84°	Clear	30/2	502	1933/1921	44.4	179	4.03	19/43	104/H201	1904/1948	22	65	2.95	36.45%
9/14/2004	81°	Clear	24/12	504	1966/1907	30.3	140	4.62	34/1	501	1926/1962	54.5	173	3.17	45.56%
9/15/2004	79°	Cloudy	24/12	504	1966/1907	31.2	144	4.62							
9/16/2004	80°	Clear	43	S101	1948	11.2	50	4.46	40	306	1901	11.4	37	3.25	37.55%
9/17/2004	76°	Cloudy	22/6	511	1922/1963	33.2	137	4.13	40	306	1901	20.4	72	3.53	16.92%
9/18/2004	75°	Rain							805/802	505	1982/1927	41.6	158	3.80	
9/19/2004															
9/20/2004	80°	Cloudy	34/1	501	1926/1962	41.8	170	4.07	35/4	509	1912/1937	57.7	205	3.55	14.47%
9/21/2004	84°	Clear	24/12	504	1966/1907	32.8	144	4.39	18/5	510	1914/1980	36.6	132	3.61	21.73%
9/22/2004	74°	Rain	24/12	504	1966/1907	33.8	145	4.29	35/4	509	1912/1937	61.1	207	3.39	26.63%
9/23/2004	78°	Cloudy	24/12	504	1966/1907	36	147	4.08	Tripper			24.3	94	3.87	5.56%
9/24/2004	77°	Clear	23/43	111/H101	1956/1948	17.3	73	4.22	34/1	501	1926/1962	55	173	3.15	34.15%
9/25/2004	75°	Rain													
9/26/2004	77°	Cloudy							28/803	506	1947/1979	50.1	163	3.25	
9/27/2004	76°	Clear	34/1	501	1926/1962	41.4	180	4.35	Tripper			24.2	104	4.30	1.17%
9/28/2004	74°	Clear	40	CCE1	1901	13.3	60	4.51	14	113	1974	18.2	69	3.79	18.99%
9/29/2004	77°	Cloudy	22/6	511	1922/1963	29.3	132	4.51	13/29	102/304	1953/1965	37.9	157	4.14	8.75%
9/30/2004	75°	Clear	43/40	S101/306	1948/1901	17.3	78	4.51	15	301	1977	41.5	161	3.88	16.22%
Totals						572.3	2460.0	4.30				936.8	3406.0	3.64	18.23%

CTTRANSIT
H302 and 202 BUS TEST DATA
SEPTEMBER, 2004

			H302						202						
	NOON														% MPG
DATE	TEMP.	CONDITIONS	RUN NO.	BLOCK #	BADGE #	FUEL	MILES	MPG	RUN NO.	BLOCK#	BADGE #	FUEL	MILES	MPG	CHANGE
9/1/2004	80°	Clear	43	H101	1946	46.3	195	4.21	18/6	510	1914/1923	40.2	132	3.28	28.26%
9/2/2004	78°	Cloudy	30/2	502	1933/1921	40.4	148	3.66	21	107	1971	18.3	64	3.50	4.75%
9/3/2004	80°	Clear	24/12	504	1921/1907	36.7	144	3.92	50/27	CC2/303	1931/1982	47.8	163	3.41	15.06%
9/4/2004	79°	Clear							27/17	504	1975/1906	51.9	172	3.31	
9/5/2004															
9/6/2004															
9/7/2004	82°	Rain	34/1	501	1926/1962	47.8	174	3.64	50/45	CC2/F101	1959/1951	18.2	90	4.95	-26.39%
9/8/2004	79°	Clear	19/43	104/H101	1904/1948	18.9	66	3.49	13	102	1953	14.3	52	3.64	-3.97%
9/9/2004	82°	Cloudy	13/43	102/H101	1953/1931	19.9	83	4.17	18/5	510	1914/1923	16.2	64	3.95	5.57%
9/10/2004	80°	Cloudy	22/10	511	1922/1963	35.1	132	3.76	43	S101	1948	23.3	87	3.73	0.72%
9/11/2004	77°	Rain							26/17	504	1976/1931	50.3	175	3.48	
9/12/2004															
9/13/2004	84°	Clear	44	S202	1968	17.3	63	3.64	41/11	506	1935/1927	45.1	156	3.46	5.28%
9/14/2004	81°	Clear	14/40	113/306	1974/1901	15.4	70	4.55	32/7	513	1928/1946	48	171	3.56	27.59%
9/15/2004	79°	Cloudy	Tripper			31.8	144	4.53	32/7	513	1928/1946	49.7	176	3.54	27.87%
9/16/2004	80°	Clear	13	102	1953	13.1	53	4.05							
9/17/2004	76°	Cloudy	43	S101	1948	36.9	143	3.88							
9/18/2004	75°	Rain													
9/19/2004															
9/20/2004	80°	Cloudy	19/44	104/S202	1904/1968	20.1	75	3.73							
9/21/2004	84°	Clear	22/6	511	1922/1946	31.9	123	3.86							
9/22/2004	74°	Rain	22/6	511	1922/1946	35.2	151	4.29	Tripper			68.3	326	4.77	-10.13%
9/23/2004	78°	Cloudy	22/6	511	1922/1984	34.8	135	3.88	32/7	513	1928/1913	47.4	175	3.69	5.07%
9/24/2004	77°	Clear	43/40	H101/306	1948/1901	19.3	81	4.20	35/4	509	1912/1937	55.4	201	3.63	15.68%
9/25/2004	75°	Rain							902	IO1	1907/1904	47.7	197	4.13	
9/26/2004	77°	Cloudy													
9/27/2004	76°	Clear	30/2	502	1933/1921	37.9	164	4.33	17/43	F102/H101	1982/1948	20.4	71	3.48	24.33%
9/28/2004	74°	Clear	20/44	105/S202	1961/1968	14.2	56	3.94	21/10	519	1917/1971	40	174	4.35	-9.34%
9/29/2004	77°	Cloudy	24/12	504	1966/1907	31.2	137	4.39							
9/30/2004	75°	Clear	40	CC1	1901	7.2	26	3.61	38	305	1938	8.3	29	3.49	3.35%
Totals						591.4	2,363.0	4.00				710.8	2,675.0	3.76	6.17%

CTTRANSIT BUS FUEL ECONOMY



Bus Type	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	Apr-04	May-04	Jun-04	Jul-04	Aug-04	Sep-04
Fleet	3.2	3.3	3.55	3.71	3.7	3.62	3.48	3.69	3.69	3.74	3.61	3.38	3.39	3.4	3.49
Base	3.87	3.92	4.26	4.39	4.43	4.67	4.58	4.49	4.49	4.39	4.11	3.55	3.64	3.58	3.69
Hybrids	4.18	4.27	4.76	5.08	4.91	4.96	4.89	4.85	5.01	4.95	4.87	4.01	4.00	3.87	4.14

CT TRANSIT

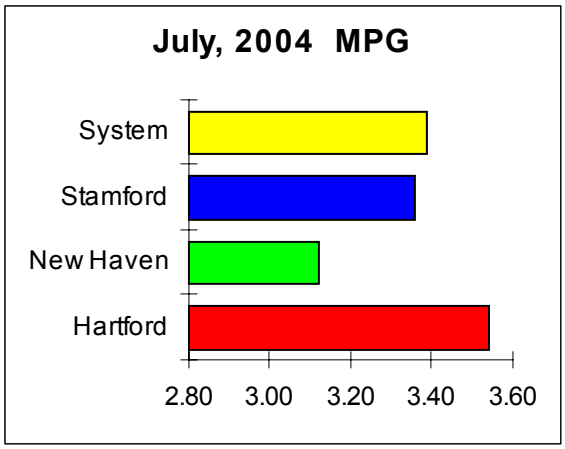
FLEET MILES & MILES PER GALLON
JULY, 2004

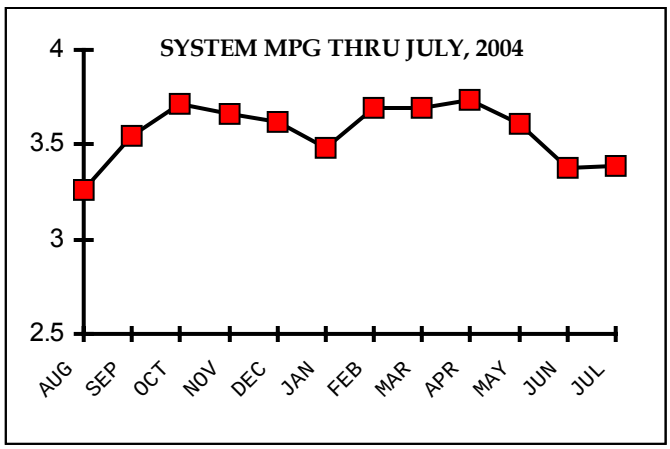
HARTFORD DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make & Series	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
MCI 911-915 & 9001-9200	23	20,796	6,710	3.10	139,994	44,939	3.12	-119,198	-38,229	-0.02
NFI 6V92 9301-9338	38	59,966	20,326	2.95	86,821	30,293	2.87	-26,855	-9,967	0.08
NFI S-50 9339-9340 & 9401-9428	30	63,066	17,193	3.67	86,482	23,086	3.75	-23,416	-5,893	-0.08
NFI S-50 941-965	25	43,581	9,463	4.61	56,185	11,266	4.99	-12,604	-1,803	-0.38
NOVA 1121 9637-9647	13	26,535	7,954	3.34	40,093	11,397	3.52	-13,558	-3,443	-0.18
NFI S-40 201-240	40	135,382	37,547	3.61	183,234	46,921	3.91	-47,852	-9,374	-0.30
MCI Commuter 303-309	7	23,702	5,612	4.22	N/A	N/A	N/A	N/A	N/A	N/A
NFI S-50 310-324, 401-441	56	208,736	59,393	3.51	N/A	N/A	N/A	N/A	N/A	N/A
Hartford Totals	232	581,764	164,198	3.54	592,809	167,902	3.53	-243,483	-68,709	0.01

NEW HAVEN DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make & Series	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NOVA 1121 9601-9623, 9626	24	54,699	17,668	3.10	72,058	23,102	3.12	-17,359	-5,434	-0.02
NFI S-50 330-371 451-492	84	225,529	72,167	3.13	N/A	N/A	N/A	N/A	N/A	N/A
New Haven Totals	108	280,228	89,835	3.12	72,058	23,102	3.12	208,170	66,733	0.00

STAMFORD DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make & Series	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NOVA 1121 9626-9636	10	22,490	7,242	3.11	25,736	8,231	3.13	-3,246	-989	-0.02
ElDorado 9904-9913	11	11,302	3,201	3.53	7,415	2,367	3.13	3,887	834	0.40
NFI S-40 101-126	26	63,714	19,701	3.23	71,979	21,603	3.33	-8,265	-1,902	-0.10
NFI S-40 127-132	6	22,339	5,682	3.93	24,839	5,950	4.17	-2,500	-268	-0.24
NFI Hybrid H301 & H302	2	2,838	710	4.00	8,329	2,001	4.16	-5,491	-1,291	-0.17
Stamford Totals	55	122,683	36536	3.36	138,298	40,152	3.44	-15,615	-3,616	-0.09

SYSTEM		*Current Month*			*Prior Year Month*			*Difference*		
Make	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
All buses	395	984,675	290,569	3.39	803,165	231,156	3.47	181,510	59,413	-0.09





CT TRANSIT

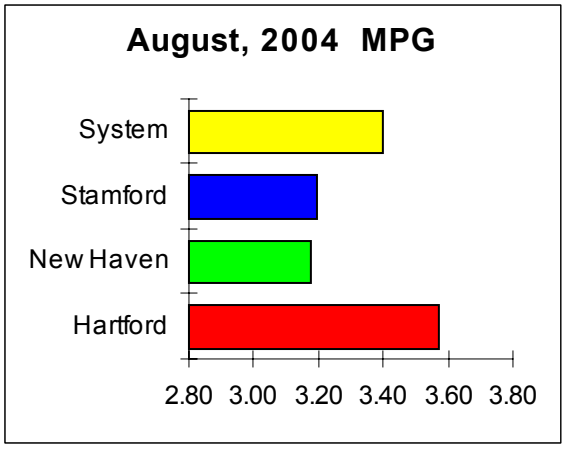
FLEET MILES & MILES PER GALLON
AUGUST, 2004

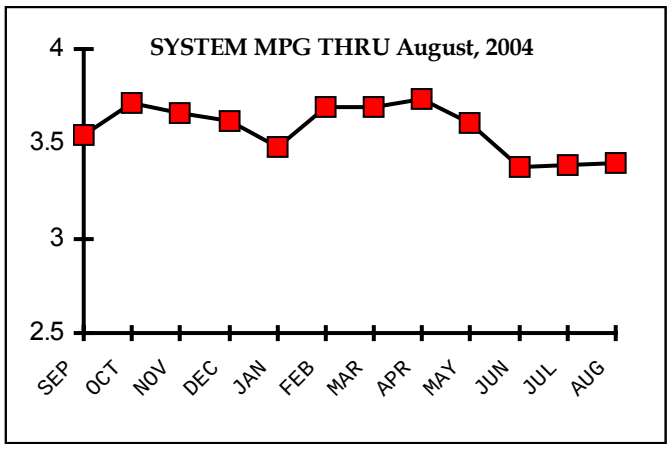
HARTFORD DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make & Series	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
MCI 911-915 & 9001-9200	23	23,743	7,626	3.11	131,949	43,452	3.04	-108,206	-35,826	0.08
NFI 6V92 9301-9338	38	66,481	21,668	3.07	89,820	31,590	2.84	-23,339	-9,922	0.22
NFI S-50 9339-9340 & 9401-9428	30	58,690	16,422	3.57	73,488	19,648	3.74	-14,798	-3,226	-0.17
NFI S-50 941-965	25	44,223	9,280	4.77	50,379	10,380	4.85	-6,156	-1,100	-0.09
NOVA 1121 9637-9647	13	28,217	8,068	3.50	31,261	8,799	3.55	-3,044	-731	-0.06
NFI S-40 201-240	40	128,384	35,230	3.64	181,630	47,099	3.86	-53,246	-11,869	-0.21
MCI Commuter 303-309	7	25,808	6,077	4.25	12,971	3,161	4.10	12,837	2,916	0.14
NFI S-50 310-324, 401-441	56	214,445	60,809	3.53	N/A	N/A	N/A	N/A	N/A	N/A
Hartford Totals	232	589,991	165,180	3.57	571,498	164,129	3.48	-195,952	-59,758	0.09

NEW HAVEN DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make & Series	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NOVA 1121 9601-9623, 9626	24	51,547	16,767	3.07	77,493	24,712	3.14	-25,946	-7,945	-0.06
NFI S-50 330-371 451-492	84	232,969	72,729	3.20	N/A	N/A	N/A	N/A	N/A	N/A
New Haven Totals	108	284,516	89,496	3.18	77,493	24,712	3.14	207,023	64,784	0.04

STAMFORD DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make & Series	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NOVA 1121 9626-9636	10	21,315	6,802	3.13	35,347	11,849	2.98	-14,032	-5,047	0.15
ElDorado 9904-9913	11	11,992	5,368	2.23	7,963	2,510	3.17	4,029	2,858	-0.94
NFI S-40 101-126	26	69,324	21,269	3.26	66,678	20,536	3.25	2,646	733	0.01
NFI S-40 127-132	6	20,562	5,327	3.86	22,194	5,195	4.27	-1,632	132	-0.41
NFI Hybrid H301 & H302	2	4,081	1,056	3.86	8,737	2,015	4.34	-4,656	-959	-0.47
Stamford Totals	55	127,274	39822	3.20	140,919	42,105	3.35	-13,645	-2,283	-0.15

SYSTEM		*Current Month*			*Prior Year Month*			*Difference*		
Make	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
All buses	395	1,001,781	294,498	3.40	789,910	230,946	3.42	211,871	63,552	-0.02





CT TRANSIT

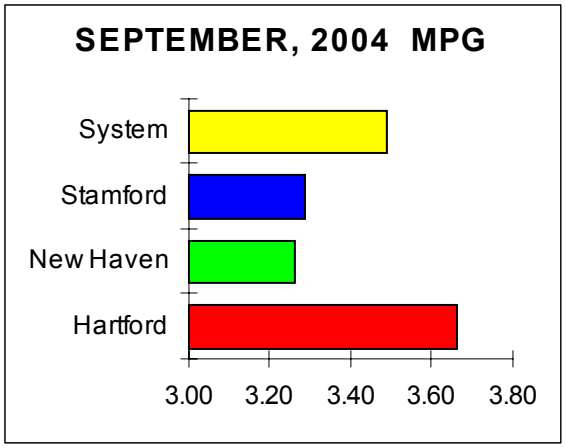
FLEET MILES & MILES PER GALLON
SEPTEMBER, 2004

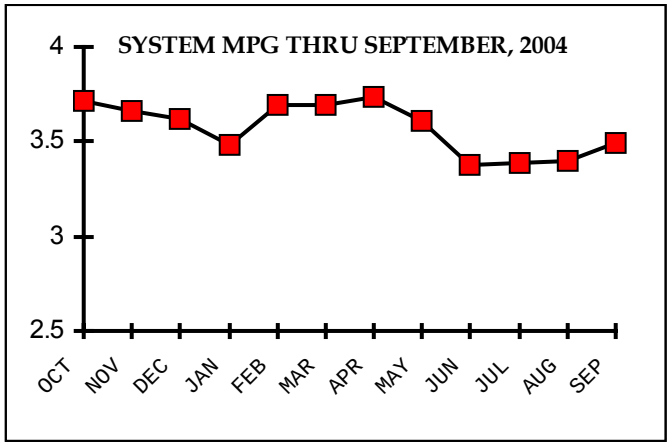
HARTFORD DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make & Series	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
MCI 911-915 & 9001-9200	23	25,494	7,678	3.32	135,985	41,812	3.25	-110,491	-34,134	0.07
NFI 6V92 9301-9338	38	59,789	19,711	3.03	84,944	28,138	3.02	-25,155	-8,427	0.01
NFI S-50 9339-9340 & 9401-9428	30	61,687	16,426	3.76	76,705	19,473	3.94	-15,018	-3,047	-0.18
NFI S-50 941-965	25	44,213	8,878	4.98	51,192	9,892	5.18	-6,979	-1,014	-0.20
NOVA 1121 9637-9647	13	28,058	8,082	3.47	31,809	8,226	3.87	-3,751	-144	-0.40
NFI S-40 201-240	40	112,522	30,101	3.74	168,989	39,346	4.29	-56,467	-9,245	-0.56
MCI Commuter 303-309	7	22,364	5,218	4.29	17,760	3,940	4.51	4,604	1,278	-0.22
NFI S-50 310-324, 401-441	56	212,073	58,475	3.63	N/A	N/A	N/A	N/A	N/A	N/A
Hartford Totals	232	566,200	154,569	3.66	567,384	150,827	3.76	-213,257	-54,733	-0.10

NEW HAVEN DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make & Series	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NOVA 1121 9601-9623, 9626	24	52,683	16,583	3.18	66,293	19,547	3.39	-13,610	-2,964	-0.21
NFI S-50 330-371 451-492	84	222,890	67,855	3.28	N/A	N/A	N/A	N/A	N/A	N/A
New Haven Totals	108	275,573	84,438	3.26	66,293	19,547	3.39	209,280	64,891	-0.13

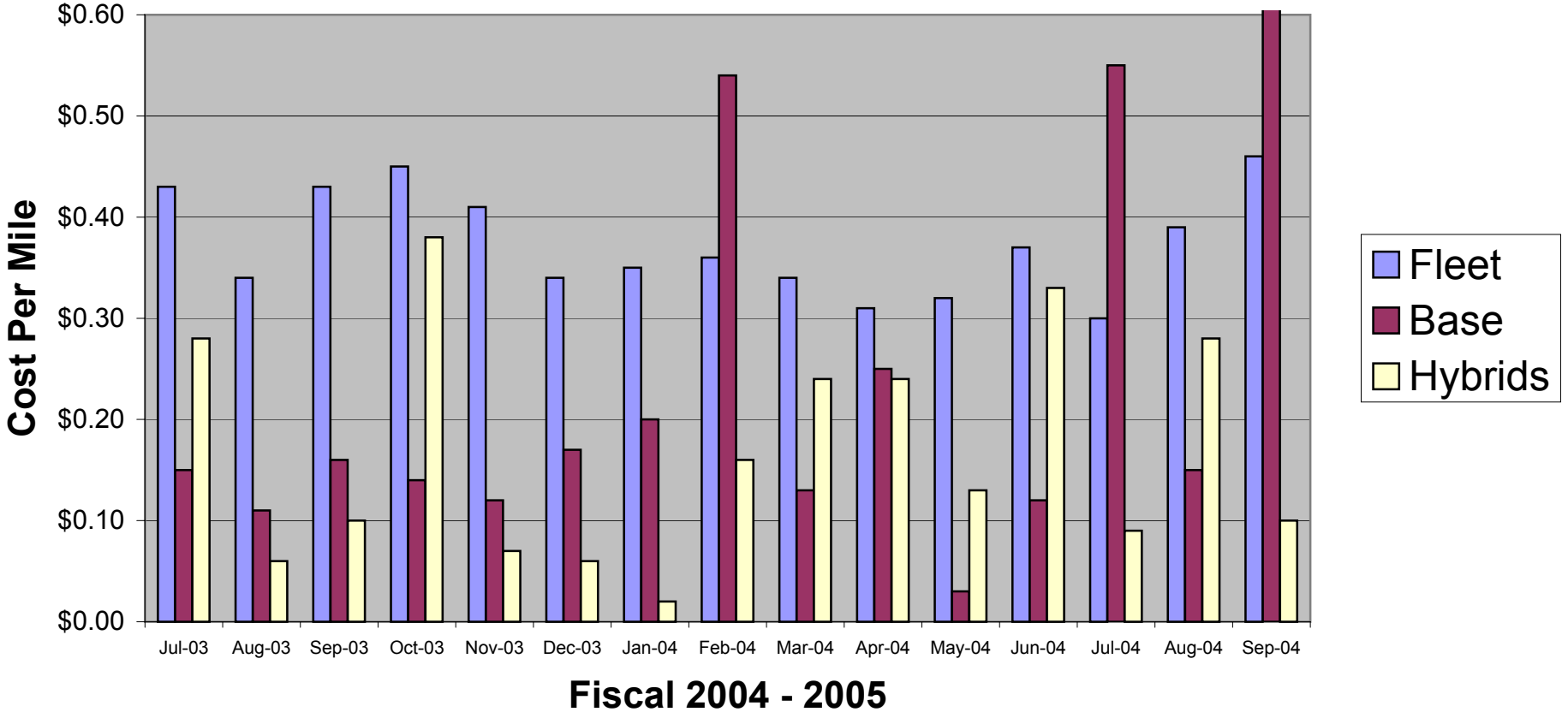
STAMFORD DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make & Series	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NOVA 1121 9626-9636	10	23,746	7,092	3.35	33,640	9,551	3.52	-9,894	-2,459	-0.17
ElDorado 9904-9913	11	10,660	5,272	2.02	7,537	2,237	3.37	3,123	3,035	-1.35
NFI S-40 101-126	26	65,340	19,386	3.37	66,912	19,263	3.47	-1,572	123	-0.10
NFI S-40 127-132	6	18,209	4,443	4.10	23,317	5,129	4.55	-5,108	-686	-0.45
NFI Hybrid H301 & H302	2	4,823	1,164	4.14	8,058	1,694	4.76	-3,235	-530	-0.61
Stamford Totals	55	122,778	37,357	3.29	139,464	37,874	3.68	-16,686	-517	-0.40

SYSTEM		*Current Month*			*Prior Year Month*			*Difference*		
Make	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
All buses	395	964,551	276,364	3.49	773,141	208,248	3.71	191,410	68,116	-0.22



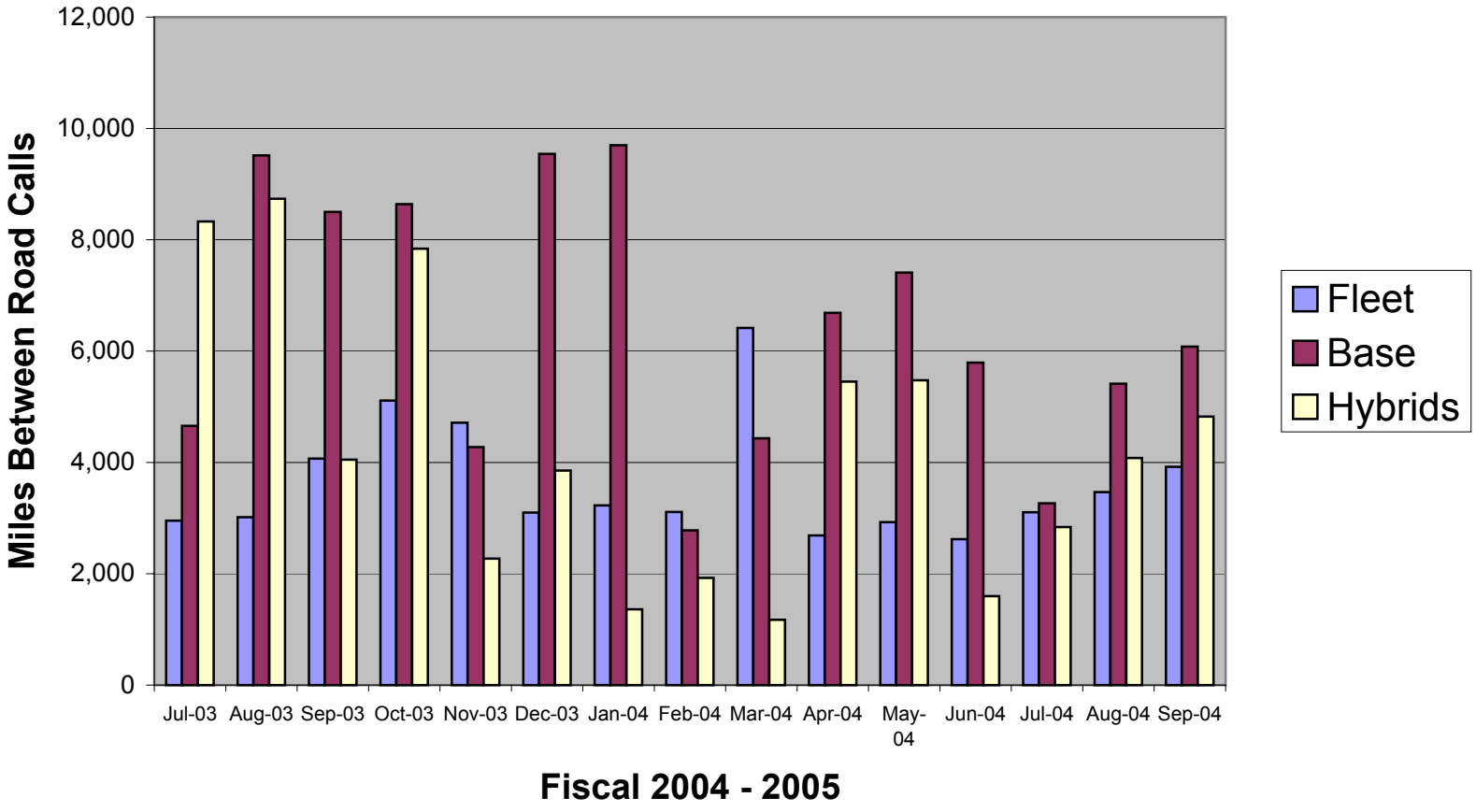


CTTRANSIT BUS MAINTENANCE
COST PER MILE



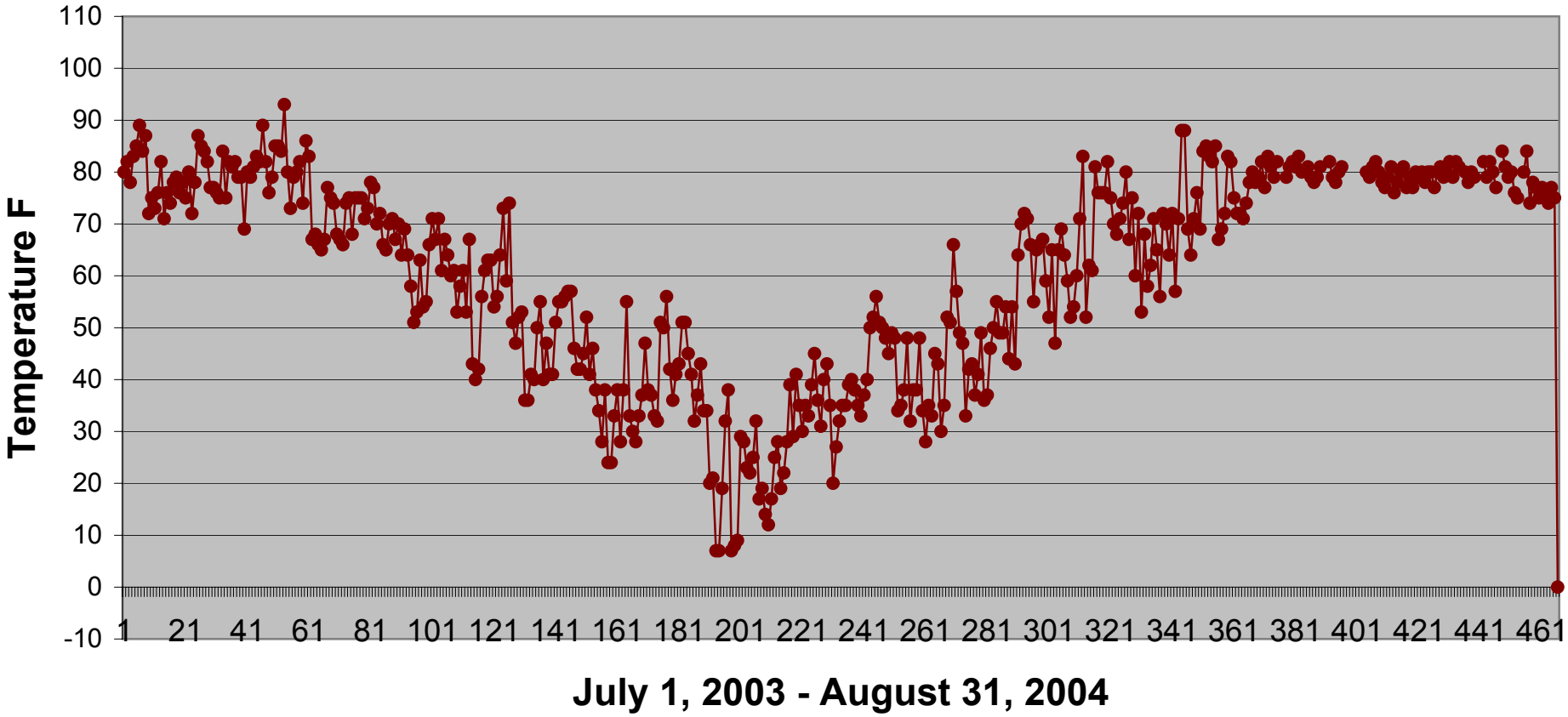
Bus Type	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	Apr-04	May-04	Jun-04	Jul-04	Aug-04	Sep-04
Fleet	0.43	0.34	0.43	0.45	0.41	0.34	0.35	0.36	0.34	0.31	0.32	0.37	0.30	0.39	0.46
Base	0.15	0.11	0.16	0.14	0.12	0.17	0.2	0.54	0.13	0.25	0.03	0.12	0.55	0.15	1.24
Hybrids	0.28	0.06	0.10	0.38	0.07	0.06	0.02	0.16	0.24	0.24	0.13	0.33	0.09	0.28	0.1

CTTRANSIT BUS
MILES BETWEEN ROAD CALLS



Bus Typ	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	Apr-04	May-04	Jun-04	Jul-04	Aug-04	Sep-04
Fleet	2955	3016	4068	5110	4713	3100	3229	3110	6416	2689	2928	2622	3106	3466	3920.9
Base	4656	9515	8501	8640	4276	9543	9699	2780	4435	6688	7410	5794	3265	5414	6081
Hybrids	8329	8737	4051	7840	2271	3854	1362	1926	1175	5453	5477	1597	2838	4081	4823

HYBRID BUS DAILY NOON
IN-SERVICE FIELD TEMPERATURE



WO	Task	Asset Part Number	Asset Description / Task Description/Work Done	Opened	Closed	Hours	Labor Cost	Parts Cost	Equip Cost	Vend Cost
Asset		301	New Flyer Hybrid Bus							
0420352	1	301	New Flyer Hybrid Bus e inspection	09/16/04	09/16/04	2.50	55.20	0.00	0.00	0.00
			e inspection							
0420344	1	301	New Flyer Hybrid Bus remove muffler install crt.	09/16/04	09/16/04	3.33	69.40	118.34	0.00	0.00
			above task completed.							
0417205	1	301	New Flyer Hybrid Bus missing bike rack.	08/14/04	08/14/04	2.17	45.22	0.00	0.00	0.00
			installed bike rack, applied locktite to 4ea. bolts through bumper inserts also used locknuts on those bolts.							
0414580	1	301	New Flyer Hybrid Bus Road call; no start.	07/16/04	07/16/04	11.00	240.61	0.00	0.00	0.00
			Towed bus in. Pulled axles. installed axles and gear grease and clean up at intermodel							
0421279	1	301	New Flyer Hybrid Bus Check Engine light on	09/27/04	09/27/04	0.00	0.00	0.00	0.00	0.00
			Replace 4089662RX Fuel pump Actuator Invoice # 010-32870							
0421212	1	301	New Flyer Hybrid Bus Weekly report.	09/25/04	09/25/04	1.50	32.90	0.00	0.00	0.00
			Make weekly report, clear code 65-13, roadtest.							
0419701	1	301	New Flyer Hybrid Bus door defect	09/09/04	09/09/04	0.50	11.04	0.00	0.00	0.00
			exchange with 122 at intermodel and return to garage							
0418523	1	301	New Flyer Hybrid Bus Weekly performance report	08/28/04	08/28/04	1.00	21.93	0.00	0.00	0.00
			Weekly report							
0418519	1	301	New Flyer Hybrid Bus B inspection	08/28/04	08/28/04	1.00	21.38	51.52	0.00	0.00

WO	Task	Asset Part Number	Asset Description / Task Description/Work Done	Opened	Closed	Hours	Labor Cost	Parts Cost	Equip Cost	Vend Cost
			Complete B inspection							
0417913	1	301	New Flyer Hybrid Bus Weekly report	08/21/04	08/21/04	1.00	21.93	0.00	0.00	0.00
			Check codes, make report.							
0416337	1	301	New Flyer Hybrid Bus e inspection	08/06/04	08/06/04	3.67	76.48	0.00	0.00	0.00
			e completed, secured boot at mirror harness, fuel leak at water sensor and rear tires rri and rro n.g. noted on work order and told supervisor.							
0413445	1	301	New Flyer Hybrid Bus a inspection	07/03/04	07/03/04	1.20	25.01	0.00	0.00	0.00
			a completed, reset temp gauge, corrected front nipple situation, clean and tightened p/s fitting at reservior.							
0414194	1	301	New Flyer Hybrid Bus Assist ATD service with update	07/13/04	07/13/04	0.00	0.00	0.00	0.00	0.00
			assist Jeff Evertt with ATD Update							
Asset		301	New Flyer Hybrid Bus	Subtotal -->		28.87	621.10	169.86	0.00	0.00

WO	Task	Asset Part Number	Asset Description / Task Description/Work Done	Opened	Closed	Hours	Labor Cost	Parts Cost	Equip Cost	Vend Cost
Asset		302	New Flyer Hybrid Bus							
0417198	1	302	New Flyer Hybrid Bus missing bike rack.	08/14/04	08/14/04	2.00	41.68	0.00	0.00	0.00
			installed bike rack, applied locktite to 4ea. bolts through bumper inserts, also used locknuts on those bolts.							
0417533	1	302	New Flyer Hybrid Bus Rear door defect	08/18/04	08/18/04	1.00	21.93	0.00	0.00	0.00
			Check rear door operation, no problem found.							
0421366	1	302	New Flyer Hybrid Bus lite defect	09/27/04	09/27/04	0.25	5.52	0.00	0.00	0.00
			r/r lite							
0420342	1	302	New Flyer Hybrid Bus replace CRT	09/16/04	09/16/04	3.50	74.83	10.35	0.00	0.00
			replaced CRT							
0421213	1	302	New Flyer Hybrid Bus Make weekly report	09/25/04	09/25/04	1.00	21.93	0.00	0.00	0.00
			Make weekly report							
0420369	1	302	New Flyer Hybrid Bus A inspection	09/16/04	09/16/04	2.00	40.32	0.00	0.00	0.00
			Perform a inspection							
0419250	1	302	New Flyer Hybrid Bus Weekly AED report	09/04/04	09/04/04	2.00	43.86	0.00	0.00	0.00
			Generate and e-mail weekly AED report. Road test to compare w/301's rolling back in drive problem.							
0418524	1	302	New Flyer Hybrid Bus Weekly performance report	08/28/04	08/28/04	1.00	21.93	0.00	0.00	0.00
			Weekly report							
0418521	1	302	New Flyer Hybrid Bus E inspection	08/28/04	08/28/04	1.00	21.38	0.00	0.00	0.00

WO	Task	Asset Part Number	Asset Description Task Description/Work Done	Opened	Closed	Hours	Labor Cost	Parts Cost	Equip Cost	Vend Cost
			Complete E inspection							
0417914	1	302	New Flyer Hybrid Bus Weekly report.	08/21/04	08/21/04	1.00	21.93	0.00	0.00	0.00
			Check codes, Make report.							
0416371	1	302	New Flyer Hybrid Bus B inspection	08/06/04	08/06/04	21.00	448.98	72.67	0.00	0.00
			B inspection							
0416152	1	302	New Flyer Hybrid Bus fire ext defect	08/04/04	08/04/04	0.25	5.52	25.75	0.00	0.00
			r/r fire ext							
0414192	1	302	New Flyer Hybrid Bus Assist ATD service with updates	07/13/04	07/13/04	0.00	0.00	0.00	0.00	0.00
			Travel to customers location Assist Jeff Evertt with update							
Asset		302	New Flyer Hybrid Bus	Subtotal -->		36.00	769.81	108.77	0.00	0.00
				Grand Total -->		64.87	1390.91	278.63	0.00	0.00

CTTRANSIT Hybrid Bus Trouble Codes

Date	H301	H302	Notes
7/14/2003	D1=7319=Inverter A Can link from TCM lost	All clear	No service disruption - transparent to user
	D2=7419=Inverter B Can link from TCM lost		
	D3=6618=Can link lost with Inverter A		
7/15/2003	All clear	All clear	Follow-up check
7/21/2003	All clear	D1=6624=Can link lost with Battery Controller	No service disruption - transparent to user
		D2=6619=Can link lost with Inverter B	
7/29/2003	All clear	All clear	Follow-up check
8/4/2003	All clear	D1=6624=Can link lost with Battery Controller	No service disruption - transparent to user
8/13/2003	All clear	D1s19=Inverter A Can link from TCM lost	No service disruption - transparent to user
		D2t19=Inverter B Can link from TCM lost	
		D3f19=Can link lost with Inverter B	
8/25/2003	All clear	All clear	Follow-up check
9/2/2003	All clear	All clear	Follow-up check
9/7/2003	D1=8002=High Voltage Discharge Fault	All clear	H301 Shut down and was flat bedded in. The system was checked and rest at the garage. A road test by a Technician noted a momentary loss of power on a 4.5 5 degree ramp @ 35mph. System reset on own and the problem cleared and could not be replicated. Bus was returned to service operating OK.
	D2=7491=Inverter B Isolation Fault-Shutdown		
	D3=7391=Inverter A Isolation Fault-Shutdown		
	D4=7390=Inverter A Isolation Fault-Caution		
	D5=7490=Inverter B Isolation Fault-Caution		
	D6=6618 Can Link Lost with Inverter A		
9/9/2003	All clear	All clear	Follow-up check
09/15/2003 AM	All clear	All clear	Follow-up check
09/15/2003 PM	D1=8002 = High Voltage Discharge Fault		System failed light on the dash this afternoon. The following codes were logged in the transmission keypad. The bus was driven back under its own power, but the dash switched was cycled numerous times. The road call mechanic did not detect any fault, defect or reduced power situation.
	D2=7391 = Inverter B Isolation Fault-Shutdown		
	D3=7491 = Inverter A Isolation Fault-Shutdown		
	D4=7390 = Inverter A Isolation Fault-Caution		
	D5=7490 = Inverter B Isolation Fault-Caution		

CTTRANSIT Hybrid Bus Trouble Codes

Date	H301	H302	Notes
9/25/2003	All clear	D1=6634= Can Link lost with eng. Controller, long time out	These codes had no adverse affect on the bus operation
		D2=2312=Push Button Shift Selector	
10/6/2003	All clear	No Code But Note	Indicated transmission fluid was one quart over. It has been found that the two minute waiting period for a cold bus check is insufficient. Up to 5 minutes or a drive around the facility will set the bus for proper level check. The dipstick is not considered as accurate as the electronic level sensor per Allison.
10/6/2003	All clear	D1=6634= Can Link lost with eng. Controller, long time out	These codes had no adverse affect on the bus operation
		D2=2312=Push Button Shift Selector	
11/3/2003	OL Hi 01qt.	D1=2815=Clutch 1 pressure failed on shutdown	
		D2=5615=Range2 verification-disabled clutch	
		D3=5614=Range2 verification-limit transmission output torque	
		D4=8132=Motor B overspeed - warning	
		D5=7421=inverter B Motor overspeed	
		D6=5613=range 1 verification - disable clutch	
		D7=5612=range1 verification-limit transmission output torque	
		D8=2816=No code info	
11/11/2003	D1 = Engine Torque Verification= stop system	D1-2816 = There is no listing	Cummins injection control valve found to be faulty
	C276 = High current detected	D2-5614=Range 2 verification-Limit Transmission Output Torque	
	C277=failure in the injection control valve	D3-5613=Range 1 verification - Disable Clutch	
	C449=fuel pressure exceeded maximum	D4-5612=Range 1 Verification - Limit Transmission Output Torque	
	C456= fuel pressure accumulator not changing	D5-5615=Range 2 Verification - Disabled Clutch	
		D2-2815=Clutch 1 pressure failed on Shutdown	
		D8-2916 = there is no listing	
11/13/2003	D1 = 2312 = pushbutton shift selector	All Clear	2312 is usually generated by switching off power to the transmission keypad only, while power is still applied to the system. It is a Cummins engine issue.
11/24/2003	D1 = 6523 = Enginge Torque Verification	D1 = 6634 = Can link lost	No adverse bus operations

CTTRANSIT Hybrid Bus Trouble Codes

Date	H301	H302	Notes
12/1/2003	All Clear	D1=6634	Not cleared from previous week
12/8/2003	D1=2312 Push button shift selector	D1=7605 Battery State of Charge Low Warning	No adverse bus operations
	D2=6523 Engine torque verification	D2=6634 Can link lost with engine controller	
		D3=7452 Inverter B, AC current invalid	
		D4=6523 Engine torque verification	
12/14/2003	All Clear	D1=7605 Battery Stte of Charge Low - Warning	No adverse bus operations
		D2=6634 Can Link lost with engine controller	
		D3=7452 Inverter B, AC current invalid	
		D4=6523 Engine torque verification	
12/31/2003	D1=7014 Controller Watchdog timeout TCM	D1=6618 Can link lost with Inverter A	No adverse bus operations
	D2=6513 Engine Controller Warning	D2=Can link lost with Inverter B	
		D3=Can link lost with Engine Controller	
		D4= Can link lost with Vehicle Controller	
		D5=6513 Engine controller warning	
		D6=7319 Inverter A CAN link with TCM lost	
		D7=7419 Inverter B CAN link with TCM lost	
		D8=6629 Can link lost with Minor Engine Messages	
1/5/2004	All Clear	All Clear	
1/12/2004	All Clear	All Clear	
1/19/2004	All Clear	All Clear	
1/25/2004	6513=Engine Controller warning	7421=Inverter B motor overspeed	
	5614=Range 2 verification- limit Transmission output torque	7435=Inverter B primary encoder signal lost	
	5612= Range 1 verification- limit transmission output torque		
	2815= Clutch 1 pressure failed on shutdown		
	2816= Clutch 1 pressure switch failed off		

CTTRANSIT Hybrid Bus Trouble Codes

Date	H301	H302	Notes
2/2/2004	Oil Cooler Failure had these codes	Pac Brake/Exhaust Brake Pivot Failure Codes	
	5614=Range 2 verification- limit Transmission output torque	7604=Battery State of Charge Low Caution	
	5613= Range 1 verification- disable clutch	7452=Inverter B AC current invalid	
	5612= Range 1 verification- limit transmission output torque	6513=engine controller warning	
	2815= Clutch 1 pressure failed on shutdown	6628=can link lost with electronic brake controller	
	2816= no code listed	7421=inverter B motor overspeed	
	5615= Range 2 verification- disable clutch	7435=inverter B primary encoder signal lost	
		7437=inverter B loss of both encoder signals	
		7438=inverter B secondary encoder signal lost	
		1718=inverter b can enable mismatch	
		1724=reported/calculated engine speed mismatch	
2/8/2004	All Clear	All Clear	
2/15/2004	All Clear	All Clear	
2/22/2004	All Clear	7421=inverter B motor overspeed	
		7435=inverter B primary encoder signal lost	
		7437=inverter B loss of both encoder signals	
		7438=inverter B secondary encoder signal lost	
		1718=inverter b can enable mismatch	
		8133=motor B overspeed shutdown	
2/29/2004	All Clear	All Clear	
3/7/2004	7604=battery state of charge low caution	All Clear	
	6513=engine controller warning		
	7605=battery state of charge low warning		
	7606=battery state of charge low shutdown		
3/14/2004	All Clear	All Clear	
3/21/2004	All Clear	6513=engine controller warning	
3/28/2004	All Clear	6513=engine controller warning	
4/4/2004	All Clear	All Clear	

CTTRANSIT Hybrid Bus Trouble Codes

Date	H301	H302	Notes
4/12/2004	7014=Controller Software Watchdog Timeout TCM	6513=engine controller warning	
	6513=engine controller warning		
	6629=Can Link Lost with Minor Engine Messages		
4/18/2004	6513= Engine Controller Warning	6513= Engine Controller Warning	H302 shutdown and road call - oil cooler problem
	1313=TCM Ignition Circuit Voltage Low - Cauti	2815= Clutch 1 pressure failed on shutdown	
		5612=Range 1 verification - limit transmission output torque	
		5614=Range 2 verification- limit Transmission output torque	
		5615= Range 2 verification- disable clutch	
		2816= Clutch 1 Pressure Switch Failed Off	
4/25/2004	All Clear	All Clear	
5/9/2004	6513 = Engine Controller Warning	All Clear	
6/30/2004	All Clear	7460=inverter B low voltage interrupt	H302 - Shutdown but started with reboot
7/24/2004	All Clear	All Clear	
8/21/2004	All Clear	All Clear	
8/28/2004	6513 = Engine Controller Warning	All Clear	
9/4/2004	All Clear	All Clear	
9/11/2004	All Clear	All Clear	
9/18/2004	All Clear	All Clear	
9/25/2004	6513 = Engine Controller Warning	All Clear	
10/2/2004	All Clear	78-91=Battery subpack current deviation high	No adverse operation and on reset code went away