Third Quarter
CTTRANSIT

Demonstration and Evaluation of Hybrid Diesel Electric Transit Buses

January, February & March 2004

Report No. CT-170-1884-3-04-5

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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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 and repair costs. Bus operator 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.

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

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Third Quarter
CTTRANSIT
Demonstration and Evaluation of
Hybrid Diesel Electric Transit Buses
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. Performance data collection began on July 1st 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. 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 our Bus Operators. A survey of the Bus Operators was conducted this quarter with results to be summarized next quarter. A passenger survey will also be conducted next quarter.
- The hybrids are in great demand for demonstrations by various groups and special events. The only downside has 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% 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 this quarter. Some emissions testing delays were experienced by very cold weather and snow conditions. Larry Oeler from the EPA observed emissions testing on February 25th and he commented that he was very impressed with our program.
- 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.
- To date we have been very pleased with our two hybrid buses reliability and performance. Although they had two road calls in December we note that they were fuel pump problems on the internal combustion engine and were not hybrid design related. We have had no battery problems at all and historically this area has been the biggest problem with electric drive design vehicles. We continue to be slightly disappointed with the vehicle fuel economy which although it is significantly better than a similar new diesel bus is not as high as we had hoped it would be.
- A copy of the SAE Report "The Influence of Idle, Drive Cycle and Accessories on the Fuel Economy of Urban Hybrid Electric Buses – Chassis Dynamometer Tests" was distributed to the Hybrid Bus Technical Advisory Committee.

Connecticut Transit Hybrid Bus Project
Gas Emissions
Progress Report
June 1, 2003 - March 31, 2004

Principal Investigator: *Baki Cetegen*

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:

Measurements have been performed in 3 different driving cycles:
1. Enfield commuter route: Highway driving cycle (34 miles)
2. Farmington avenue city route: City driving cycle (5.6 miles)
3. Avon mountain route driving cycle (8.2 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

Testing Schedule:

Testing has been performed on the following dates with the identified buses:
- Jan 06, 2004: Hybrid Bus 301
- Jan 07, 2004: Hybrid Bus 301
- Jan 21, 2004: Hybrid Bus 301
- Jan 23, 2004: Conventional Diesel Bus 201
- Jan 30, 2004: Conventional Diesel Bus 201
- Feb 11, 2004: Conventional Diesel Bus 202
- Feb 13, 2004: Conventional Diesel Bus 202
- Feb 18, 2004: Conventional Diesel Bus 202
- Feb 27, 2004: Hybrid Bus 302

Issues Encountered:

- Synchronization:
  - Multiple laptops for data gathering making the process of data synchronization difficult.
- Readings:
  - Negative Exhaust Flow Rate due to very low ambient temperatures (sub zero) and/or lack of Pitot Tube calibrations
  - NO_x analyzer set up to capture readings up to 1000 PPM which the measurements saturate at.
  - UHC negative readings due to lack of zero calibration
  - State of charge has not been verified due to difficult way of analyzing Allison's data
- Calibration:
  - Absence of NO_x sensor Calibration

Solutions Identified and Implemented:

- Synchronization:
  - As a way to synchronized the data we use several techniques:
    - Time synchronization of every laptop at the beginning of testing
    - Time measurement of every laptop in every driving cycle to identify possible delay times
    - Time measurements at a specific land marking or event (i.e. time at a specific street, time when turning on engine, etc.)
    - The use of an electric pulse going to each one of the laptops as an event mark has been suggested. We are still evaluating this option due to the inconvenience of sending this pulse to the engine laptops.
  - Currently we are trying to reduce the number of laptops used and data entry fields required.
- Readings:
  - Negative Exhaust Flow readings will be reduced implementing more Pitot Tube calibrations in our procedure. Also, it has been suggested to extend the length of the exhaust pipe to avoid effects of downstream pipe exit turbulence in the Pitot Tube readings, and to thermally insulate all the hoses connected to the Pitot tube to avoid water vapor condensation. These solutions are to be implemented in our next testing.
  - Settings of the NO_x analyzer was changed to read a maximum concentration of 3000 ppm
  - The number of zero calibrations has been increased in order to avoid HC negative readings. Also, Horiba has come and modified the system to increase the time required between zero calibrations.
  - CT transit has acquired current probes that will greatly simplify the acquisition of state of charge information. This equipment will be attached directly to Horiba system avoiding additional synchronization issues.
- Calibration:
  - The NO_x sensor calibration is implemented in the future tests. Calibration gases have been ordered and a new calibration procedure has been adopted (see attachment). This will be implemented in our next testing. Also, Horiba has calibrated our current NO_x sensor and provided a new one as backup.

Many of the solutions have been implemented as an ongoing process during the period of testing. A meeting was held on February 15, 2004 between Horiba, CT Transit and University of Connecticut as a way to check and verify the data gathered and to update our testing procedures. Additionally, a meeting was held at UConn among J. Warhola, B. Holmen, B. Cetegen and A. Chaparro to come up with the modified test and calibration procedures. The upcoming tests will implement these new procedures

ATTACHMENT: Zirconia Sensor Calibration Procedure

One day before testing:

Location: Room under normal air conditions (try to be as far away as possible of the garage fumes)

1. Measure and record current zero and span readings before any calibration is done.
2. Perform Zero and Span calibration using the bubbler (refer to Mexa-720 NO_x analyzer Instruction Manual page 7)

Day of testing:

Location: Bus parked outside of garage

1. Warm up Mexa-720 NO_x analyzer system (3 minutes).
2. Start measuring and recording NO_x readings (2 minutes).
   - 2.1. If readings are higher than a certain ppm value (50 ppm), the sensor will be taken out of the exhaust pipe and re-zeroed.
   - 2.2. If this yields unsatisfactory NO_x analyzer behavior (erratic and/or significantly varying readings based on our earlier good measurements, a full recalibration of the Nox sensor will be perormed.
3. Continue with bus testing.
4. After finishing bus testing, remove Zirconia sensor from exhaust pipe and perform NO_x measurements under air conditions. Record data to determine NO_x readings drift.

Connecticut Transit Hybrid Bus Project
Particulate Matter Emissions
Progress Report

June 1, 2003 - March 31, 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.

Due to problems with the dynamometer at the CT Transit facility in Hartford, the project scope was changed in late summer 2003 from laboratory driving cycle measurements to "on-road", real-world emissions testing. This involved appreciable changes in instrumentation and testing protocols, but has resulted in the following accomplishments as of March 31, 2004.

Accomplishments to Date:

1. Designed and CTTransit built instrument "modules" for installation on buses that allow reproducible setup and data collection from bus to bus;
2. Designed and laboratory tested Labview setup for recording temperatures and flowrates;
3. Worked with CTTransit personnel to enable logging of vehicle operating parameters;
4. Developed on-board emissions test protocols (quality control samples, driving conditions, route, etc.);
5. Performed preliminary "dry-run" on-road tests of single bus October 22. No power to instruments; assessed response of magnehelics to road bumps. All OK;
6. Tested on-board instrumentation packages at CTTransit facility; Streamlined operating procedures;
7. Conducted preliminary on-board tests of the two mini-diluters, the SMPS, the ELPI and Labview systems were conducted on November 20 and 21, 2003. Instruments were powered from the CT Transit generator and compressed air from the UConn compressor, both located on a trailer hitched to the hybrid bus. Data collected included: ELPI size distributions (7 nm to 10 micrometers aerodynamic diameter), time-resolved SMPS particle number concentrations at four mobility diameters (10, 20, 40, 100 nm), total particulate mass (filter), size-resolved $PM_{2.5}$ for chemical analysis, magnehelic data for second-by-second dilution ratio and vehicle position by GPS.

8. Vibration problems noted in ELPI preliminary data were addressed by building and implementation of a second vibration platform provided by CTTransit. This greatly reduced frequency of large negative current signals, but hard bumps are still detected by the ELPI. Fortunately, these extreme current values are ~ instantaneous spikes in the dataset that are easily removed during data analysis.
9. Bus routes for on-road testing were finalized in December, 2003. The three routes are:
   1) Bus Schedule 5 & 13: Enfield-Somers/Windsor Locks (Expressway commuter route = I-91)
   2) Bus Schedule E: Farmington Avenue: West Hartford Center (Local "Stop-n-go")
   3) Bus Schedule 1: Avon-Canton Express ("Mountain")
   In addition to these routes, the following QA/QC tests will be conducted:
   1. Tunnel Blank (TB) at beginning and end of testing each day. TB is conducted with bus engine off; duration = 20 min. Objective is to measure individual emissions parameters in the exhaust pipe and dilution system as a "background" measurement.
   2. Warm-up run. Prior to the first Enfield commuter route, run bus up interstate 91 until engine coolant temperature exceeds 170oF. This typically involves exiting at Day Hill Road and then returning to Leibert Road for start of actual test routes.
   3. Instrument blanks. SMPS and ELPI data are collected with HEPA filter on instrument inlet to ensure reliable and reproducible instrument operation between test days.
10. First on-road tests on the above routes were conducted January 6, 2004. The following sampling issues were discovered during this sampling trip:
    a. Extreme cold ambient temperatures led to water condensation in dilution tunnel B and destroyed magnehelic. To solve this problem, additional heat tape for exhaust probe and mass flowmeters were purchased for dilution air flow monitoring of both mini-diluters.
    b. Thermocouples (monitoring temperature of exhaust and diluted exhaust) and transmitting magnehelics had extremely noisy signals when operating Labview on the bus. Problem was solved by using 100k resistor across thermocouple wires at Labview board, use of single power strip for all Labview instruments (thermocouples, flowmeters, magnehelics), separation of flow and thermocouple signals to different data acquisition cards and addition of shielded metal cases for the two connector blocks. Labview/diluter calibration was rechecked on January 29, including mass flowmeters.
    c. Laptop clocks did not all keep time throughout the 4 hour sampling period. This issue remains unresolved.
11. Tests to determine relative lag times between Horiba, SMPS, ELPI and engine scantool on January 7, 2004 using the hybrid bus high and low idle switch.
12. Collected on-road data as outlined in Table 2 using dilution configurations, engine scantool, PM filter and real-time particle instrument protocols that were under continually improving development during the January and February tests.
13. Review of data collected in January and February was conducted during March 2004 in order to evaluate sampling protocols, assess new data collection needs, ensure data quality and completeness. Several issues have been noted during this preliminary data assessment:
    a. Horiba NOx sensor calibration. Realization that NOx data collected to date may not be valid.
    b. Engine scantool time resolution variation within one test and between days. Resolution varies from 1.0 sec to 1.9 sec and is not constant for the hybrid bus. This will make it very difficult to relate emissions to engine operating mode.

c. Engine scantool file structure differs for hybrid and diesel. Cross-comparison between bus types will therefore be limited to use of the four parameters collected by the Navistar diesel engine scantool. The Navistar engine scantool data resolution is ~ 20 times higher than that for the hybrid bus, but also not constant within one file.
d. Horiba GPS data loss occurred on some days.
e. Need for routine methodology to timestamp the engine scantool data with actual clock time, not relative time that is logged to data files.
f. GPS data cannot accurately provide vehicle speed and acceleration information that is needed for on-road modal emissions characterization because accuracy of GPS determination of speed is a function of stability of vehicle operation. In other words, during freeway cruise, GPS data gives relatively accurate vehicle speed and acceleration information, but under local stop-and-go traffic the GPS speed data is not reliable.
g. Need for careful characterization of mini-diluter dilution ratios for every test day to enable comparisons.
h. PM mass data relationships between test routes on single day may be function of overall bus operating characteristics on route, even differing in outbound vs. inbound results. For example, February 18 replicate runs both had Farmington inbound (includes Avon Mountain) sample mass that was almost half that collected on the Farmington outbound + Avon Mountain samples. Because integrated mass measurements cannot simply be compared in terms of total mass collected divided by distance of route (i.e., g/mi) for real-world operation, the PM mass data, like the real-time PM number data, need to be analyzed in terms of an integrated "vehicle route operating" parameter. This parameter needs to be defined—likely in terms of vehicle speed, acceleration, percent idle, etc.parameters that depend on collection of accurate scantool data.

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.

Work Plan:

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

Analyze particle number distribution data to compare vehicle configurations.
Quantitative relationships between measured particle size distributions for the six vehicle configurations under different driving conditions will be developed. Further, we will examine the correlation relationships between regulated pollutant concentrations (NOx, HC, CO, total PM mass) and ultrafine particle total number concentration, number distribution modes and calculated ELPI mass. The correlations will be used to assess how well measurement of regulated pollutants can be used to estimate particle number distributions. This effort will require collection of replicate samples from each of the test buses to obtain statistically significant results.

The SMPS, ELPI and PM mass data will undergo statistical analyses to compare emissions from the six different vehicle configurations. The specific objective will be to compare particle size distributions under the various testing scenarios. Specifically, we will examine the variability of particle size distribution results:

1) within each driving route repetition (i.e., all freeway cruise runs) for the same vehicle
2) across test routes (e.g., freeway, arterial, grade) for the same vehicle, and
3) between vehicles (over the same, and different test routes).

Quantify ultrafine particle emissions as a function of engine operating parameters.
Total ultrafine particle number concentrations as a function of engine operating parameters (acceleration, deceleration, cruise, idle) for each of the six bus configurations will be quantified and compared to determine the bus operating modes that generate elevated ultrafine particle emissions. The relationships between vehicle operating conditions and particle size distributions measured in real-time with the ELPI instrument will be identified. The 2-5 second response time of the ELPI enables collection of meaningful particle size distributions during transient driving cycles and can be used to examine how PM emissions vary with load on the engine, engine speed, exhaust temperature, etc. It is expected that these relationships will be different for the hybrid diesel-electric bus and conventional diesel buses due to the fact that the hybrid's emissions-generating motor is not directly tied to the vehicle propulsion system as it is in a conventional diesel bus. This type of data could be used in combination with bus operation simulation models to determine an estimate of the total particulate emissions for different fleet scenarios.

Write final report summarizing project research methods and findings.
The study results will be summarized in a Project Report at the end of the research period and in peer-reviewed journal articles. The final report will compare the six bus configurations and will include:

- Documentation of all sampling methods and modifications, analytical methods, and data interpretation methods.
- Plots of particle number concentrations and size distribution and PM mass summary parameters for each test route.
- Quantitative comparisons between vehicle configurations to evaluate how ultrafine particle emissions vary between technology and with driving mode.
- Recommendation on which bus technology could best meet potential future federal fine PM criteria.

Connecticut Transit Hybrid Bus Project
Emissions Testing
Progress Report
June 1, 2003 - March 31, 2004

Principal Investigator: *John 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 **CT**TRANSIT'S "real world" bus routes.

Project Direction:

Original project was to utilize **CT**TRANSIT'S Chassis Dynamometer. Due to Allison's Hybrid design, 75 % to 80 % of its fuel & emissions savings is derived from coasting of the vehicle, (mass). The Chassis Dyno could not replicate coastdown of (mass). Upon discovery of this, a major turn in obtaining both gas and particulate had to be re-configured to mobile testing.

Project Changes & Modifications:

- Original Horiba emissions equipment purchased was for stationary use only.
- Before delivery of above original purchase, Horiba had perfected and released for production a portable self-contained vehicle mounted gas analyzer Model OBS-1003.
- **CT**TRANSIT negotiated with Horiba to accommodate **CT**TRANSIT'S change in testing state and made it possible to cancel the original order and purchase the mobile unit.
- Moving from stationary testing with particulate sampling equipment (which was designed to operate on a laboratory bench) to on board created a challenge.
- Equipment mockups were fabricated by technical services to prioritize layout of measuring equipment on 40'mobile platform.
- Design/build of custom platforms to fit all four test buses and hold laboratory equipment in position at speeds up to 65 mph and withstand uneven road conditions (pot holes) were built by **CT**TRANSIT'S craftsmen. Vibration absorbing platforms were also built for ultrasensitive laboratory equipment.

- Technical Services designed a 7’ long stainless steel exhaust extension with sampling ports & a prototype 6”diameter tailpipe adapter with the six ports required for measuring with the new Horiba mobile equipment. A 6” adapter was not available at time of purchase.

- Perforated particulate sampling tubes inserted in the exhaust stream along with piping into the bus were also fabricated.

- To accommodate the large electrical, heat & noise load an eight-foot long utility trailer was purchased. A 15 kW gas engine generator and a 30 gallon 5hp electric air compressor was mounted to the trailer along with modification of the gas engine exhaust system to vent away from compressor intake.

- Power from trailer mounted generator was transferred to bus via 50’ long power cord with 240/120 – 50 amp distribution circuit breaker panel and 16 receptacles mounted on a board. **CT**TRANSIT’S Building Electrician built power distribution center.

- All test buses had to be outfitted with custom trailer hitches & trailer wiring.

- A cover to protect the indoor only rated air compressor and generator from light rain & snow was fabricated by **CT**TRANSIT’S mechanics.

- Horiba has produced a calibrated 6” diameter sampling tube for **CT**TRANST’S project.

- Due to purchase of pre-production Hybrids, software to monitor Battery State of Charge was not released until 12-03. Further complications consisted of the design of Allison’s DOC software for their hybrid propulsion system. All parameters can be visually monitored and recorded and played back. But data cannot be exported or converted to any format for analysis. This was a setback. GM would not release their engineering version to the public.

- Cummins software, which is strictly for the Hybrid bus engine, was updated but not fully finished. The sampling rate is not adjustable in the version we have. Sampling rate was dependent on quantity of parameters chosen. An update has recently been received but sampling rate change capability has not been confirmed.

- Cttransit’s Technical Services John Warhola contracted an electrical measurement company to custom build sensing equipment to measure S.O.C. within specifications. There was no off the shelf units to purchase for this application.

- S.O.C. measuring equipment has been bench tested. First run for measuring was not successful due to configuration of Horiba data logging channel and a loose connection of the main data logging electrical buss.

Start of Emissions Testing:

Including January 6, 2004 up to February 27th. 2004 there has been 9 test days and 10 sets of data.

The Horiba units GPS was not operating steady between tests. This went on for a month. Horiba responded with shipping **CT**TRANSIT a laptop, GPS & one half of the system, which was responsible for GPS operation. Using their unit the problem was solved with the on & off operation of the GPS unit. Failure was due to incorrect connection of GPS data cable to laptop.

In March 2004, review of data collected in the previous months took place. A number of issues arose.

- Some of the OBS-1003 measurements such as (zero exhaust flow) going negative were questioned.

- During the months of January & February there were **extremely low temperatures.** The operating temperature range of the Horiba OBS-1003 was exceeded. Horiba had **no performance data to back up the extreme low temperatures we tested in**. All suggestions from Horiba of insulating had taken place.

- The OBS-1003 Nox analyzer was calibrated for a range of 0 to 1000 ppm. The range of 0 to1000ppm was being exceeded and gas emissions equipment operators changed the range to 0 to 2000ppm per instruction from Horiba Technicians. This too brought about questions of accuracy due to span change.

- Data logged by Cummins software was not logging at a steady rate.

- Data logged by the Pro-Link using their basic software limited parameters to four. Because of the primitive software, some points in the data are scrambled. Since both gas and particulate are sampling at 100ms, losing a few blocks or having a few blocks of data scrambled takes away the ability to line up engine data with emissions data.

<u>Emissions testing is on hold until Horiba addresses emission teams questions</u>.

- On March 15th. two Horiba technicians visited **CT**TRANSIT in response to our questions. Professor Cetegen, his assistant Andres Chaparro & John Warhola were present at this update session.

1. Horiba changed a circuit board, which regulates the internal cell temperature. They lowered it to give the unit more stability in low temperatures.
2. Individual cut insulation pads were installed all around the exposed surface area of the cell.
3. All three optional data logging channels were set up for 0 to 10-volt inputs.
4. Working with Horiba technicians, custom S.O.C. metering signals were simulated to the logging channels and confirmed to be operational.
5. Horiba technician's custom tailored data logging channels for S.O.C. to read and record in units of amperes.
6. Nox sensor scale was increased from 0 to 2000ppm up to 0 to 3000ppm.
7. Horiba is supplying CTTRANSIT a spare Nox sensor (no charge) in return for performance reporting.

- **Horiba's recommendations during this repair session included:**

1. Nox sensor degrades over time is non-linear and depending on use has an expected life of 1 year. They recommend we do a 3-point calibration on the Nox sensor every two weeks. **Calibration gases have been ordered to meet this recommendation and will arrive the first week of April 04.**
2. **CT**TRANSIT is to ship their Nox sensor to Horiba for calibration and they will supply us with an error rate on the sensor. **Unit was shipped, calibrated & is back.**
3. Horiba recommended a 6" extension be added to the end of the exhaust pipe. **CT**TRANSIT is to monitor and see if it improves stability in exhaust flow rate and when zeroing.
4. Changes in our protocol suggested by Horiba are to continue data logging for a few minutes with engine off before re-calabration of gas & Nox sensor.
5. Recommend to datalog and record with engine still off after all calibration is done before the next run starts and observe any drift.
6. Recommend vigilant monitoring of exhaust flow readout during emission testing. As soon as it goes negative proceed with re-calibration even in the middle of the run.
7. Recommend avoiding large swings in temperature of the exhaust system and pitot tube in reference to calibration.

Emissions Team meetings

- On March 25th a meeting with Professor Holmén, Professor Cetegen, Graduate Assistant, Andres Chaparro and John Warhola was held at UCONN.

Main topics of discussion were engine data logging time frame inconsistencies in conjunction with too many laptops to synchronize. Editing and adding to the protocol for testing and the subject of obtaining a device to take the place of all engine data loggers and be able to log the parameters required on a stable clock at the frequency desired.

All of the subjects for discussion were not covered due to lack of time. Due to the lack of calibration gases in our possession at that time, it was decided that any emissions testing would be useless and would not be following the new protocol. Emissions testing was cancelled until all gases are acquired.

- On March 31st a meeting with Professor Holmén, Professor Cetegen, Graduate Assistant, Andres Chaparro and John Warhola was held at UCONN.

Further discussion about changes in protocol took place including data logging with engine off at end of run and data logging with engine off after calibration checking for drifting before the start of a new test.

Recommendations are for all tubing both small and large be fully insulated to avoid any temperature changes affecting low measured differences.

To update the Cummins software and confirm the upgrade of the software as far as setting frequency of sampling rate.

Upon end of emissions testing session Andres Charparro is to make copies of all data logging files pertaining to the Horiba instrument and engine data logging instruments.

John Warhola is to instruct Andres Charparro in operation of engine data logging files for copy purposes.

Professor Cetegen is to review files and advise on quality of data for analysis.

John Warhola is to investigate taping into a rpm signal from the engine ECM if its available so as to connect to the spare option 3 data logging port on the Horiba unit to simplify line up of emissions and rpm.

John Warhola re-initiated contact with Vansco corporation of Canada. Back in October 2003 the company had a serial Data logger, which possibly could answer all of the concerns about data logging from any vehicle, which has a J1939 protocol. Earlier investigation of this unit proved risky because they would not let us try the unit out first and it required some extra knowledge no one was familiar enough with to take it on at the time.

As of this time Vansco has units available in an upgraded version, (USB) high speed and will provide some decoding software and limited support if we are willing to provide feedback on a test basis. I have yet to be informed if the company has approved **CT**TRANSIT to be included in the pilot testing of this unit. It still has some software glitches in it with no guarantees.

Upon discussion of the Vansco unit the team has decided that if we are approved, we would not depend on it until it proves itself. We would still data log independently and run the Vansco unit along side.

Tentative scheduling for the month of April includes:

- upon receipt of new calibration gases perfect Nox sensor calibration. wk of 4-4-04
- testing of new routine on bus 4-12-04
- back on schedule doing complete emissions testing:
- 4-14-04
- 4-16-04
- 4-21-04
- 4-23-04
- 4-28-04
- 4-30-04

All issues and concerns at the present time were covered at this meeting.

John D. Warhola

3-31-04

CTTRANSIT BUS OPERATOR HYBRID DIESEL ELECTRIC BUS SURVEY

Bus Operator Name _____ Date: _____

List bus route(s) on which you've driven the Hybrid Bus: _____

_____

1. I have driven the hybrid bus: ❑ first time today ❑ occasionally ❑ often

2. Was it hard to get used to driving the hybrid bus? ❑ yes ❑ no ❑ a little

3. How does the hybrid bus overall **noise level** compare to a standard diesel bus?
❑ better ❑ worse ❑ the same

4. How does the hybrid bus **acceleration** compare to a standard diesel bus?
❑ better ❑ worse ❑ the same

5. How does the hybrid bus **braking** compare to a standard diesel bus?
❑ better ❑ worse ❑ the same

6. How does the hybrid bus **vibration** compare to a standard diesel bus?
❑ better ❑ worse ❑ the same

7. In **normal driving conditions,** how does the hybrid bus handling compare to a standard diesel bus?
❑ better ❑ worse ❑ the same

8. In **rain/snow conditions,** how does the hybrid bus handling compare to a standard diesel bus?
❑ better ❑ worse ❑ the same

9. How does the hybrid bus window **defroster** compare to a standard diesel bus?
❑ better ❑ worse ❑ the same

10. How does the hybrid bus **interior heat** compare to a standard diesel bus?
❑ better ❑ worse ❑ the same

11. How does the hybrid bus **interior AC** compare to a standard diesel bus?
❑ better ❑ worse ❑ the same

12. Do you prefer to drive the hybrid bus or a standard diesel bus? ❑ hybrid ❑ standard diesel
Why? _____

13. What is the most pleasing feature of the hybrid bus? _____

14. What is the most annoying feature of the hybrid bus? _____

From your perspective, what should be changed on the hybrid bus if we were to purchase additional hybrids?

_____

_____

Please list any comments, positive or negative, that a **passenger** has made to you about this special bus:

_____

_____

Please list any comments, positive or negative, that **you** may have about this special bus:

_____

_____

Thank you! (please return this survey to the Dispatcher)

CTTRANSIT Hybrid Bus Operator Survey
March, 2004

1. I have driven the hybrid bus:	**First Time Today**	**Occasionally**	**Often**
	3	24	1
	10.7%	85.7%	3.6%
2. Was it hard to get used to driving the hybrid bus?	**Yes**	**No**	**A Little**
	1	20	7
	3.6%	71.4%	25.0%
3. How does the hybrid bus overall noise level compare to a standard diesel bus?	**Better**	**Worse**	**The Same**
	16	4	8
	57.1%	14.3%	28.6%
4. How does the hybrid bus acceleration compare to a standard diesel bus?	**Better**	**Worse**	**The Same**
	26	1	1
	92.9%	3.6%	3.6%
5. How does the hybrid bus braking compare to a standard diesel bus?	**Better**	**Worse**	**The Same**
	17	1	10
	60.7%	3.6%	35.7%
6. How does the hybrid bus vibration compare to a standard diesel bus?	**Better**	**Worse**	**The Same**
	15	3	9
	55.6%	11.1%	33.3%
7. In normal driving conditions, how does the hybrid bus handling compare to a standard diesel bus?	**Better**	**Worse**	**The Same**
	15	1	12
	53.6%	3.6%	42.9%
8. In rain/snow conditions, how does the hybrid bus handling compare to a standard diesel bus?	**Better**	**Worse**	**The Same**
	7	5	8
	35.0%	25.0%	40.0%
9. How does the hybrid bus window defroster compare to a standard diesel bus?	**Better**	**Worse**	**The Same**
	5	0	17
	22.7%	0.0%	77.3%
10. How does the hybrid bus interior heat compare to a standard diesel bus?	**Better**	**Worse**	**The Same**
	13	0	15
	46.4%	0.0%	53.6%
11. How does the hybrid bus interior AC compare to a standard diesel bus?	**Better**	**Worse**	**The Same**
	6	0	6
	50.0%	0.0%	50.0%
12. Do you prefer to drive the hybrid bus or a standard diesel bus? ? hybrid ? standard diesel	**Prefer Hybrid**	**Prefer Standard**	
	16	4	
	80.0%	20.0%	

#12. Do you prefer to drive the hybrid bus or a standard diesel bus? Why?

- Faster - you keep better schedule
- It doesn't matter
- You use the brake pedal less. Bus slows on it's own.
- During normal driving conditions, the hybrid has good acceleration
- Too fast on take-off for the line jobs, some braking in snow.
- Hybrid too fast on take-off
- Runs smoother - less noise - better brakes
- Better acceleration
- These buses are better to handle and good pick-up
- Pick-up is quick
- Drives better and handles better
- Not as much jerky motion
- Overall better
- Better acceleration
- No preference
- New - different
- Doesn't matter
- No noise
- Smooth quiet ride
- Hybrid - It has the power and handles a little better
- Hybrid - Power
- Hybrid - Best bus they ever bought
- I have only driven once, so I can't give a fair assessment
- Better acceleration, better handling
- Faster, you keep better schedule
- Cleaner/ Fast take off
- Better acceleration
- Excessive noise and vibration

#13. What is the most pleasing feature of the hybrid bus?

- The way it slows
- Acceleration
- Design - appearance
- A good ride. Also, drives good.
- Less noise
- Fast pick-up when taking off
- The same as 200's
- The way it accelerates
- Take off
- Climate control N/C heat
- Faster on take-off
- New different
- Can't tell - I didn't know
- Acceleration
- Quiet
- Power and sharper turns
- The shades in a sunny day
- Take off power
- Good
- It's sturdy
- All features work faster
- The window shades/clean/faster
- Acceleration
- Power

#14. What is the most annoying feature of the hybrid bus?

- Top heavy
- Sometimes braking can be an annoying feature
- Rear axle noise
- The take-off
- Farebox too low
- The top piece hanging over the bus. You got to be careful about not hitting the trees.
- Loud
- Retarder braking
- Turning it on
- Can't tell - I don't know
- Noise
- Back door closes slower
- Climbing in drivers seat
- Repairs
- The outside rear camera
- A little more noise than the other buses
- Nothing

#14. From your perspective, what should be changed on the hybrid bus if we were to purchase additional hybrids?

- Make farebox higher (smile) or the seat lower
- I have no opinion at this time. I don't drive the bus on a regular schedule
- The hesitation in speed, while making a turn, in bad weather
- The take-off should be changed
- N/A at the present time
- Add a cup holder
- Outside rearview mirrors I find them difficult to see out of those mirrors
- Coffee holders
- Add more cameras like the 300's have on the outside and front windshield
- Idling noise & takes off too fast
- Driver controlled retarder - amount of braking
- Keep it the same
- Nothing, I guess
- Noise level
- Adjust rear door and see if trim unit could be lifted up, so drivers could see it better
- Nothing I guess
- Change the brake system
- Leave it alone. Don't change anything.
- Passenger capacity (a little bigger)
- Too early to tell
- If it was possible for the manufacturer to address the noise issue that would be helpful
- Nothing

#14. Please list any comments, positive or negative, that a passenger has made to you about this special bus.

- Passengers felt they like the bus because it was new and to the curb can alight safer
- In general, most passengers say they like the bus
- Maybe speed, but not much more
- Passengers seem to like them, but had a big wheel chair and that needs more room to board
- Nice new buses
- They like the bus the way it accelerates, because they feel that the driver is fast and they will make it on time to their next destination. Also, some don't like it because the way it takes off, they feel it is too dangerous
- None, I can recall
- They seem to like acceleration
- I haven't heard anything
- Ride very smooth
- Everyone said it was a better ride, quite ride for noise and better all around
- The size of bus
- All passengers love these buses people going by ask about the bus say it's pretty and fast
- It's new. They like new buses.
- Smooth riding
- They like it

#14. Please list any comments, positive or negative, that you may have about this special bus.

- I find in the new buses that you have to lean over to see coins in farebox. It is rather low.
- Overall, it seems to be a good riding, handling bus.
- If the take-off speed can be adjusted and fix the traction in the rear tires!
- It's a good bus; I just didn't like the take-off
- Has very smooth driving - the driver seat feels more comfortable
- I find them difficult to see out of those mirrors
- I am very pleased with these buses, only the farebox is too low
- Coffee holder
- Need a place to hold a coffee holder
- It does accelerate a little too fast, but my opinion is that if you are a safe driver, it's up to you to take off fast on the hybrid buses or not.
- Prefer the diesel
- I like the bus very much
- Nothing, I guess
- Good speed and good acceleration taking-off from stop
- I like the bus for speed and handling, fare box to low on all the new buses.
- I like it because of the power
- I love it
- Ok
- I like driving it
- Noise of the engine

CTTRANSIT
JANUARY, 2004 HYBRID BUS TEST PROGRAM DATA

Total Fleet	*Fleet Total*	*Fleet Avg*
Miles	968,795.00	2465.1
Fuel - Gallons	278,752.00	709.3
Oil - Quarts	2,965.00	7.5
Road Calls	300	0.8
Maintenance Parts Cost	$200,604.06	$510.44
Maintenance Labor Cost	$137,858.00	$350.78
Total Maintenance Cost	$338,462.06	$861.23
Total Cost/Mile	$0.35	$0.35
Miles/Gallon Fuel	3.48	3.48
Miles/Quart Oil	326.7	326.7
Miles/Road Call	3,229.3	3,229.3

Base Comparison Buses	*201*	*202*	*201 & 202*	*Base Avg*	*Hybrid vs Base*
Miles	4,606	5,093	9,699	4,850	-1444
Fuel - Gallons	1,006.1	1,110.1	2,116.2	1,058.1	-361.75
Oil - Quarts	5.0	2.0	7.0	3.5	0.7
Road Calls	1	0	1	0.5	2.0
Maintenance Parts Cost	$615.24	$706.48	$1,321.72	$660.86	-$660.86
Maintenance Labor Cost	$226.65	$385.10	$611.75	$305.88	-$227.22
Total Maintenance Cost	$841.89	$1,091.58	$1,933.47	$966.74	-$888.08
Total Cost/Mile	$0.18	$0.21	$0.20	$0.20	-$0.18
Miles/Gallon Fuel	4.58	4.59	4.58	4.58	6.70%
Miles/Quart Oil	921.20	2,546.50	1,385.57	1,385.57	-41.5%
Miles/Road Call	4606.00	N/A	9699.00	9699.00	-722.00

Hybrid Buses	*H301*	*H302*	*H301 & H302*	*Hybrid Avg*	*Hybrid vs Fleet*
Miles	3,714	3,097	6,811	3,406	940
Fuel - Gallons	757.4	635.3	1392.7	696.35	-12.9
Oil - Quarts	8.1	0.3	8.4	4.2	-3.3
Road Calls - Hybrid Related	0	0	0	0	-0.8
Road Calls	2	3	5	2.5	1.7
Maintenance Parts Cost	$0.00	$0.00	$0.00	$0.00	-$510.44
Maintenance Labor Cost	$46.84	$110.47	$157.31	$78.66	-$272.13
Total Maintenance Cost	$46.84	$110.47	$157.31	$78.66	-$782.57
Total Cost/Mile	$0.01	$0.04	$0.02	$0.02	-$0.33
Miles/Gallon Fuel	4.90	4.87	4.89	4.89	40.71%
Miles/Quart Oil	458.52	10,323.33	810.83	810.83	59.70%
Miles/Road Call - Hybrid Related	0	0	0	N/A	N/A
Miles/ Road Call Total	1857.0	1032.3	1362.2	1362.2	-1,867.1

CTTRANSIT
H301 and 201 BUS TEST DATA
JANUARY, 2004

			H301						201						
	NOON														% MPG
DATE	TEMP.	CONDITIONS	RUN NO.	BLOCK #	BADGE #	FUEL	MILES	MPG	RUN NO.	BLOCK#	BADGE #	FUEL	MILES	MPG	CHANGE
01/01/04	41	Clear	Tripper			14.3	68	4.76	Tripper			21.5	108	5.02	-5.34%
01/02/04	32	Ptly. Cloudy	11	L-2	1138	48.1	245	5.09	7	L-1	1165	55.5	254	4.58	11.30%
01/03/04	37	Cloudy	Tripper			43.7	198	4.53	Tripper			37.6	170	4.52	0.21%
01/04/04	43	Rain	Tripper			40.5	184	4.54	Tripper			21.1	97	4.60	-1.17%
01/05/04	34	Ptly. Cloudy	Tripper			13.5	59	4.37	Tripper			8.9	35	3.93	11.13%
01/06/04	34	Ptly. Cloudy							Tripper			25.9	121	4.67	
01/07/04	20	Clear							Tripper			37.2	182	4.89	
01/08/04	21	Clear	181	Q-2	1228	30.3	133	4.39	24	Q-4	1621	32.1	126	3.93	11.83%
01/09/04	7	Ptly. Cloudy	200	E-3	1346	27.5	124	4.51	201	E-4	1465	33.2	158	4.76	-5.25%
01/10/04	7	Cloudy	7	L-1	1165	48.1	246	5.11	11	L-2	1138	54.7	249	4.55	12.35%
01/11/04	19	Clear	Tripper			14.3	73	5.10							
01/12/04	32	Ptly. Cloudy	Tripper			25.7	132	5.14	Tripper			42.6	211	4.95	3.70%
01/13/04	38	Ptly. Cloudy							Tripper			18.3	89	4.86	
01/14/04	7	Ptly. Cloudy							Tripper			59.4	288	4.85	
01/15/04	8	Clear	Tripper			18.7	95	5.08	Tripper			1.8	8	4.44	14.30%
01/16/04	9	Ptly. Cloudy	Tripper			10	47	4.70	Tripper			14	59	4.21	11.53%
01/17/04	29	Clear	Tripper			34.4	157	4.56	Tripper			32.8	133	4.05	12.55%
01/18/04	28	Snow							Tripper			12.2	62	5.08	
01/19/04	23	Ptly. Cloudy	11	L-2	1138	43.8	239	5.46	7	L-1	1165	53.2	252	4.74	15.20%
01/20/04	22	Clear	117	X-1	1767	50.1	270	5.39	118	X-2	1530	31.2	153	4.90	9.90%
01/21/04	25	Clear	827	KT-3	1759	25.7	116	4.51	825	KT-2	1731	33.4	134	4.01	12.50%
01/22/04	32	Cloudy	Tripper			27.7	132	4.77	Tripper			42	200	4.76	0.07%
01/23/04	17	Ptly. Cloudy	127	YM-1	1635	30.2	165	5.46	18	YM-2	1321	55	267	4.85	12.55%
01/24/04	19	Cloudy	23	Q-1	1666	31	142	4.58	204	Q-3	1511	32.5	123	3.78	21.03%
01/25/04	14	Clear	420	E-1	1036	18.2	95	5.22	406	E-2	1329	33.8	173	5.12	1.98%
01/26/04	12	Ptly. Cloudy	Tripper			49.4	238	4.82	Tripper			12.2	47	3.85	25.06%
01/27/04	17	Ptly. Cloudy	114	L-1	1165	46.9	244	5.20	115	L-2	1414	52.7	263	4.99	4.25%
01/28/04	25	Light Snow							Tripper			40.6	200	4.93	
01/29/04	28	Clear	Tripper			16.4	78	4.76	Tripper			47.6	179	3.76	26.47%
01/30/04	19	Ptly. Cloudy	820	K-4	1694	24.1	110	4.56	142	K-2	1752	30.8	106	3.44	32.62%
01/31/04	22	Clear	200	E-3	1346	24.8	124	5.00	201	E-4	1465	32.3	159	4.92	1.57%
Totals						757.4	3,714	4.90				1,006.1	4,606	4.58	7.11%

CTTRANSIT
H302 and 202 BUS TEST DATA
JANUARY, 2004

			H302						202						
	NOON														% MPG
DATE	TEMP.	CONDITIONS	RUN NO.	BLOCK #	BADGE #	FUEL	MILES	MPG	RUN NO.	BLOCK#	BADGE #	FUEL	MILES	MPG	CHANGE
01/01/04	41	Clear	418	KT-3	1406	26	125	4.81	417	KT-2	1309	56.6	257	4.54	5.88%
01/02/04	32	Ptly. Cloudy	Tripper			5.3	27	5.09	Tripper			33.2	135	4.07	25.28%
01/03/04	37	Cloudy	115	L-2	1764	42	230	5.48	114	L-1	1543	50.5	253	5.01	9.31%
01/04/04	43	Rain	827	KT-3	1759	25	136	5.44	825	KT-2	1731	35	155	4.43	22.84%
01/05/04	34	Ptly. Cloudy							Tripper			45.6	258	5.66	
01/06/04	34	Ptly. Cloudy	Tripper			9.1	46	5.05	Tripper			14.4	65	4.51	11.99%
01/07/04	20	Clear	Tripper			26.9	123	4.57	Tripper			13	48	3.69	23.84%
01/08/04	21	Clear							Tripper			33.7	141	4.18	
01/09/04	7	Ptly. Cloudy							Tripper			36.2	184	5.08	
01/10/04	7	Cloudy							Tripper			44.7	193	4.32	
01/11/04	19	Clear							Tripper			11.1	58	5.23	
01/12/04	32	Ptly. Cloudy	Tripper			33.7	158	4.69	Tripper			10.3	52	5.05	-7.13%
01/13/04	38	Ptly. Cloudy	36	Bx-535	1693	35.9	198	5.52	22	X-2	1089	35.3	188	5.33	3.56%
01/14/04	7	Ptly. Cloudy	7	L-1	1165	54.3	250	4.60	11	L-2	1138	47.7	247	5.18	-11.09%
01/15/04	8	Clear	12	U-1	822	34.7	160	4.61	206	U-3	1478	57.1	248	4.34	6.16%
01/16/04	9	Ptly. Cloudy							Tripper			45	199	4.42	
01/17/04	29	Clear							Tripper			47.5	244	5.14	
01/18/04	28	Snow							Tripper			32.6	134	4.11	
01/19/04	23	Ptly. Cloudy	Tripper			47	206	4.38	Tripper			35.4	140	3.95	
01/20/04	22	Clear	Tripper			11	63	5.73	Tripper			52.6	270	5.13	11.58%
01/21/04	25	Clear	Tripper			37.4	177	4.73	Tripper			5.8	25	4.31	9.80%
01/22/04	32	Cloudy	22	X-2	1089	15	81	5.40	36	Bx-535	1693	56.2	258	4.59	17.63%
01/23/04	17	Ptly. Cloudy	Tripper			46.1	196	4.25	11	L-2		48.4	166	3.43	23.96%
01/24/04	19	Cloudy	Tripper			19.5	94	4.82	Tripper			49.7	188	3.78	27.44%
01/25/04	14	Clear	Tripper			10.3	58	5.63							
01/26/04	12	Ptly. Cloudy							Tripper			36.2	175	4.83	
01/27/04	17	Ptly. Cloudy	206	U-3	1478	49.9	223	4.47	12	U-1	822	38.2	170	4.45	0.42%
01/28/04	25	Light Snow	127	YM-1	1569	25	131	5.24	18	YM-2	1321	31.5	149	4.73	10.78%
01/29/04	28	Clear	Tripper			43.4	231	5.32	Tripper			12.9	54	4.19	27.15%
01/30/04	19	Ptly. Cloudy	120	E-13	1439	37.8	184	4.87	198	E-8	1455	40.9	177	4.33	12.48%
01/31/04	22	Clear							Tripper			52.8	262	4.96	
Totals						635.3	3,097	4.87				1,110.1	5,093	4.59	6.26%

CTTRANSIT
FEBRUARY, 2004 HYBRID BUS TEST PROGRAM DATA

Total Fleet	*Fleet Total*	*Fleet Avg*
Miles	933,017.00	2350.2
Fuel - Gallons	252,863.00	636.9
Oil - Quarts	2,411.00	6.1
Road Calls	300	0.8
Maintenance Parts Cost	$215,415.23	$545.36
Maintenance Labor Cost	$116,309.20	$294.45
Total Maintenance Cost	$331,724.43	$839.81
Total Cost/Mile	$0.36	$0.36
Miles/Gallon Fuel	3.69	3.69
Miles/Quart Oil	387.0	387.0
Miles/Road Call	3,110.1	3,110.1

Base Comparison Buses	*201*	*202*	*201 & 202*	*Base Avg*	*Hybrid vs Base*
Miles	3,941	1,618	5,559	2,780	109.5
Fuel - Gallons	879.7	357.8	1,237.5	618.8	-23.55
Oil - Quarts	0.3	3.2	3.5	1.8	1.9
Road Calls	0	0	0	0	1.5
Maintenance Parts Cost	$1,799.49	$678.41	$2,477.90	$1,238.95	-$840.35
Maintenance Labor Cost	$201.39	$312.61	$514.00	$257.00	-$180.18
Total Maintenance Cost	$2,000.88	$991.02	$2,991.90	$1,495.95	-$1,020.53
Total Cost/Mile	$0.51	$0.61	$0.54	$0.54	-$0.37
Miles/Gallon Fuel	4.48	4.52	4.49	4.49	8.05%
Miles/Quart Oil	13,136.67	505.63	1,588.29	1,588.29	-50.2%
Miles/Road Call	3941.00	1618.00	5559.00	2780.00	-854.00

Hybrid Buses	*H301*	*H302*	*H301 & H302*	*Hybrid Avg*	*Hybrid vs Fleet*
Miles	3,912	1,866	5,778	2,889	539
Fuel - Gallons	797.7	392.7	1190.4	595.2	-41.7
Oil - Quarts	2.2	5.1	7.3	3.7	-2.4
Road Calls - Hybrid Related	0	0	0	0	-0.8
Road Calls	0	3	3	1.5	0.7
Maintenance Parts Cost	$794.05	$3.15	$797.20	$398.60	-$146.76
Maintenance Labor Cost	$143.14	$10.51	$153.65	$76.83	-$217.63
Total Maintenance Cost	$937.19	$13.66	$950.85	$475.43	-$364.38
Total Cost/Mile	$0.24	$0.01	$0.16	$0.16	-$0.19
Miles/Gallon Fuel	4.90	4.75	4.85	4.85	31.55%
Miles/Quart Oil	1778.18	365.88	791.51	791.51	51.11%
Miles/Road Call - Hybrid Related	0	0	0	N/A	N/A
Miles/ Road Call Total	3912.00	622.0	1926.0	1926	-1,184.1

CTTRANSIT
H301 and 201 BUS TEST DATA
FEBRUARY, 2004

			H301						201						
	NOON														% MPG
DATE	TEMP.	CONDITIONS	RUN NO.	BLOCK #	BADGE #	FUEL	MILES	MPG	RUN NO.	BLOCK#	BADGE #	FUEL	MILES	MPG	CHANGE
02/01/04	28	Clear													
02/02/04	39	Ptly. Cloudy							Tripper			35.3	167	4.73	
02/03/04	29	Cloudy										48.7	218	4.48	
02/04/04	41	Ptly. Cloudy	Tripper			24.9	135	5.42	Hold			8	35	4.38	23.92%
02/05/04	35	Clear													
02/06/04	30	Light Rain	Tripper			26.4	126	4.77	7	L-1	1165	33.9	151	4.45	7.15%
02/07/04	35	Cloudy	115	L-2	1414	14.6	81	5.55	114	L-1	1543	49.9	235	4.71	17.81%
02/08/04	33	Clear	Tripper			51.8	258	4.98	Tripper			52.9	251	4.74	4.97%
02/09/04	39	Ptly. Cloudy							201	E-4	1465	37.4	183	4.89	
02/10/04	45	Clear	23	Q-1	1349	29	135	4.66	181	Q-2	1228	32.7	157	4.80	-3.04%
02/11/04	36	Ptly. Cloudy	14	F2-1	1130	10.2	53	5.20	10	F2-4	1135	37.4	147	3.93	32.20%
02/12/04	31	Cloudy	127	YM-1	1569	39.7	178	4.48	18	YM-2	1126	36	153	4.25	5.50%
02/13/04	40	Ptly. Cloudy	12	U-1	822	31.6	176	5.57	206	U-3	1777	47.8	237	4.96	12.33%
02/14/04	43	Clear	Tripper			31.9	161	5.05							
02/15/04	35	Clear	Tripper			46.5	258	5.55							
02/16/04	20	Clear	Tripper			22.9	104	4.54							
02/17/04	27	Ptly. Cloudy	22	X-2	1089	51.1	249	4.87	36	Bx-535	1148	25.5	109	4.27	14.00%
02/18/04	32	Clear	198	E-8	1687	46.8	266	5.68	120	E-13	1439	59.9	301	5.03	13.11%
02/19/04	35	Ptly. Cloudy	204	Q-3	1511	30.7	159	5.18	24	Q-4	1356	39.6	182	4.60	12.69%
02/20/04	35	Ptly. Cloudy	Tripper			27.4	119	4.34	Tripper			32.2	126	3.91	10.99%
02/21/04	39	Clear	Tripper			35.1	146	4.16	Tripper			53.4	193	3.61	15.09%
02/22/04	40	Clear	Tripper			43.7	252	5.77							
02/23/04	38	Clear													
02/24/04	35	Cloudy	Tripper			41.6	161	3.87	Tripper			21.8	83	3.81	1.65%
02/25/04	33	Clear	7	L-1	1165	16.5	78	4.73	11	L-2	1138	46.6	214	4.59	2.94%
02/26/04	37	Ptly. Cloudy	Tripper			49.4	248	5.02	Tripper			49.7	244	4.91	2.26%
02/27/04	40	Ptly. Cloudy	Tripper			43.3	206	4.76	Tripper			28.7	140	4.88	-2.47%
02/28/04	50	Clear	804	K-7	1747	41.6	236	5.67	130	K-2	1759	61.6	244	3.96	43.22%
02/29/04	52	Cloudy	176	TN-2	1620	41	127	3.10	813	TN-1	1777	40.7	171	4.20	-26.27%
Totals						797.7	3,912	4.90				879.7	3,941	4.48	9.47%

CTTRANSIT
H302 and 202 BUS TEST DATA
FEBRUARY, 2004

			H302						202						
	NOON														% MPG
DATE	TEMP.	CONDITIONS	RUN NO.	BLOCK #	BADGE #	FUEL	MILES	MPG	RUN NO.	BLOCK#	BADGE #	FUEL	MILES	MPG	CHANGE
02/01/04	28	Clear							Tripper			33.6	156	4.64	
02/02/04	39	Ptly. Cloudy							Tripper			38.5	173	4.49	
02/03/04	29	Cloudy	Tripper			30.9	131	4.24	Tripper			57.2	262	4.58	-7.44%
02/04/04	41	Ptly. Cloudy	Tripper			16.3	55	3.37	Tripper			48.6	206	4.24	-20.39%
02/05/04	35	Clear													
02/06/04	30	Light Rain							Tripper			45.5	207	4.55	
02/07/04	35	Cloudy							Tripper			35.3	163	4.62	
02/08/04	33	Clear							Tripper			50.3	234	4.65	
02/09/04	39	Ptly. Cloudy							Tripper			38.8	181	4.66	
02/10/04	45	Clear	Tripper			6.4	19	2.97							
02/11/04	36	Ptly. Cloudy							Tripper			10	36	3.60	
02/12/04	31	Cloudy	Tripper			33.9	147	4.34							
02/13/04	40	Ptly. Cloudy	Tripper			28.6	126	4.41							
02/14/04	43	Clear	Tripper			41.3	206	4.99							
02/15/04	35	Clear	Tripper			42.3	264	6.24							
02/16/04	20	Clear													
02/17/04	27	Ptly. Cloudy	Tripper			43.2	190	4.40							
02/18/04	32	Clear	Tripper			36.6	167	4.56							
02/19/04	35	Ptly. Cloudy	Tripper			42.1	199	4.73							
02/20/04	35	Ptly. Cloudy	Tripper			36.2	193	5.33							
02/21/04	39	Clear	Tripper			34.9	169	4.84							
02/22/04	40	Clear													
02/23/04	38	Clear													
02/24/04	35	Cloudy													
02/25/04	33	Clear													
02/26/04	37	Ptly. Cloudy													
02/27/04	40	Ptly. Cloudy													
02/28/04	50	Clear													
02/29/04	52	Cloudy													
Totals						392.7	1,866	4.75				357.8	1,618	4.52	5.08%

CTTRANSIT
MARCH, 2004 HYBRID BUS TEST PROGRAM DATA

Total Fleet	*Fleet Total*	*Fleet Avg*
Miles	1,052,178.00	2650.3
Fuel - Gallons	284,926.00	717.7
Oil - Quarts	2,627.00	6.6
Road Calls	164	0.4
Maintenance Parts Cost	$218,501.24	$553.17
Maintenance Labor Cost	$140,735.25	$356.29
Total Maintenance Cost	$359,236.49	$909.46
Total Cost/Mile	$0.34	$0.34
Miles/Gallon Fuel	3.69	3.69
Miles/Quart Oil	400.5	400.5
Miles/Road Call	6,415.7	6,415.7

Base Comparison Buses	*201*	*202*	*201 & 202*	*Base Avg*	*Hybrid vs Base*
Miles	4,105	4,764	8,869	4,435	-1772
Fuel - Gallons	919.0	1,054.4	1,973.4	986.7	-455.25
Oil - Quarts	0.0	4.7	4.7	2.4	-0.4
Road Calls	1	1	2	1	0.5
Maintenance Parts Cost	$271.79	$409.35	$681.14	$340.57	$75.64
Maintenance Labor Cost	$132.43	$311.85	$444.28	$222.14	-$7.28
Total Maintenance Cost	$404.22	$721.20	$1,125.42	$562.71	$68.36
Total Cost/Mile	$0.10	$0.15	$0.13	$0.13	$0.11
Miles/Gallon Fuel	4.47	4.52	4.49	4.49	11.47%
Miles/Quart Oil	N/A	1,013.62	1,887.02	1,887.02	-29.5%
Miles/Road Call	4105.00	4764.00	8869.00	4434.50	-2659.50

Hybrid Buses	*H301*	*H302*	*H301 & H302*	*Hybrid Avg*	*Hybrid vs Fleet*
Miles	3,752	1,573	5,325	2,663	12
Fuel - Gallons	750.6	312.3	1062.9	531.5	-186.2
Oil - Quarts	4.0	0.0	4.0	2.0	-4.6
Road Calls - Hybrid Related	0	0	0	0	-0.4
Road Calls	2	1	3	1.5	1.1
Maintenance Parts Cost	$67.63	$764.80	$832.43	$416.22	-$136.95
Maintenance Labor Cost	$153.44	$276.28	$429.72	$214.86	-$141.43
Total Maintenance Cost	$221.07	$1,041.08	$1,262.15	$631.08	-$278.38
Total Cost/Mile	$0.06	$0.66	$0.24	$0.24	-$0.11
Miles/Gallon Fuel	5.00	5.04	5.01	5.01	35.67%
Miles/Quart Oil	938.00	N/A	1331.25	1331.25	69.91%
Miles/Road Call - Hybrid Related	0	0	0	N/A	N/A
Miles/ Road Call Total	1876.00	1573.00	1775.0	1775	-4,640.7

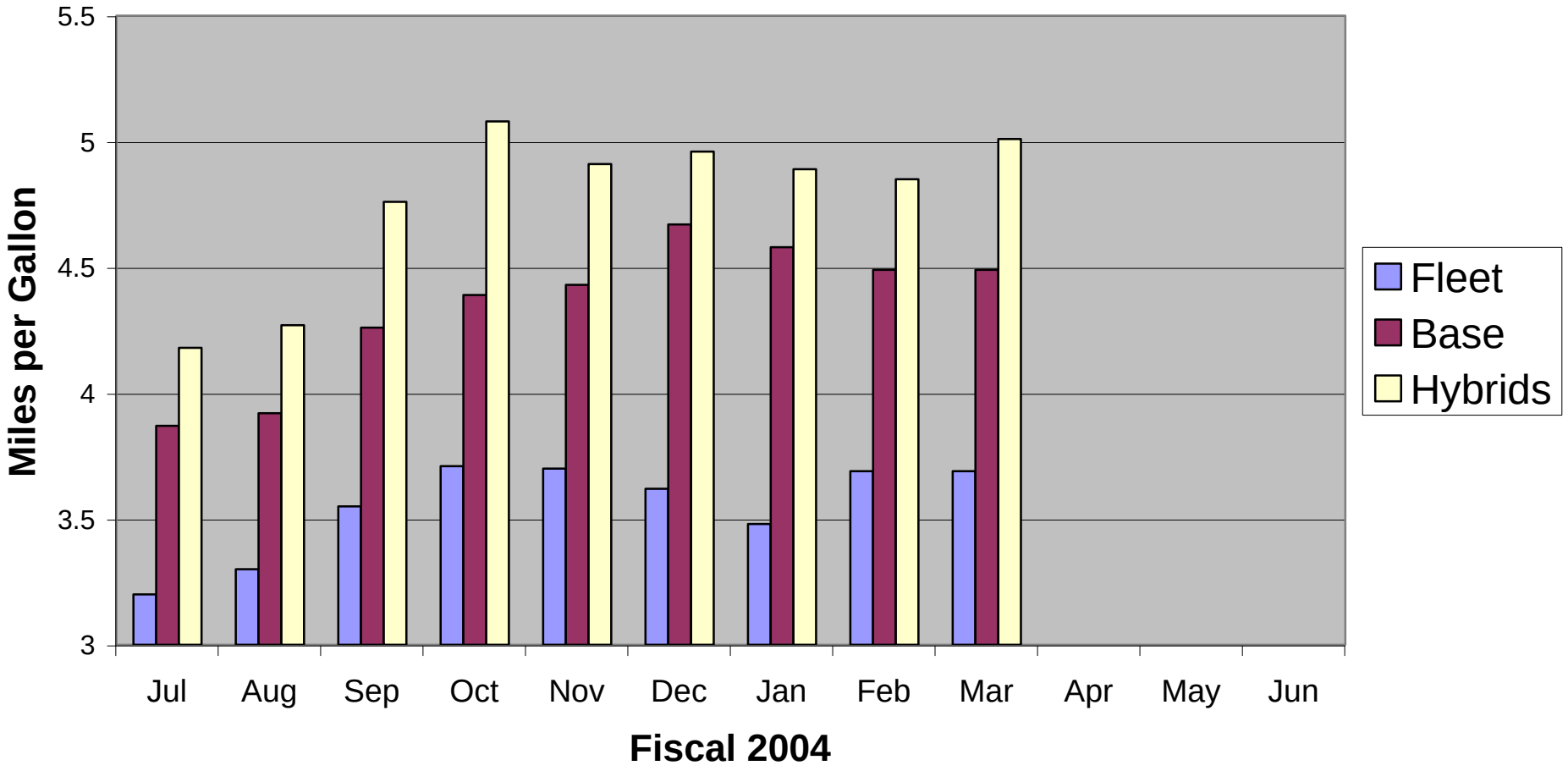
CTTRANSIT
H301 and 201 BUS TEST DATA
MARCH, 2004

			H301						201						
	NOON														% MPG
DATE	TEMP.	CONDITIONS	RUN NO.	BLOCK #	BADGE #	FUEL	MILES	MPG	RUN NO.	BLOCK#	BADGE #	FUEL	MILES	MPG	CHANGE
03/01/04	56	Clear													
03/02/04	51	Clear	127	YM-1	1569	47.9	274	5.72	18	YM-2	1321	16.8	65	3.87	47.85%
03/03/04	50	Clear	Tripper			30.5	176	5.77	Tripper			50.4	238	4.72	22.20%
03/04/04	48	Ptly Cloudy	Tripper			27.7	133	4.80	Tripper			52.2	222	4.25	12.90%
03/05/04	45	Rain	181	Q-2	1228	41	206	5.02	23	Q-1	1349	46.2	185	4.00	25.47%
03/06/04	49	Showers	Tripper			30	124	4.13	Tripper			37.2	160	4.30	-3.90%
03/07/04	48	Clear	Tripper			25.3	124	4.90	Tripper			34.8	132	3.79	29.21%
03/08/04	34	Light Snow	Tripper			23.4	136	5.81	Tripper			40	200	5.00	16.24%
03/09/04	35	Light Snow	Tripper			11.3	38	3.36	Tripper			36.8	142	3.86	-12.85%
03/10/04	38	Clear	Tripper			40.3	203	5.04	Tripper			21.3	91	4.27	17.90%
03/11/04	48	Ptly Cloudy	Tripper			34.6	168	4.86	Tripper			16.3	71	4.36	11.47%
03/12/04	32	Ptly Cloudy	Tripper			32.2	137	4.25							
03/13/04	38	Clear	Tripper			51.1	243	4.76	Tripper			38.3	173	4.52	5.28%
03/14/04	38	Cloudy													
03/15/04	48	Ptly Cloudy													
03/16/04	34	Light Snow	206	U-3	1478	30.1	150	4.98							
03/17/04	28	Cloudy	Tripper			39.4	193	4.90	Tripper			35.5	164	4.62	6.03%
03/18/04	35	Cloudy	Tripper			35.6	161	4.52	Tripper			47.9	255	5.32	-15.05%
03/19/04	33	Ptly Cloudy							201	E-4	1465	43.3	176	4.06	
03/20/04	45	Clear	Tripper			44.5	243	5.46	Tripper			34.2	157	4.59	18.95%
03/21/04	43	Clear	Tripper			6.6	30	4.55	Tripper			46.9	264	5.63	-19.25%
03/22/04	30	Ptly Cloudy													
03/23/04	35	Clear	Tripper			27.3	135	4.95	Tripper			48.5	237	4.89	1.20%
03/24/04	52	Ptly Cloudy	18	YM-2	1321	28	129	4.61	127	YM-1	1569	48.2	222	4.61	0.03%
03/25/04	51	Ptly Cloudy	24	Q-4	1356	39.3	230	5.85	204	Q-3	1511	35.4	180	5.08	15.10%
03/26/04	66	Ptly Cloudy	10	F2-4	1135	25.9	146	5.64	14	F2-1	881	31	123	3.97	42.07%
03/27/04	57	Clear	Tripper			29.7	143	4.81	Tripper			43.6	184	4.22	14.09%
03/28/04	49	Clear							Tripper			34.1	129	3.78	
03/29/04	47	Clear													
03/30/04	33	Cloudy	12	U-1	822	16.3	69	4.23	206	U-3	1478	38.7	136	3.51	20.46%
03/31/04	42	Light Rain	Tripper			32.6	161	4.94	Tripper			41.4	199	4.81	2.74%
Totals						750.6	3752.0	5.00				919.0	4105.0	4.47	11.91%

CTTRANSIT
H302 and 202 BUS TEST DATA
MARCH, 2004

			H302						202						
	NOON														% MPG
DATE	TEMP.	CONDITIONS	RUN NO.	BLOCK #	BADGE #	FUEL	MILES	MPG	RUN NO.	BLOCK#	BADGE #	FUEL	MILES	MPG	CHANGE
03/01/04	56	Clear													
03/02/04	51	Clear	Tripper			33	167	5.06	Tripper			73.9	353	4.78	5.94%
03/03/04	50	Clear							Tripper			45.3	218	4.81	
03/04/04	48	Ptly Cloudy							Tripper			20.4	77	3.77	
03/05/04	45	Rain							Tripper			41.3	152	3.68	
03/06/04	49	Showers							Tripper			44	215	4.89	
03/07/04	48	Clear							Tripper			26.9	117	4.35	
03/08/04	34	Light Snow							Tripper			40.5	201	4.96	
03/09/04	35	Light Snow							Tripper			39.3	155	3.94	
03/10/04	38	Clear							Tripper			39.6	159	4.02	
03/11/04	48	Ptly Cloudy							Tripper			47.7	195	4.09	
03/12/04	32	Ptly Cloudy							Tripper			48.5	224	4.62	
03/13/04	38	Clear							Tripper			47.2	226	4.79	
03/14/04	38	Cloudy							Tripper			34.4	174	5.06	
03/15/04	48	Ptly Cloudy													
03/16/04	34	Light Snow	Tripper			5.1	22	4.31	Tripper			26.8	115	4.29	0.53%
03/17/04	28	Cloudy	22	X-2	1089	9.4	37	3.94	35	Bx-535	1176	31.1	124	3.99	-1.28%
03/18/04	35	Cloudy	Tripper			49.1	270	5.50	Tripper			59	319	5.41	1.71%
03/19/04	33	Ptly Cloudy	Tripper			28.5	144	5.05	Tripper			10.4	54	5.19	-2.69%
03/20/04	45	Clear	Tripper			7.2	30	4.17	Tripper			34.8	126	3.62	15.08%
03/21/04	43	Clear							Tripper			33.6	138	4.11	
03/22/04	30	Ptly Cloudy													
03/23/04	35	Clear							Tripper			50.4	186	3.69	
03/24/04	52	Ptly Cloudy	Tripper			42.9	209	4.87	Tripper			32	141	4.41	10.57%
03/25/04	51	Ptly Cloudy	198	E-8	1455	10.1	36	3.56	120	E-13	1439	39.5	175	4.43	-19.55%
03/26/04	66	Ptly Cloudy	Tripper			29.3	148	5.05	Tripper			40.4	181	4.48	12.74%
03/27/04	57	Clear	Tripper			39	207	5.31				14.4	75	5.21	1.91%
03/28/04	49	Clear										43	197	4.58	
03/29/04	47	Clear													
03/30/04	33	Cloudy	7	L-1	1165	11.2	57	5.09	11	L-2	1138	42.8	210	4.91	3.72%
03/31/04	42	Light Rain	Tripper			47.5	246	5.18				47.2	257	5.44	-4.88%
Totals						312.3	1,573.0	5.04				1,054.4	4,764.0	4.52	11.48%

CTTRANSIT BUS FUEL ECONOMY



Bus Type	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Fleet	3.2	3.3	3.55	3.71	3.7	3.62	3.48	3.69	3.69	0	0	0
Base	3.87	3.92	4.26	4.39	4.43	4.67	4.58	4.49	4.49	0	0	0
Hybrids	4.18	4.27	4.76	5.08	4.91	4.96	4.89	4.85	5.01	0	0	0

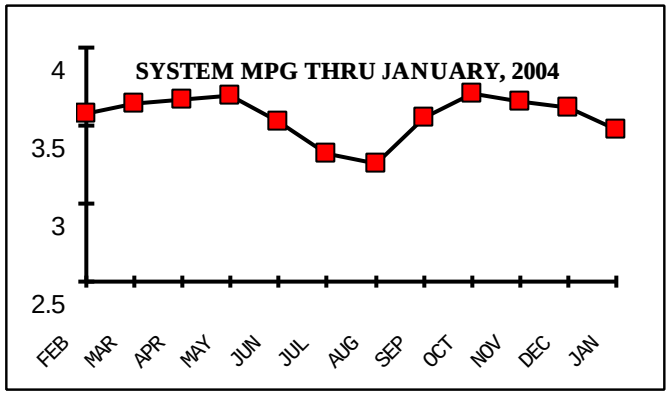
FLEET MILES & MILES PER GALLON
JANUARY, 2004

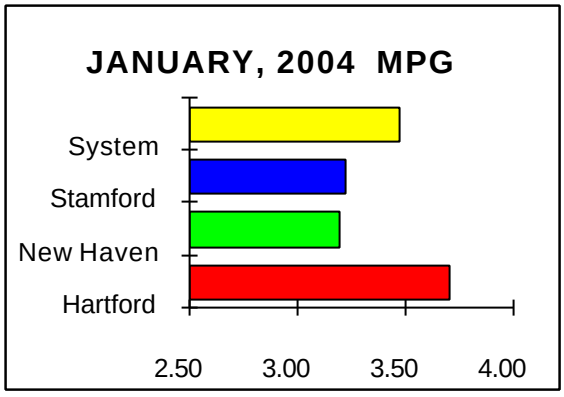
HARTFORD DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make & Series	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NFI S-40 201-240	40	162,042	37,360	4.34	164,765	36,434	4.52	-2,723	926	-0.18
NOVA 1121 9637-9649	10	31,778	8,207	3.87	35,847	9,587	3.74	-4,069	-1,380	0.13
MCI 911-915 & 9001-9200	77	138,583	43,370	3.20	198,303	60,199	3.29	-59,720	-16,829	-0.10
NFI 6V92 9301-9338	38	78,859	27,257	2.89	81,382	26,954	3.02	-2,523	303	-0.13
NFI S-50 9339-9340 & 9401-9428	30	71,035	18,045	3.94	76,642	18,224	4.21	-5,607	-179	-0.27
NFI S-50 941-965	25	46,456	9,631	4.82	61,398	11,407	5.38	-14,942	-1,776	-0.56
NFI Hybrid H301 & H302	2	6,811	1,393	4.89	N / A	N / A	N / A	N / A	N / A	N / A
MCI Commuter 303-309	7	19,851	4,529	4.38	N / A	N / A	N / A	N / A	N / A	N / A
Hartford Totals	229	555,415	149,792	3.71	618,337	162,805	3.80	-89,584	-18,935	-0.09

NEW HAVEN DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NOVA 1121 9601-9623	23	60,099	18,407	3.27	68,972	20,050	3.44	-8,873	-1,643	-0.17
ElDorado 9901-9903	3	1,216	611	1.99	3,481	1,335	2.61	-2,265	-724	-0.62
NFI S-50 330-371	41	77,706	21,977	3.54	N / A	N / A	N / A	N / A	N / A	N / A
MCI 9101 - 9186	43	146,084	48,196	3.03	217,948	70,133	3.11	-71,864	-21,937	-0.08
New Haven Totals	110	285,105	89,191	3.20	290,401	91,518	3.17	-5,296	-2,327	0.02

STAMFORD DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NOVA 1121 9626-9636	14	31,110	10,922	2.85	29,302	9,424	3.11	1,808	1,498	-0.26
ElDorado 9904-9913	10	7,823	3,957	1.98	7,529	4,133	1.82	294	-176	0.16
NFI S-40 101-126	26	66,078	19,470	3.39	71,872	20,304	3.54	-5,794	-834	-0.15
NFI S-40 127-132	6	23,264	5,420	4.29	22,752	5,163	4.41	512	257	-0.11
Stamford Totals	56	128,275	39,769	3.23	131,455	39,024	3.37	1,808	1,498	-0.14

SYSTEM		*Current Month*			*Prior Year Month*			*Difference*		
Make	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
All buses	395	968,795	278,752	3.48	1,040,1 93	293,347	3.55	-71,398	-14,595	-0.07





CT TRANSIT

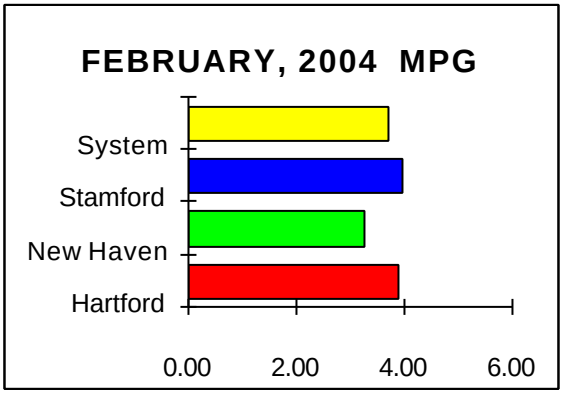
FLEET MILES & MILES PER GALLON
FEBRUARY, 2004

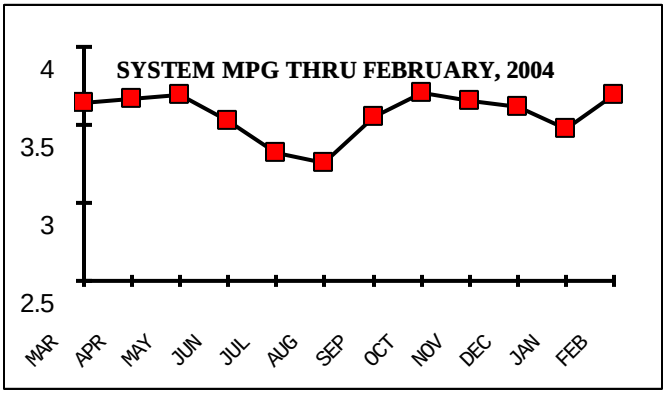
HARTFORD DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make & Series	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NFI S-40 201-240	40	163,647	36,548	4.48	153,744	33,440	4.60	9,903	3,108	-0.12
NOVA 1121 9637-9649	10	34,364	8,562	4.01	36,825	9,682	3.80	-2,461	-1,120	0.21
MCI 911-915 & 9001-9200	63	118,997	35,453	3.36	171,790	51,645	3.33	-52,793	-16,192	0.03
NFI 6V92 9301-9338	38	75,465	25,398	2.97	72,938	24,470	2.98	2,527	928	-0.01
NFI S-50 9339-9340 & 9401-9428	30	72,483	17,713	4.09	69,640	16,572	4.20	2,843	1,141	-0.11
NFI S-50 941-965	25	47,073	9,171	5.13	51,989	9,711	5.35	-4,916	-540	-0.22
NFI Hybrid H301 & H302	2	5,778	1,190	4.86	N/A	N/A	N/A	N/A	N/A	N/A
MCI Commuter 303-309	7	20,057	4,330	4.63	N/A	N/A	N/A	N/A	N/A	N/A
NFI S-50 310-324	14	7,067	2,148	3.29	N/A	N/A	N/A	N/A	N/A	N/A
Hartford Totals	229	544,931	140,513	3.88	556,926	145,520	3.83	-44,897	-12,675	0.05

NEW HAVEN DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NOVA 1121 9601-9623	23	57,090	17,200	3.32	66,333	19,376	3.42	-9,243	-2,176	-0.10
ElDorado 9901-9903	3	1,270	586	2.17	2,981	1,112	2.68	-1,711	-526	-0.51
NFI S-50 330-371	41	106,939	30,303	3.53	N/A	N/A	N/A	N/A	N/A	N/A
MCI 9101 - 9186	45	101,634	33,648	3.02	194,223	62,620	3.10	-92,589	-28,972	-0.08
New Haven Totals	112	266,933	81,737	3.27	263,537	83,108	3.17	3,396	-1,371	0.09

STAMFORD DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NOVA 1121 9626-9636	14	24,875	6,929	3.59	28,339	8,784	3.23	-3,464	-1,855	0.36
ElDorado 9904-9913	10	8,940	2,627	3.40	7,243	3,206	2.26	1,697	-579	1.14
NFI S-40 101-126	26	65,824	16,580	3.97	64,142	17,726	3.62	1,682	-1,146	0.35
NFI S-40 127-132	6	21,514	4,477	4.81	19,770	4,469	4.42	1,744	8	0.38
Stamford Totals	56	121,153	30,613	3.96	119,494	34,185	3.50	-3,464	-1,855	0.46

SYSTEM		*Current Month*			*Prior Year Month*			*Difference*		
Make	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
All buses	397	933,017	252,863	3.69	939,957	262,813	3.58	-6,940	-9,950	0.11





CT TRANSIT

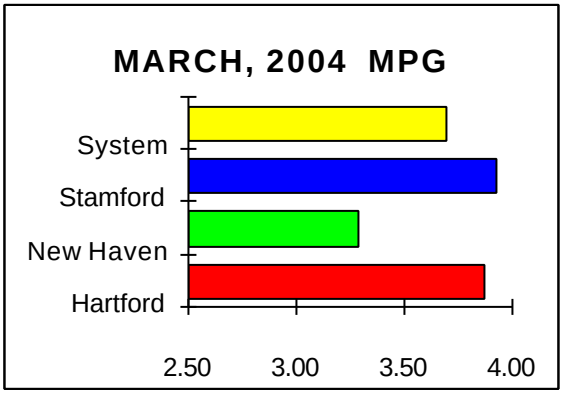
FLEET MILES & MILES PER GALLON
MARCH, 2004

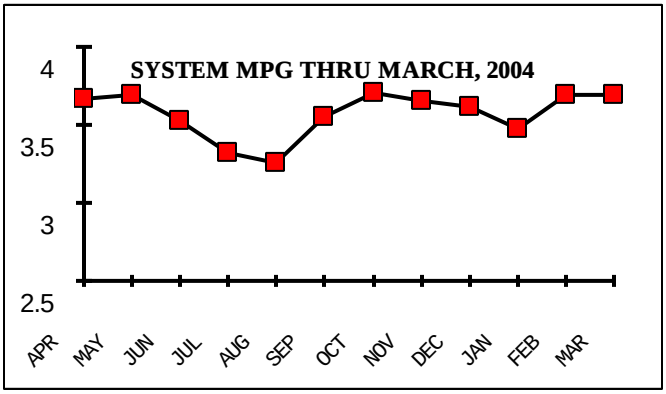
HARTFORD DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make & Series	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NFI S-40 201-240	40	168,715	38,450	4.39	175,864	38,215	4.60	-7,149	235	-0.21
NOVA 1121 9637-9649	13	39,360	10,031	3.92	41,371	10,560	3.92	-2,011	-529	0.01
MCI 911-915 & 9001-9200	63	112,909	33,586	3.36	169,143	50,425	3.35	-56,234	-16,839	0.01
NFI 6V92 9301-9338	38	83,700	28,132	2.98	81,174	26,754	3.03	2,526	1,378	-0.06
NFI S-50 9339-9340 & 9401-9428	30	75,290	18,816	4.00	73,053	17,561	4.16	2,237	1,255	-0.16
NFI S-50 941-965	25	55,473	10,693	5.19	58,125	10,674	5.45	-2,652	19	-0.26
NFI Hybrid H301 & H302	2	5,610	1,119	5.01	N/A	N/A	N/A	N/A	N/A	N/A
MCI Commuter 303-309	7	23,585	5,092	4.63	N/A	N/A	N/A	N/A	N/A	N/A
NFI S-50 310-324	14	51,691	13,280	3.89	N/A	N/A	N/A	N/A	N/A	N/A
Hartford Totals	232	616,333	159,199	3.87	598,730	154,189	3.88	-63,283	-14,481	-0.01

NEW HAVEN DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NOVA 1121 9601-9623	23	57,475	17,329	3.32	70,833	20,051	3.53	-13,358	-2,722	-0.22
ElDorado 9901-9903	3	1,541	675	2.28	3,442	1,187	2.90	-1,901	-512	-0.62
NFI S-50 330-371	41	121,474	34,445	3.53	N/A	N/A	N/A	N/A	N/A	N/A
MCI 9101 - 9186	43	118,246	38,345	3.08	212,452	67,425	3.15	-94,206	-29,080	-0.07
New Haven Totals	110	298,736	90,794	3.29	286,727	88,663	3.23	12,009	2,131	0.06

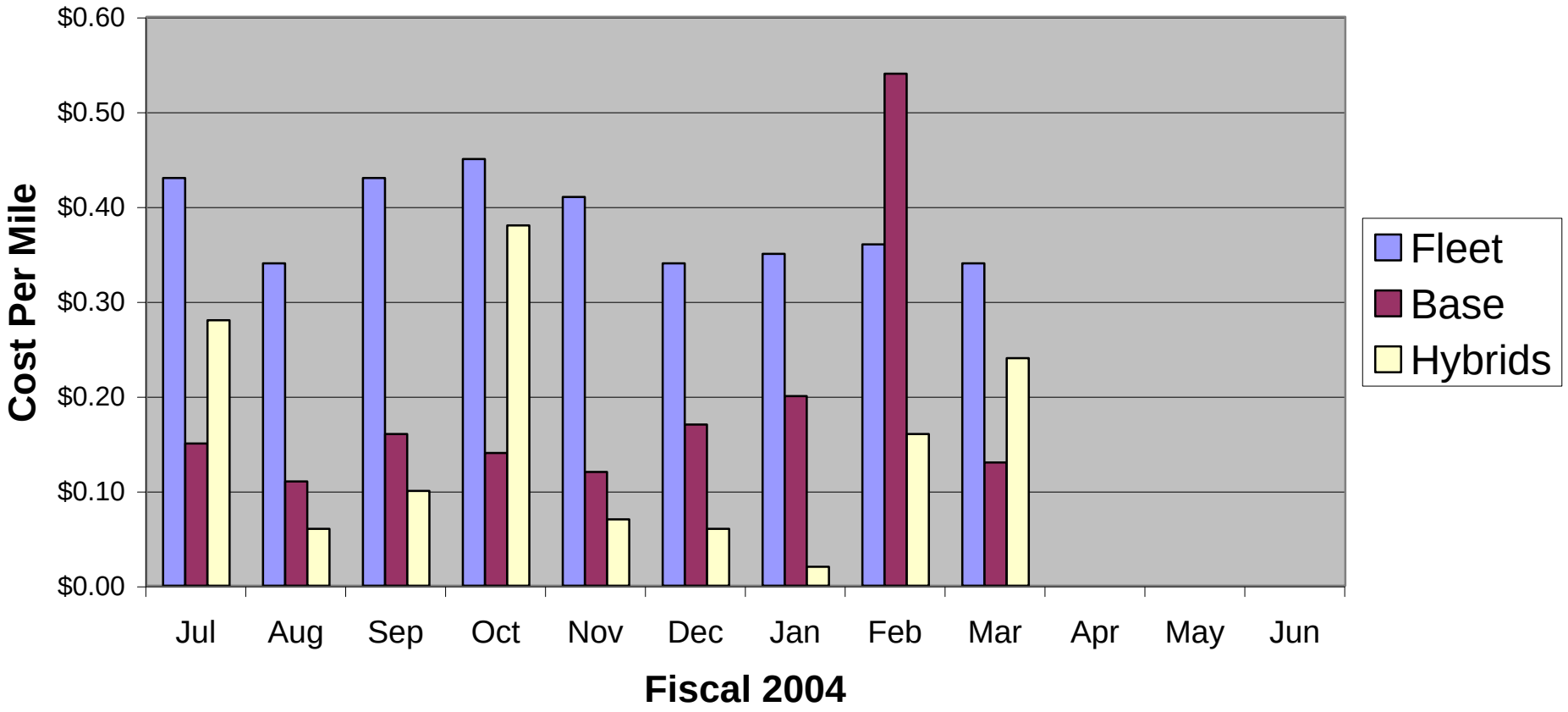
STAMFORD DIVISION		*Current Month*			*Prior Year Month*			*Difference*		
Make	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
NOVA 1121 9626-9636	11	25,626	7,164	3.58	32,146	9,349	3.44	-6,520	-2,185	0.14
ElDorado 9904-9913	10	11,685	3,235	3.61	7,262	3,370	2.15	4,423	-135	1.46
NFI S-40 101-126	26	75,131	19,321	3.89	68,716	18,589	3.70	6,415	732	0.19
NFI S-40 127-132	6	24,667	5,213	4.73	23,114	5,085	4.55	1,553	128	0.19
Stamford Totals	53	137,109	34,933	3.92	131,238	36,393	3.61	-6,520	-2,185	0.32

SYSTEM		*Current Month*			*Prior Year Month*			*Difference*		
Make	No.	Miles	Gallons	MPG	Miles	Gallons	MPG	Miles	Gallons	MPG
All buses	395	1,052,178	284,926	3.69	1,016,695	279,245	3.64	35,483	5,681	0.05



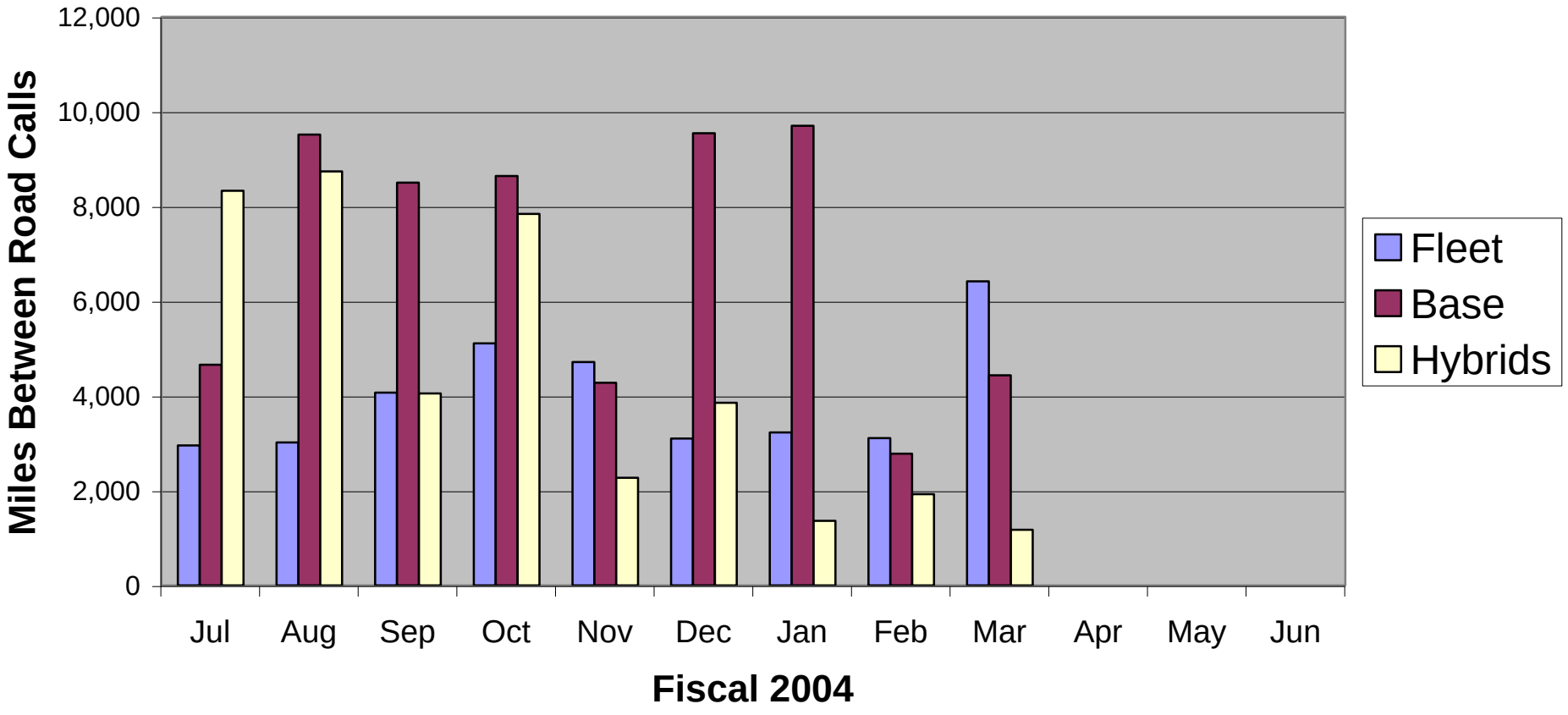


CTTRANSIT BUS MAINTENANCE
COST PER MILE



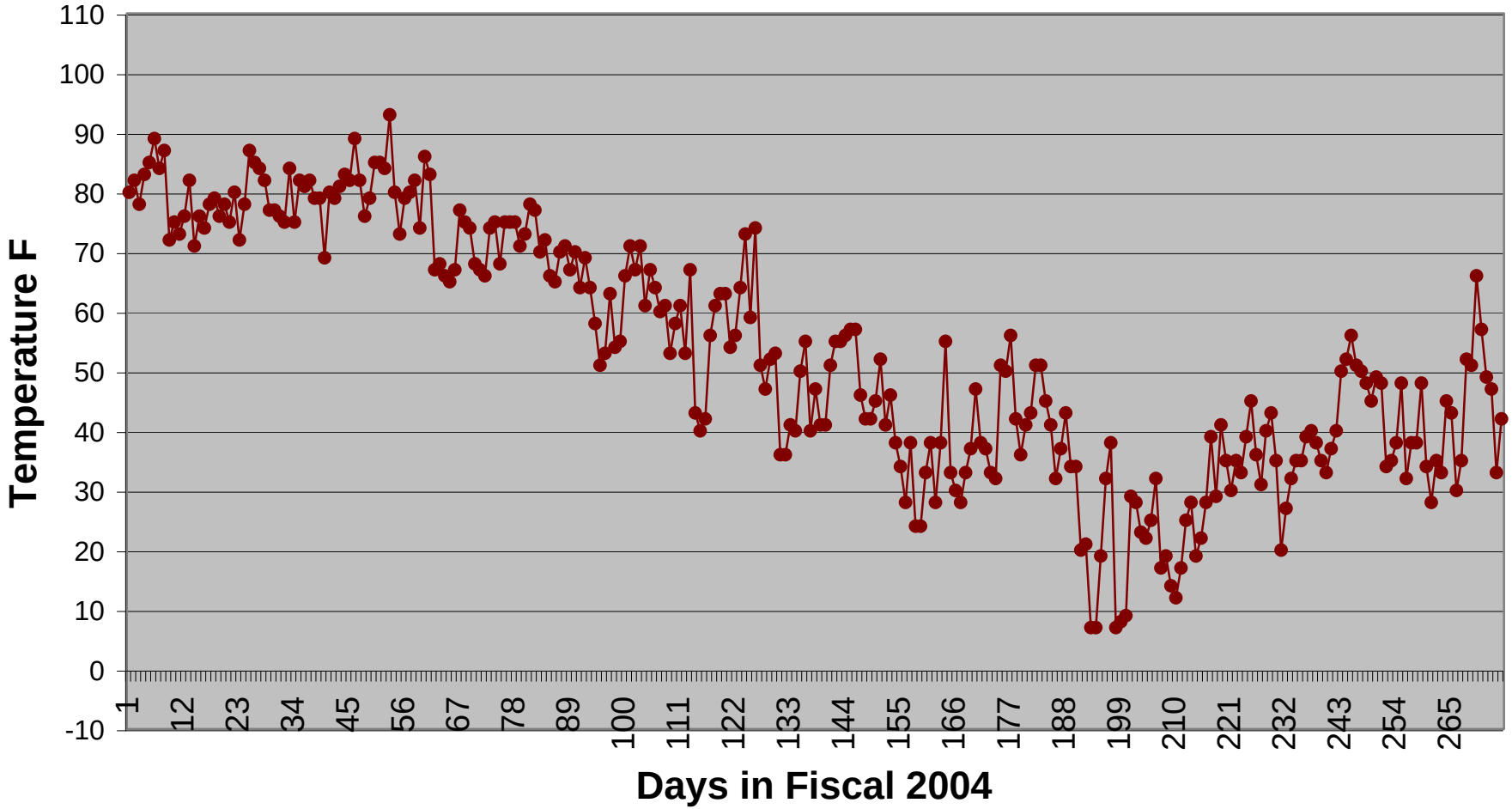
Bus Type	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Fleet	0.43	0.34	0.43	0.45	0.41	0.34	0.35	0.36	0.34	0	0	0
Base	0.15	0.11	0.16	0.14	0.12	0.17	0.2	0.54	0.13	0	0	0
Hybrids	0.28	0.06	0.10	0.38	0.07	0.06	0.02	0.16	0.24	0	0	0

CTTRANSIT BUS
MILES BETWEEN ROAD CALLS



Bus Type	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Fleet	2955	3016	4068	5110	4713	3100	3229	3110	6416	0	0	0
Base	4656	9515	8501	8640	4276	9543	9699	2780	4435	0	0	0
Hybrids	8329	8737	4051	7840	2271	3854	1362	1926	1175	0	0	0

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							
0400160	1	301	New Flyer Hybrid Bus Bill Transport Slow Replaced Bill Transport	02/09/04	02/09/04	0.50	10.69	765.05	0.00	0.00
0404661	1	301	New Flyer Hybrid Bus A/C Warranty Inspection (Thermo-KIng Dealer) completed	03/29/04	03/29/04	2.00	41.68	0.00	0.00	0.00
0404486	1	301	New Flyer Hybrid Bus Perform the E Check in accordance with Task Card service bus	03/26/04	03/26/04	0.25	5.25	0.00	0.00	0.00
0403322	1	301	New Flyer Hybrid Bus Perform the B Check in accordance with Task Card Perform the B Check in accordance with Task Card	03/12/04	03/15/04	4.00	85.52	67.63	0.00	0.00
0402577	1	301	New Flyer Hybrid Bus Perform the E Check in accordance with Task Card service .bus	03/04/04	03/04/04	1.00	20.99	0.00	0.00	0.00
0401517	1	301	New Flyer Hybrid Bus Perform the A Check in accordance with Task Card a-insp	02/23/04	02/24/04	2.00	41.68	0.00	0.00	0.00
0400817	1	301	New Flyer Hybrid Bus Perform the E Check in accordance with Task Card service bus	02/16/04	02/16/04	0.25	5.25	0.00	0.00	0.00
0399774	1	301	New Flyer Hybrid Bus	02/04/04	02/05/04	4.00	85.52	29.00	0.00	0.00

			Perform the B Check in accordance with Task Card							
			Perform the B Check in accordance with Task Card							
0398794	1	301	New Flyer Hybrid Bus	01/23/04	01/23/04	0.25	5.24	0.00	0.00	0.00
			Perform the E Check in accordance with Task Card							
			service bus							
0397552	1	301	New Flyer Hybrid Bus	01/09/04	01/13/04	2.00	41.60	0.00	0.00	0.00
			Perform the A Check in accordance with Task Card							
Asset		301	New Flyer Hybrid Bus	Subtotal -->		16.25	343.42	861.68	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							
0403316	1	302	New Flyer Hybrid Bus pac brake replace pac brake	03/12/04	03/12/04	1.50	32.07	593.59	0.00	0.00
0400588	1	302	New Flyer Hybrid Bus left low beam light out replaced light	02/13/04	02/13/04	0.25	5.26	3.15	0.00	0.00
0400719	1	302	New Flyer Hybrid Bus insp service bus	02/13/04	02/13/04	0.25	5.25	0.00	0.00	0.00
0404868	1	302	New Flyer Hybrid Bus Perform the E Check in accordance with Task Card service bus	03/31/04	03/31/04	0.25	5.25	0.00	0.00	0.00
0402458	1	302	New Flyer Hybrid Bus Perform the A Check in accordance with Task CardPerform the A Check in accordance with Task CardPerform the A Check in accordance with Task CardPerform the A Check in accordance with Task CardPerform the A Check in accordance with Task CardPerform the B Check in accordance with Task Card Perform the B Check in accordance with Task Card	03/03/04	03/04/04	4.00	85.52	103.58	0.00	0.00
0398807	1	302	New Flyer Hybrid Bus Perform the A Check in accordance with Task Card A-INSP.	01/23/04	01/25/04	2.00	42.68	0.00	0.00	0.00

0397930	1	302	New Flyer Hybrid Bus Perform the E Check in accordance with Task Card service .bus	01/14/04	01/14/04	1.00	20.95	0.00	0.00	0.00
Asset		302	New Flyer Hybrid Bus	Subtotal -->		9.25	196.98	700.32	0.00	0.00
				Grand Total -->		25.50	540.40	1562.00	0.00	0.00

CTTRANSIT Hybrid Bus Trouble Codes

Date	H301	H302	Notes
07/14/03	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		
07/15/03	All clear	All clear	Follow-up check
07/21/03	All clear	D1=6624=Can link lost with Battery Controller	No service disruption - transparent to user
		D2=6619=Can link lost with Inverter B	
07/29/03	All clear	All clear	Follow-up check
08/04/03	All clear	D1=6624=Can link lost with Battery Controller	No service disruption - transparent to user
08/13/03	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	
08/25/03	All clear	All clear	Follow-up check
09/02/03	All clear	All clear	Follow-up check
09/07/03	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		
09/09/03	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
09/25/03	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	
10/06/03	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.
10/06/03	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	
11/03/03	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	
11/11/03	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	
11/13/03	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.
11/24/03	D1 = 6523 = Enginge Torque Verification	D1 = 6634 = Can link lost	No adverse bus operations

CTTRANSIT Hybrid Bus Trouble Codes

Date	H301	H302	Notes
12/01/03	All Clear	D1=6634	Not cleared from previous week
12/08/03	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	
12/14/03	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	
12/31/03	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	
01/05/04	All Clear	All Clear	
01/12/04	All Clear	All Clear	
01/19/04	All Clear	All Clear	
01/25/04	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
02/02/04	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	
02/08/04	All Clear	All Clear	
02/15/04	All Clear	All Clear	
02/22/04	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	
02/29/04	All Clear	All Clear	
03/07/04	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		
03/14/04	All Clear	All Clear	
03/21/04	All Clear	6513=engine controller warning	
03/28/04	All Clear	6513=engine controller warning	