

Final Technical Report

Project Title: Southern Nevada Alternative Fuels Demonstration Project

Recipient: City of Las Vegas, Nevada

Award Number: DE-FG36-06GO86068

Project Start Date: August 1, 2006
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I. INTRODUCTION

Hydrogen fuel is becoming a more accepted way to power vehicles. Unlike other alternative fuels, hydrogen engines can achieve “Near Zero” regulated tailpipe emissions and CO₂ levels. Another advantage of hydrogen fuel is that it can be used with the existing internal combustion engine technology and leverage existing manufacturing facilities. Hydrogen ICE powertrains can be significantly more efficient than the most advanced diesel technologies. Ford Motor Company (Ford) was the first automaker to develop commercially available hydrogen-powered internal-combustion engines (H₂ICEs, also known as hydrogen engines) and has a fleet of approximately 30 E-450 H₂ICE shuttle buses in North America. Two of these vehicles were driven by the City of Las Vegas, Nevada, for this Department of Energy Southern Nevada Alternative Fuels Demonstration Project. Even with the environmental benefits of hydrogen fuel, H₂ICEs still face considerable challenges. Like all hydrogen-powered vehicles, H₂ICEs have a limited driving range of 150 to 200 miles, due to fuel storage limitations and fuel infrastructure issues. The public’s perceived dangers of transporting, storing, and using hydrogen fuel is changing slowly, but many still believe the risks of using hydrogen outweigh the benefits. In addition, H₂ICEs are still very expensive. During this project performance, reliability, safety, efficiency, and rider comment data was collected. Ford and the City of Las Vegas (City) jointly participated in this US Department of Energy (DOE) demonstration project.

II. PROJECT OBJECTIVE

The project objective is to help both Ford and the City demonstrate and evaluate the performance characteristics of 100% hydrogen fueled vehicles, in particular the E-450 H₂ICE shuttle buses developed by Ford. The City will lease two of these buses from Ford for two years. These E-450 shuttle buses use a 6.8-liter supercharged Triton V-10 engine with a hydrogen storage system equivalent to 29 gallons of gasoline. The buses are outfitted with additional equipment used to gather information needed for the evaluation. By using ICE technology and utilizing a virtually emission free fuel, benefits to be derived include air quality enhancement and vehicle performance improvements from domestically produced, renewable energy sources. The Southern Nevada Alternative Fuels Program is designed to demonstrate, in a day-to-day bus operation, the reliability and efficiency of a hydrogen bus operation under extreme conditions. The routes selected are high visibility, downtown corridor routes primarily serving the senior community and operate three to five days per week in five to ten hour daily time slots depending on passenger demand. The buses will be driven over a two year period by City bus drivers. Ford will train City mechanics on the day to day maintenance and diagnostics of the buses. With Ford’s assistance and direction, services and repairs will be performed by the City’s mechanics at the City Fleet West Service Center facilities.

III. BACKGROUND

Hydrogen is the most abundant and simplest element in the universe. It is also the lightest of all elements and gases, and is 14 times lighter than air. Hydrogen is

colorless, odorless, and nontoxic. Unlike carbon-based fuels, hydrogen produces no harmful by-products upon combustion. Hydrogen has the highest combustion energy per pound relative to any other fuel and offers 2-3 times more energy than most other common fuels.

Although it was not successful, in 1807 Francois Isaac de Rivaz designed the first internal combustion engine and car that used hydrogen and oxygen as fuel. Later, in 1970, Paul Dieges patented (US patent 3844262) a modification to the gasoline powered internal combustion engine which allowed the engine to run on hydrogen. The H2ICE is a modified version of the traditional gasoline internal combustion engine (ICE) vehicle. Modifications to the traditional gasoline ICE typically include hardened valves and valve seats, stronger connecting rods, iridium tipped spark plugs, higher voltage ignition coil, fuel injectors designed for a gaseous fuel instead of a liquid, larger crankshaft damper, stronger head gasket material, modified (for a supercharger) intake manifold, positive pressure supercharger, and a high temperature engine oil. The hydrogen engines burn fuel in the same manner that gasoline engines do. H2ICE technology can be used where fuel cells are not yet a viable solution, such as in very cold weather.

Even with this technology available for 200 years, H2ICE vehicles are not commercially available today. H2ICE vehicles are cheaper to manufacture for commercial applications than a hydrogen fuel cell vehicle because the cost of retooling for production is lower, but the cost is still substantial over a gasoline ICE vehicle.

One major issue with having H2ICE vehicles as a viable solution for the masses is the lack of hydrogen fueling sites. The City of Las Vegas is a good fit for demonstration projects such as this project because it has its own hydrogen energy fueling station that was brought online in November 2002. The station was built under a separate cooperative agreement¹ (DE-FC36-99NV13578) between DOE and Air Products and Chemicals, Inc. in partnership with the City of Las Vegas and Plug Power, Inc. as a commercial demonstration of hydrogen as a safe and clean energy alternative. The site originally featured the co-production of hydrogen fuel and electric power. In February 2004, the on-site steam reformer used to generate the hydrogen fuel was disengaged. Liquid fuel deliveries were started at that time and continue today. The two H2ICE buses will be fueled at this hydrogen energy station.

IV. TECHNICAL APPROACH

The technology used during the demonstration project in the Ford buses is a modified internal combustion engine that allows the vehicles to run on 100% hydrogen fuel. Hydrogen gives a more thorough fuel burn which results in more power and responsiveness and less pollution. The resultant emissions from the tailpipe are 2010

¹ The final technical report for the hydrogen energy station can be found at the Office of Scientific and Technical Information website <http://www.osti.gov/bridge/advancedsearch.jsp> (identifier number DEFC36-99NV13578).

Phase II compliant with NO after treatment. The shuttle buses have a 6.8-liter supercharged Triton V-10 engine with a hydrogen storage system equivalent to 29 gallons of gasoline. The buses are also outfitted with additional equipment used to gather information needed for the evaluation. The City of Las Vegas will lease two experimental E-450 hydrogen engine buses from Ford for a two year period.

The City will purchase a computer and special tools for diagnostics and repairs on the buses. Ford Motor Company will train City mechanics on how to perform diagnostics and repairs on the buses as directed by Ford. The City will have one qualified repair technician and one qualified technical assistant for servicing the buses. City bus drivers and Fleet personnel will be trained on how to fuel the vehicles and on maintenance and documentation procedures. First Responders will be briefed on the H2ICE bus system and specific information related to handling possible emergency situations.

A. Design considerations:

The vehicle testing and product design cycle the H2ICE shuttle bus demonstration vehicles were put through in order to ensure that the H2ICE buses are road worthy mirrored the testing that would occur during a normal vehicle program.

During this phase, vehicles underwent engine durability testing, vehicle durability testing, crash testing and other tests required for any vehicle of this type.

During the H2ICE shuttle bus development phase, Ford initiated the long process of identifying and then negotiating vehicle demonstration user agreements with interested partners.

B. Data collection:

Performance, reliability, safety, efficiency, and rider comments data will be collected. The method of data collection will be both electronically and manually. Ford will use onboard vehicle diagnostics and a computer system at the City's Fleet West Service Center (WSC) site to diagnose warning messages and monitor vehicle performance. To get rider comments, survey cards will be created for this demonstration project. Fueling data will be monitored by Ford's onboard software and fill information will be written down by the bus driver or mechanic on fuel logs at the time of fueling. Air Product's hydrogen site software also records fill activity when the fuel is dispensed. This data is emailed to the City each month and will be sent to Ford for comparison to their online diagnostic and the City's manual log's data. All data collected will be analyzed by Ford.

C. Fuel:

The City has had an operational hydrogen fuel site at the Fleet WSC since November 2002. Liquid hydrogen is delivered to the site. This is where the buses will refuel each day before driving their routes.

V. PROJECT RESULTS

A. Vehicle Deployment:

Two Ford E-450 H2ICE buses were leased from Ford Motor Company fully fitted for using hydrogen fuel. An agreement between the City of Las Vegas and Ford Motor Company was signed and ratified by the City Council. Lease payments per the contract terms were made to Ford. The buses arrived at the City mid June 2007 and were identified as #H594 and #H595. A press release was held on August 14, 2007 to introduce the H2ICE buses to the public. The buses were placed in service and the first bus run was on August 22, 2007. The buses operated for approximately five to eight hours each day they were in service. The lease agreement with Ford ran from June 2007 through June 2009. The buses were shipped back to Ford the end of June 2009.

The City revenues decreased when the economy started to fail causing unplanned budget cuts. The revenues continued to fall over the project term and additional budget cuts were made during this time. One of the budget cuts discontinued the City's downtown bus operations starting July 2009. With the decreasing revenues and the anticipated shut down of bus operations, the City had a shortage of bus drivers. This reduced the driving time of the H2ICE buses each week from the planned three days a week. In order to get more mileage on the buses during the project period, the City drove them on additional routes outside of the planned downtown routes when the seating capacity and driving range of the buses were able to accommodate the route. The bus operations continued to operate through the end of June 2009, which was the end of the two year lease with Ford. No extension for the lease agreement was possible with the budget cuts.

C. Training:

Prior to placing the buses into service, Ford trained City Fleet staff on how to perform diagnostics and repairs on the buses. Bus drivers and Fleet personnel were trained on how to fuel the vehicles and on maintenance and documentation procedures. First Responders were given an overview of the H2ICE bus system and specific information related to handling any emergency situations that might occur.

B. Fuel Station Experience:

The initial intent was to run both buses on the same day if passenger demand created the need. However, it was discovered the buses could not both run on the same day due to capacity restrictions of the hydrogen fuel site. Upgrading the fuel site, which would allow both buses to be fueled on the same day, was considered. It was decided to not upgrade the site due to the costs involved.

C. Compiling Data:

The City started receiving weekly performance reports from Ford at the end of September 2007 for each bus. The reports used data taken from the buses' online computers and contained various information including the fuel dispensed, engine running time, distance driven, and fuel economy.

Rider survey cards were issued at different times throughout the project and the data from completed survey cards was compiled manually. All data collected was sent to Ford for analysis.

The hydrogen refueling site records the fills for the blended dispensers, but there is no way to identify which vehicle is associated with each fill. The fill times in the file from the hydrogen vendor were compared to the manual logs and the reports from Ford to determine the fills related to the H2ICE buses. It was determined the fuel pressure reading at the fuel site was not accurate. Due to the pressure reading variances at the fuel site and since manual logs are prone to human error, the decision was made to use the data from Ford's diagnostic software for reporting fill information.

D. Maintenance:

Several maintenance issues were repaired during the project. Many of these issues were related to a very small fuel leak. The hydrogen management system performed excellent in identifying the leaks.

One issue occurred where the check engine light came on and the vehicle was towed back to the fleet WSC for diagnostics. The problem was found to be a leaking intercooler coolant hose.

VI. DATA RESULTS

The data results from this project are summarized below. Detailed documentation of vehicle data collection is shown in Appendix A. On-Road Fuel Economy, Maintenance Summary, Safety Summary, and Emissions Readings, Survey Results and Passenger Comments are shown.

A. On-Road Fuel Economy:

The data is compiled based on miles/kg of H₂ used. The refueling data was generated by an automatic database algorithm. Manual analysis was used when the algorithm provided unreasonable data. Based on the calculations, the fuel consumption of bus #H594 ranged from 3.6 to 7.1 miles/kg H₂ with the average being 5.3 miles/kg H₂ used. The fuel consumption of bus #H595 ranged from 3.9 to 8.2 miles/kg H₂ with the average being 5.2 miles/kg H₂ used.

B. Maintenance Summary:

Several maintenance issues were repaired during the project. Many of these issues were related to a very small fuel leak. The hydrogen management system performed excellent in identifying the leaks.

One issue occurred where the check engine light came on and the vehicle was towed back to the fleet WSC for diagnostics. The problem was found to be a leaking intercooler coolant hose.

C. Safety Summary:

The check engine light came on while bus #H595 was in service early in the project during August 2007. The engine starting making noises and was losing power, so the bus was towed back to the Fleet WSC for diagnostics. It was found the engine light came on because the coolant hose was leaking coolant and unable to cool the intake air. The warm intake air made the engine lose power. Also, the jack screw was completely separate. Neither of these issues would have caused the engine to make noises, so we were unable to validate this comment from the bus driver. Ford determined neither of these issues were a safety issue or concern. No situations occurred during the project that required assistance from First Responders

D. Emissions Readings:

Emissions readings were not obtained during the project. The City planned to measure the vehicle exhaust with an emissions analyzer machine but discovered the bus emission levels were below the capability of their machine.

E. Survey Results:

The surveys were given to passengers periodically throughout the project. Table 1 summarizes the total responses for each bus.

Table 1.

Bus H594	Summary Tally of Answers to Questions															
	Overall Comfort?				Smoothness?			Noise Level?			Overall Ride?			Environmental Importance?		
	Very Good	Good	OK	Not Good	Smother	Same	Rougher	Quieter	Same	Noisier	Better	Same	Worse	Very	No Opinion	Not
# of Surveys	1	2	3	4	1	2	3	1	2	3	1	2	3	1	2	3
180	130	48	2	0	126	52	1	146	32	1	127	45	1	154	16	3

H595	Summary Tally of Answers to Questions															
	Overall Comfort?				Smoothness?			Noise Level?			Overall Ride?			Environmental Importance?		
	Very Good	Good	OK	Not Good	Smother	Same	Rougher	Quieter	Same	Noisier	Better	Same	Worse	Very	No Opinion	Not
# of Surveys	1	2	3	4	1	2	3	1	2	3	1	2	3	1	2	3
149	115	31	2	0	102	42	2	117	24	3	113	22	3	132	4	1

F. Passenger Comments:

Passenger comments were solicited on the survey cards. The majority of comments were favorable. Table 2 summarizes the types of comments received for each bus.

Table 2.

Summary of Passenger Comments	<i>Bus H594</i>	<i>Bus H595</i>
	# of Comments	# of Comments
# of Comments Received (some have more than one subject per comment)	44	34
Positive Environment	10	8
Positive Overall Comfort/Ride	19	11
Suggestions or Negative Comments:	11	6
More Seats	3	2
More Room	4	0
Air Conditioning	1	3
Performance	1	0
Miscellaneous Other	2	1
Misc Comments:	7	10
Good/Nice/Thank You	7	8
Miscellaneous Other	0	2

VII. CONCLUSIONS

Hydrogen fuel offers many benefits over carbon-based fuels. H2 ICE technology can drive transition to H2 economy. The combined fleet has accumulated over 300,000 miles (1/4/2010), with extremely positive feedback

VIII. LESSONS LEARNED

The controllable issues encountered during this demonstration project were mainly due to the size of the hydrogen fuel tanks at the site and the amount of fuel that could be dispensed during a specified period of time. The time it took to rebuild the pressure at the fuel site for the size of tanks on the H2ICE buses was greater than the need for filling both buses on the same day. This limited the amount of drive time for each bus.

The uncontrollable issues encountered during this project were related to the economy and the budget cutbacks required during the project duration. The budget cutbacks left us with fewer bus drivers than expected, and with the ultimate shut down of the City's downtown bus operations. This also limited the amount of drive time for each bus.

Ford dealerships were targeted as primary service facilities for customers. City of Las Vegas requested to provide their own service and maintenance. City of Las Vegas West Service Center proved to be an excellent partner. The flexibility and access to the technicians made servicing prototype vehicles easier than a dealership.

IX. RECOMMENDATIONS FOR FUTURE WORK

A means of measuring exhaust emissions from the buses was not available at the City. A method of measuring the emissions would have helped verify the lower/virtually non-existent pollutants.

Having a hydrogen site with a greater fueling capacity will help increase the amount of driving time and data collected.

Appendix A

On-Road Fuel Economy Rev 7 [2008-07-27]

Data since inception of the program, all vehicles

Report Date	12/30/2009				
Deployment Start	8/22/2007				
H2 Tank Pressure	5000 psi				
Vehicle Model:	Ford H2ICE Bus				
Location of Operation:	Las Vegas, NV				
Vehicle #	H594				
Date	Fill-up Number	Odometer at Fill (miles)	kg H2 used	miles/kg H2	Comments ⁽¹⁾
24-Aug-07	1	850.6	n/a	n/a	Delivered to customer
30-Aug-07	2	902.8	11.16	4.7	
31-Aug-07	3	971.6	14.65	4.7	
5-Sep-07	4	1023.0	10.60	4.8	
6-Sep-07	5	1031.2	n/a	n/a	Less than 10 miles
10-Sep-07	6	1080.8	11.27	5.1	
18-Sep-07	7	1108.5	4.78	5.8	
21-Sep-07	8	1170.5	11.18	5.5	
27-Sep-07	9	1233.2	12.22	5.1	
4-Oct-07	10	1233.4	n/a	n/a	Less than 10 miles
15-Oct-07	11	1237.1	n/a	n/a	Less than 10 miles
18-Oct-07	12	1292.8	11.31	5.3	
29-Oct-07	13	1350.1	9.77	5.9	
5-Nov-07	14	1419.4	12.53	5.5	
8-Nov-07	15	1483.4	11.12	5.8	
14-Nov-07	16	1542.3	9.78	6.0	
15-Nov-07	17	1591.0	7.57	6.4	
16-Nov-07	18	1647.3	9.22	6.1	
20-Nov-07	19	1701.9	9.14	6.0	
26-Nov-07	20	1753.7	7.32	7.1	
27-Nov-07	21	1798.1	6.74	6.6	
30-Nov-07	22	1856.7	10.15	5.8	
3-Dec-07	23	1856.9	n/a	n/a	Less than 10 miles
6-Dec-07	24	1916.6	10.58	5.7	
13-Dec-07	25	1968.9	9.46	5.5	
18-Dec-07	26	2023.9	9.68	5.7	
19-Dec-07	27	2080.9	9.92	5.7	
28-Dec-07	28	2195.4	20.09	5.7	
10-Jan-08	29	2252.0	9.12	6.2	
7-Feb-08	30	2349.2	15.88	6.1	

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Data since inception of the program, all vehicles

Report Date	12/30/2009				
Deployment Start	8/22/2007				
H2 Tank Pressure	5000 psi				
Vehicle Model:	Ford H2ICE Bus				
Location of Operation:	Las Vegas, NV				
Vehicle #	H594				
Date	Fill-up Number	Odometer at Fill (miles)	kg H2 used	miles/kg H2	Comments ⁽¹⁾
8-Feb-08	31	2396.7	7.38	6.4	
28-Feb-08	32	2444.0	8.16	5.8	
29-Feb-08	33	2487.8	7.81	5.6	
14-Mar-08	34	2533.0	8.25	5.5	
9-Apr-08	35	2616.2	14.35	5.8	
15-Apr-08	36	2651.6	7.76	4.6	
1-May-08	37	2715.4	12.90	4.9	
14-May-08	38	2745.8	5.09	6.0	
16-May-08	39	2804.6	13.10	4.5	
20-May-08	40	2851.0	8.90	5.2	
22-May-08	41	2914.8	12.74	5.0	
23-May-08	42	2979.6	11.13	5.8	
28-May-08	43	3043.4	13.12	4.9	
13-Jun-08	44	3090.1	12.31	3.8	
18-Jun-08	45	3146.9	10.21	5.6	
9-Jul-08	46	3210.7	13.14	4.9	
10-Jul-08	47	3259.4	10.60	4.6	Manual Analysis
22-Jul-08	48	3323.2	13.78	4.6	
23-Jul-08	49	3387.0	12.60	5.1	Manual Analysis
31-Jul-08	50	3408.4	3.75	5.7	
7-Aug-08	51	3463.3	13.14	4.2	
8-Aug-08	52	3526.1	15.92	3.9	
11-Aug-08	53	3585.0	11.35	5.2	
12-Aug-08	54	3634.9	12.30	4.1	
20-Aug-08	55	3698.8	11.19	5.7	Manual Analysis
22-Aug-08	56	3764.7	15.00	4.4	
26-Aug-08	57	3828.7	13.33	4.8	
5-Sep-08	58	3872.1	9.36	4.6	
9-Sep-08	59	3934.2	12.03	5.2	
16-Sep-08	60	3997.6	13.91	4.6	
16-Sep-08	61	3997.9	n/a	n/a	Less than 10 miles
1-Oct-08	62	4061.6	13.86	4.5	

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Data since inception of the program, all vehicles

Report Date	12/30/2009				
Deployment Start	8/22/2007				
H2 Tank Pressure	5000 psi				
Vehicle Model:	Ford H2ICE Bus				
Location of Operation:	Las Vegas, NV				
Vehicle #	H594				
Date	Fill-up Number	Odometer at Fill (miles)	kg H2 used	miles/kg H2	Comments ⁽¹⁾
2-Oct-08	63	4124.7	15.13	4.2	
8-Oct-08	64	4159.3	6.95	5.0	
15-Oct-08	65	4189.3	6.00	5.0	
20-Oct-08	66	4243.6	10.88	5.0	
21-Oct-08	67	4308.2	12.68	5.1	
22-Oct-08	68	4372.2	9.58	6.7	
23-Oct-08	69	4431.4	9.99	5.9	
29-Oct-08	70	4496.5	5.02	5.8	
30-Oct-08	71	4560.2	12.24	5.2	
13-Nov-08	72	4623.7	11.84	5.4	
21-Nov-08	73	4688.1	11.06	5.8	
24-Nov-08	74	4754.0	9.94	6.6	
3-Dec-08	75	4818.2	11.78	5.4	
4-Dec-08	76	4866.8	10.26	4.7	
19-Dec-08	77	4932.0	5.39	5.7	
23-Dec-08	78	4981.8	9.08	5.5	
29-Dec-08	79	5045.5	11.44	5.6	
30-Dec-08	80	5104.9	11.17	5.3	
5-Jan-09	81	5164.5	11.74	5.1	
6-Jan-09	82	5227.2	11.59	5.0	Manual Analysis
12-Jan-09	83	5271.9	8.58	5.2	
26-Jan-09	84	5323.6	10.35	5.0	
27-Jan-09	85	5383.5	11.61	5.2	
29-Jan-09	86	5441.3	11.12	5.2	
3-Feb-09	87	5500.7	11.15	5.3	
10-Feb-09	88	5563.0	11.98	5.2	
20-Feb-09	89	5627.1	12.10	5.3	
25-Feb-09	90	5692.0	10.63	6.1	
2-Mar-09	91	5756.0	11.85	5.4	
23-Mar-09	92	5860.5	13.29	6.5	Manual Analysis
30-Mar-09	93	5885.4	3.95	6.3	
6-Apr-09	94	5886.1	n/a	n/a	Less than 10 miles

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Deployment Start	8/22/2007				
H2 Tank Pressure	5000 psi				
Vehicle Model:	Ford H2ICE Bus				
Location of Operation:	Las Vegas, NV				
Vehicle #	H594				
Date	Fill-up Number	Odometer at Fill (miles)	kg H2 used	miles/kg H2	Comments ⁽¹⁾
6-Apr-09	95	5886.3	n/a	n/a	Less than 10 miles
21-Apr-09	96	5945.0	12.34	4.4	
6-May-09	97	6004.0	15.16	3.9	
12-May-09	98	6063.7	13.17	4.5	
14-May-09	99	6118.1	14.93	3.6	
15-May-09	100	6174.7	14.41	3.9	
26-May-09	101	6223.9	11.81	4.2	
1-Jun-09	102	6283.1	11.92	5.0	
24-Jun-09	103	6295.4	2.60	4.7	

Footnotes:

(1) Data may be collected manually (via driver logs). Electronic copies should be submitted on a quarterly basis. Include significant comments & anomalies.

(2) Fuel economy for short drives between fills (less than 10 miles) is subject to large errors and so is not calculated. Fuel used and miles driven are accumulated for the next calculation.

(3) Refueling data is generated by an automatic database algorithm. Manual analysis is used when the algorithm provides unreasonable data.

On-Road Fuel Economy Rev 7 [2008-07-27]

Data since inception of the program, all vehicles

Report Date	12/30/2009				
Deployment Start	8/22/2007				
H2 Tank Pressure	5000 psi				
Vehicle Model:	Ford H2ICE Bus				
Location of Operation:	Las Vegas, NV				
Vehicle #	H595				
Date	Fill-up Number	Odometer at Fill (miles)	kg H2 used	miles/kg H2	Comments ⁽¹⁾
22-Aug-07	1	539.9	n/a	n/a	Delivered to customer
23-Aug-07	2	591.3	9.92	5.2	
29-Aug-07	3	613.3	5.06	4.3	Defueled for repairs
5-Sep-07	4	613.5	n/a	n/a	Initial fill after repairs
17-Sep-07	5	642.7	3.99	7.3	
3-Oct-07	6	721.5	13.09	6.0	
4-Oct-07	7	776.8	6.91	8.0	
12-Oct-07	8	828.1	8.60	6.0	
15-Oct-07	9	880.0	8.06	6.4	
19-Oct-07	10	929.8	9.98	5.0	
23-Oct-07	11	995.3	10.69	6.1	
5-Nov-07	12	1045.9	8.91	5.7	
21-Nov-07	13	1103.1	9.57	6.0	
26-Nov-07	14	1128.5	3.11	8.2	
7-Jan-08	15	1129.6	n/a	n/a	Less than 10 miles
25-Jan-08	16	1181.8	12.13	4.4	
7-Mar-08	17	1261.5	13.91	5.7	Manual analysis
21-Mar-08	18	1350.3	18.21	4.9	
25-Mar-08	19	1397.1	9.46	4.9	
29-Apr-08	20	1489.1	18.37	5.0	
29-Apr-08	21	1566.5	9.77	7.9	
1-May-08	22	1632.7	14.75	4.5	
21-May-08	23	1671.6	6.30	6.2	Manual analysis
22-May-08	24	1735.2	12.51	5.1	
23-May-08	25	1735.5	n/a	n/a	Less than 10 miles
28-May-08	26	1799.5	11.55	5.6	Manual analysis
29-May-08	27	1863.2	12.49	5.1	
30-May-08	28	1913.1	10.30	4.8	
18-Jun-08	29	1972.6	12.01	5.0	
25-Jun-08	30	2036.8	15.41	4.2	
30-Jun-08	31	2069.0	4.96	6.5	Manual analysis
1-Jul-08	32	2133.8	14.60	4.5	

On-Road Fuel Economy Rev 7 [2008-07-27]

Data since inception of the program, all vehicles

Report Date	12/30/2009				
Deployment Start	8/22/2007				
H2 Tank Pressure	5000 psi				
Vehicle Model:	Ford H2ICE Bus				
Location of Operation:	Las Vegas, NV				
Vehicle #	H595				
Date	Fill-up Number	Odometer at Fill (miles)	kg H2 used	miles/kg H2	Comments ⁽¹⁾
9-Jul-08	33	2180.4	10.70	4.4	
17-Jul-08	34	2243.6	12.99	4.9	
24-Jul-08	35	2308.1	13.73	4.7	
28-Jul-08	36	2374.0	14.84	4.4	
29-Jul-08	37	2401.3	3.90	7.0	
30-Jul-08	38	2465.8	14.04	4.6	
31-Jul-08	39	2530.1	14.19	4.5	
1-Aug-08	40	2596.0	15.01	4.4	
13-Aug-08	41	2651.4	14.26	3.9	Manual analysis
20-Aug-08	42	2716.1	14.74	4.4	
21-Aug-08	43	2779.8	13.39	4.8	
27-Aug-08	44	2843.1	13.46	4.7	
28-Aug-08	45	2907.3	14.00	4.6	
10-Sep-08	46	2951.3	9.96	4.4	
17-Sep-08	47	3015.8	13.89	4.6	
18-Sep-08	48	3079.5	13.93	4.6	
22-Sep-08	49	3142.8	14.56	4.3	
23-Sep-08	50	3206.7	13.92	4.6	
29-Sep-08	51	3260.8	11.48	4.7	
30-Sep-08	52	3324.8	13.95	4.6	Manual analysis
1-Oct-08	53	3388.9	13.68	4.7	
16-Oct-08	54	3410.1	3.97	5.3	
23-Oct-08	55	3475.7	11.50	5.7	
24-Oct-08	56	3542.5	11.20	6.0	
27-Oct-08	57	3606.4	10.26	6.2	
29-Oct-08	58	3670.3	12.78	5.0	
6-Nov-08	59	3713.6	7.89	5.5	
12-Nov-08	60	3777.6	11.14	5.7	
19-Nov-08	61	3842.7	12.09	5.4	
20-Nov-08	62	3901.7	9.56	6.2	
25-Nov-08	63	3962.7	9.83	6.2	Manual Analysis

On-Road Fuel Economy Rev 7 [2008-07-27]

Data since inception of the program, all vehicles

Report Date	12/30/2009				
Deployment Start	8/22/2007				
H2 Tank Pressure	5000 psi				
Vehicle Model:	Ford H2ICE Bus				
Location of Operation:	Las Vegas, NV				
Vehicle #	H595				
Date	Fill-up Number	Odometer at Fill (miles)	kg H2 used	miles/kg H2	Comments ⁽¹⁾
3-Dec-08	64	4029.4	11.97	5.6	
10-Dec-08	65	4092.3	13.66	4.6	
23-Dec-08	66	4136.8	8.07	5.5	
24-Dec-08	67	4196.8	11.77	5.1	
26-Jan-09	68	4263.5	11.73	5.6	
28-Jan-09	69	4313.5	10.01	5.0	
4-Feb-09	70	4373.5	13.64	4.4	
20-Feb-09	71	4431.1	9.96	5.8	
24-Feb-09	72	4495.2	11.93	5.4	
4-Mar-09	73	4554.8	13.79	4.3	
18-Mar-09	74	4642.4	13.98	6.3	Manual Analysis
23-Mar-09	75	4672.6	4.85	6.2	
30-Mar-09	76	4721.9	9.56	5.2	
3-Apr-09	77	4722.2	n/a	n/a	Less than 10 miles
7-Apr-09	78	4777.8	11.39	4.9	
21-Apr-09	79	4841.5	14.18	4.5	
22-Apr-09	80	4895.4	11.29	4.8	
28-Apr-09	81	4954.0	11.96	4.9	
7-May-09	82	5077.0	16.70	7.4	
13-May-09	83	5137.6	14.15	4.3	
14-May-09	84	5196.1	14.23	4.1	
21-May-09	85	5241.0	10.64	4.2	
29-May-09	86	5295.8	12.08	4.5	
4-Jun-09	87	5359.0	13.47	4.7	
5-Jun-09	88	5422.5	13.79	4.6	
12-Jun-09	89	5487.0	14.39	4.5	
16-Jun-09	90	5550.8	13.80	4.6	
24-Jun-09	91	5562.4	2.03	5.7	

Footnotes:

(1) Data may be collected manually (via driver logs). Electronic copies should be submitted on a quarterly basis. Include significant comments & anomalies.

(2) Fuel economy for short drives between fills (less than 10 miles) is subject to large errors and so is not calculated. Fuel used and miles driven are accumulated for the next calculation.

(3) Refueling data is generated by an automatic database algorithm. Manual analysis is used when the algorithm provides unreasonable data.

Maintenance Summary: Rev 5 [2008-01-25]

Data since inception of the program, all vehicles

	Report Date	12/31/2009							
	Automaker	Ford Motor Company							
#	Component Name	H2 System	Unique Vehicle Identifier	Maintenance Type	Associated with an on-road vehicle failure, shut-down?	Scheduled, Un-Scheduled	Date of Repair, Replacement	Vehicle Miles Traveled (with this component installed) at Repair, Replacement	Comments, Description of Maintenance
1	Oil Separator Drain Hose "Y" connector	H2ICE	H594	Replacement	No	Un-Scheduled	8/22/2007	850	TSB #H07-08-14. Replaced "Y" connector.
2	Oil Separator Drain Hose "Y" connector	H2ICE	H595	Replacement	No	Un-Scheduled	8/22/2007	591	TSB #H07-08-14. Replaced "Y" connector.
3	Shutoff screw	H2ICE	H595	Repair	Yes	Un-Scheduled	8/24/2007	620	Check engine light came on while in service. Driver completed route and while driving to garage for repairs, engine started making noise and was losing power, so driver stopped at roadside. Bus was towed to garage and defueled. Found intercooler coolant hose was loose from fitting. Reinstalled hose, filled and bled coolant system. Found fuel leak at #6 tank valve lockdown screw. Tightened screw. Cleared check engine light and returned bus to service.

Maintenance Summary: Rev 5 [2008-01-25]

Data since inception of the program, all vehicles

	Report Date	12/31/2009							
	Automaker	Ford Motor Company							
#	Component Name	H2 System	Unique Vehicle Identifier	Maintenance Type	Associated with an on-road vehicle failure, shut-down?	Scheduled, Un-Scheduled	Date of Repair, Replacement	Vehicle Miles Traveled (with this component installed) at Repair, Replacement	Comments, Description of Maintenance
4	Super charger intercooler coolant line	H2ICE	H594	Check Only	No	Un-Scheduled	9/25/2007	1,170	TSB #H07-09-07. Inspect the intercooler coolant line.
5	EMM software & telematics software	H2ICE	H594	Adjustment	No	Un-Scheduled	10/8/2007	1,023	TSB #H07-09-12. EMM B2AD4 test and telematics DTC software update.
6	Tank package harness	H2ICE	H594	Replacement	No	Un-Scheduled	10/8/2007	1,052	TSB #H07-10-04. Weather proofing hydrogen tank package harness connectors. Replace plug C4123.
7	EMM software & Telematics software	H2ICE	H595	Adjustment	No	Un-Scheduled	10/8/2007	752	TSB #H07-09-12. EMM B2AD4 test and telematics DTC software update.
8	Tank package harness	H2ICE	H595	Check Only	No	Un-Scheduled	10/8/2007	823	TSB #H07-10-04. Weather proofing hydrogen tank package harness connectors.
9	Engine	H2ICE	H594	Repair	No	Un-Scheduled	12/12/2007	1,968	Driver reported engine keeps choking, has no power, fails to pass 60 mph, and engine is using large amounts of fuel (running rich.) Mechanics could not verify concern, no DTC (diagnostic trouble codes) were present.

Maintenance Summary: Rev 5 [2008-01-25]

Data since inception of the program, all vehicles

#	Report Date	12/31/2009			Associated with an on-road vehicle failure, shut-down?	Scheduled, Un-Scheduled	Date of Repair, Replacement	Vehicle Miles Traveled (with this component installed) at Repair, Replacement	Comments, Description of Maintenance
	Automaker	Ford Motor Company							
	Component Name	H2 System	Unique Vehicle Identifier	Maintenance Type					
10	Manifold pressure gauge	H2ICE	H595	Repair	No	Un-Scheduled	Nov/Dec 07 (ongoing)	1,129	Repair leaks in system. One leak was found and corrected in the tank manifold pressure gauge. A possible second small leak has not yet been found.
11	Manifold pressure gauge	H2ICE	H595	Repair	No	Un-Scheduled	Completed Nov/Dec 07 repairs (line 10) in Jan 07.	1,129	Completed check for leaks. Placed bus back in service.
12	EMM software & Telematics software	H2ICE	H594	Adjustment	No	Un-Scheduled	1/16/2008	2,307	TSB #H07-12-18. EMM, Telematics, and PCM software update.
13	EMM software & Telematics software	H2ICE	H595	Adjustment	No	Un-Scheduled	1/16/2008	1,130	TSB #H07-12-18. EMM, Telematics, and PCM software update.
14	Super charger intercooler coolant line	H2ICE	H594	Check Only	No	Un-Scheduled	1/18/2008	2,307	TSB #H08-01-16. Inspect intercooler coolant line grommet.
15	Super charger intercooler coolant line	H2ICE	H595	Check Only	No	Un-Scheduled	1/18/2008	1,130	TSB #H08-01-16. Inspect intercooler coolant line grommet.
16	Fuel lines	H2ICE	H595	Repair	No	Un-Scheduled	2/6/2008	1,211	Check engine light came on. Brought bus back to shop. Located 2 leaks. Replaced 2 flex fuel lines.

Maintenance Summary: Rev 5 [2008-01-25]

Data since inception of the program, all vehicles

	Report Date	12/31/2009							
	Automaker	Ford Motor Company							
#	Component Name	H2 System	Unique Vehicle Identifier	Maintenance Type	Associated with an on-road vehicle failure, shut-down?	Scheduled, Un-Scheduled	Date of Repair, Replacement	Vehicle Miles Traveled (with this component installed) at Repair, Replacement	Comments, Description of Maintenance
17	Vent lines	H2ICE	H594	Check Only	No	Un-Scheduled	4/2/2008	2,621	Perform TSB H08-03-03. Repair vent lines. Inspect and drain water from vent lines and install new vent caps.
18	Vent lines	H2ICE	H595	Check Only	No	Un-Scheduled	4/2/2008	1,440	Perform TSB H08-03-03. Repair vent lines. Inspect and drain water from vent lines and install new vent caps.
19	Telematics software	H2ICE	H594	Adjustment	No	Un-Scheduled	4/14/2008	2,621	Perform TSB H08-03-06 and apply update 1.2.5 to the Telematics software.
20	Telematics software	H2ICE	H595	Adjustment	No	Un-Scheduled	4/14/2008	1,488	Perform TSB H08-03-06 and apply update 1.2.5 to the Telematics software.
21	Door yoke, sensor plugs, & lower alternator harness	H2ICE	H594	Check Only	No	Un-Scheduled	4/22/2008	2,652	Perform inspection as per special service message H0002. Inspect lower alternator harness. Inspect sensor plugs for corrosion. Inspect door yoke (H0002) and apply thread lock, inspect lower alternator plug. Inspect and apply dielectric compound to both H2 sensor plugs, oil sensor plug, and super charger cooler pump plug.

Maintenance Summary: Rev 5 [2008-01-25]

Data since inception of the program, all vehicles

	Report Date	12/31/2009							
	Automaker	Ford Motor Company							
#	Component Name	H2 System	Unique Vehicle Identifier	Maintenance Type	Associated with an on-road vehicle failure, shut-down?	Scheduled, Un-Scheduled	Date of Repair, Replacement	Vehicle Miles Traveled (with this component installed) at Repair, Replacement	Comments, Description of Maintenance
22	Door yoke, sensor plugs, & lower alternator harness	H2ICE	H595	Check Only	No	Un-Scheduled	4/22/2008	1,489	Perform inspection as per special service message H0002. Inspect lower alternator harness. Inspect sensor plugs for corrosion. Inspect door yoke (H0002) and apply thread lock, inspect lower alternator plug. Inspect and apply dielectric compound to both H2 sensor plugs, oil sensor plug, and super charger cooler pump plug.
23	Check engine light	H2ICE	H595	Check Only	No	Un-Scheduled	5/6/2008	1,632	Check engine light on. Check for DTC's, clear DTC's 2 times and reset 2 times, remove tank side cover, complete a fuel tank solenoid test. Check tank wire harness and clear codes again. No problems found at this time.
24	Check engine light	H2ICE	H595	Check Only	No	Un-Scheduled	5/19/2008	1,671	Check mil light is on. Test tanks for leak, no leaks found. Cleared codes per Matt Fast's instructions.

Maintenance Summary: Rev 5 [2008-01-25]

Data since inception of the program, all vehicles

	Report Date	12/31/2009							
	Automaker	Ford Motor Company							
#	Component Name	H2 System	Unique Vehicle Identifier	Maintenance Type	Associated with an on-road vehicle failure, shut-down?	Scheduled, Un-Scheduled	Date of Repair, Replacement	Vehicle Miles Traveled (with this component installed) at Repair, Replacement	Comments, Description of Maintenance
25	Diagnostic codes	H2ICE	H595	Check Only	No	Un-Scheduled	6/25/2008	2,036	Check diagnostic trouble codes. Diagnose DTC #P0181, consult with Ford, clear codes, conduct a test per Ford, capture two computer screen shots and email them to Ford, reclear DTC's (fuel rail temp. sensor.)
26	Diagnostic codes	H2ICE	H595	Check Only	No	Un-Scheduled	7/23/2008	2,244	Diagnostic trouble code P0181. Diagnose, clear codes, complete a wiggle test, swap both fuel rail temperature sensors one with the other, per Ford
27	Diagnostic codes	H2ICE	H594	Check Only	No	Un-Scheduled	8/21/2008	3,698	Trouble shoot, trouble code P0181. Check DTC codes and clear the codes.
28	Diagnostic codes, plugs, and wire connections	H2ICE	H595	Repair	No	Un-Scheduled	8/21/2008	2,596	Perform test per Ford to repair P0181. Defuel and search wire harness for damage. Check plugs and wire connections. Remove wires from plug shells checked. Repair some connections and cleared codes, prepare bus for service.

Maintenance Summary: Rev 5 [2008-01-25]

Data since inception of the program, all vehicles

	Report Date	12/31/2009							
	Automaker	Ford Motor Company							
#	Component Name	H2 System	Unique Vehicle Identifier	Maintenance Type	Associated with an on-road vehicle failure, shut-down?	Scheduled, Un-Scheduled	Date of Repair, Replacement	Vehicle Miles Traveled (with this component installed) at Repair, Replacement	Comments, Description of Maintenance
29	Diagnostic codes	H2ICE	H595	Repair	No	Un-Scheduled	8/21/2008	2,651	Trouble shoot code 2BAD4 and repair. Check codes, leak test, repair leaks at tanks #1 and 3 jack screws, clear codes, and replace tank side cover.
30	Check engine light	H2ICE	H594	Check Only	No	Un-Scheduled	10/14/2008	4,189	Check engine light is on. Pull codes, diagnose, and clear codes. Miss fire code from wet engine at car wash.
31	Check engine light	H2ICE	H595	Repair	No	Un-Scheduled	10/17/2008	3,409	Check engine light is on. Pull codes, test, and diagnose. Repair two leaks at tanks #1 and 3, clear codes.
32	Solenoid	H2ICE	H595	Replacement	No	Un-Scheduled	10/24/2008	3,475	Check for hydrogen leak near solenoid at end of tank. Locate leaks, order parts, replace jack screws on tanks #1 and 3.
33	Ground wires	H2ICE	H595	Repair	No	Un-Scheduled	11/14/2008	3,777	TSB #H08-04-04 Early built vehicles now require additional grounds to be installed. Inspect fiberglass bus body and air conditioning to frame grounds and install as needed.

Maintenance Summary: Rev 5 [2008-01-25]

Data since inception of the program, all vehicles

	Report Date	12/31/2009							
	Automaker	Ford Motor Company							
#	Component Name	H2 System	Unique Vehicle Identifier	Maintenance Type	Associated with an on-road vehicle failure, shut-down?	Scheduled, Un-Scheduled	Date of Repair, Replacement	Vehicle Miles Traveled (with this component installed) at Repair, Replacement	Comments, Description of Maintenance
34	Ground wires	H2ICE	H594	Repair	No	Un-Scheduled	12/11/2008	4,867	TSB #H08-04-04 Early built vehicles now require additional grounds to be installed. Inspect fiberglass bus body and air conditioning to frame grounds and install as needed.
35	Air conditioner line fittings	H2ICE	H594	Check Only	No	Un-Scheduled	12/11/2008	4,867	TSB #08-11-03 2006 E-450 vehicles may exhibit corrosion on the aftermarket A/C line fittings. Clean and coat anti-corrosion fittings.
36	Air conditioner line fittings	H2ICE	H595	Check Only	No	Un-Scheduled	12/11/2008	4,092	TSB #08-11-03 2006 E-450 vehicles may exhibit corrosion on the aftermarket A/C line fittings. Clean and coat anti-corrosion fittings.
37	Fuel injectors	H2ICE	H594	Replacement	No	Un-Scheduled	12/11/2008	4,867	Replace all 10 fuel injectors per Ford.
38	Check engine light	H2ICE	H595	Check Only	No	Un-Scheduled	1/2/2009	4,197	Check codes and clear and leak test.
39	Check engine light	H2ICE	H595	Check Only	No	Un-Scheduled	1/2/2009	4,197	Check codes and clear. Leak test. Left fuel rail solenoid leaks, part ordered.
40	Solenoid	H2ICE	H595	Replacement	No	Un-Scheduled	1/20/2009	4,197	Install left fuel solenoid photograph wire pins. Repair harness plug. Clear codes.
41	Alternator	H2ICE	H594	Repair	No	Un-Scheduled	5/12/2009	6,063	Diagnose DTC P1106 and repair lower alternator.

Safety Summary: Rev 4 [2007-10-28]

Data since inception of the program, all vehicles

	Report Date	12/31/2009			
	Automaker	Ford Motor Company			
#	Event Type	Unique Vehicle Identifier	Associated with an on-road vehicle failure, shut-down?	Date of Event	Detailed Event Description/Result
1	Check engine light on	H595	Yes	8/24/2007	Check engine light came on while in service. Driver completed route and while driving to garage for repairs, engine started making noise and was losing power, so driver stopped at roadside. Bus was towed to garage and defueled. Found intercooler coolant hose was loose from fitting. Reinstalled hose, filled and bled coolant system. Found fuel leak at #6 tank valve lockdown screw. Tightened screw. Cleared check engine light and returned bus to service.
2					
3					
4					
5					

Emissions Comparison: Rev 2 [2007-4-20]

Data since inception of the program, all vehicles

Report Date:	12/31/2009		Report Date:	12/31/2009	
Fuel Type:	CNG/H2		Fuel Type:	CNG/H2	
Deployment Start:	8/22/2007		Deployment Start:	8/22/2007	
Vehicle Model:	Ford H2ICE Bus		Vehicle Model:	Ford H2ICE Bus	
Location of Operation:	Las Vegas, NV		Location of Operation:	Las Vegas, NV	
Vehicle #	H594		Vehicle #	H595	
	@ Idle	xxxx RPM's		@ Idle	xxxx RPM's
Date			Date		
Mileage	cannot collect data		Mileage	cannot collect data	
Air Temp °F			Air Temp °F		
Gas Temp °F			Gas Temp °F		
HC ppm			HC ppm		
O2 %			O2 %		
CO ppm			CO ppm		
NO ppm			NO ppm		
NO2 ppm			NO2 ppm		
NOx ppm			NOx ppm		
CO2 %			CO2 %		
Combustion Efficiency %			Combustion Efficiency %		
Losses %			Losses %		
Exc. Air			Exc. Air		
Sensor Temp °F			Sensor Temp °F		

Footnotes:

- (1) Data cannot be collected. The City's emissions analyzer machines are not calibrated for straight H2 systems.

Survey Card:



City of Las Vegas



Please take a moment to complete a brief survey about this bus ride. Your opinion matters to us!

Date of bus ride _____ Time of bus ride _____ a.m. / p.m.

How was the overall comfort (seats, temperature, cleanliness) of this bus? (*circle one*)

Very good

Good

O.K. but could be better

Not good

Compared to other bus rides the smoothness of this ride was (*circle one*)

Smoother

About the same

Rougher

Compared to other bus rides the noise level of this bus was (*circle one*)

Quieter

About the same

Noisier

In general, compared to other bus rides this bus ride was (*circle one*)

Better

About the same

Worse

How important is it to you to ride in a bus that is cleaner for the environment? (*circle one*)

Very important

No opinion

Not important

Additional comments about this bus ride: _____

***Thank you for taking the time to complete our survey!
Please return this survey packet to the bus driver.***

Survey Results: Rev 3 [2007-9-30]

Data since inception of the program, all vehicles

Report Date						12/31/2009																							
Automaker						Ford Motor Company																							
Vehicle Unique Identifier						Bus H594																		Tally of Answers to Questions					
						Overall Comfort?				Smoothness ?			Noise Level?			Overall Ride?			Environmental Importance?										
						Very Good	Good	OK	Not Good	Smoother	Same	Rougher	Quieter	Same	Noisier	Better	Same	Worse	Very	No Opinion	Not								
#	# of Passengers	Date of Ride	AM	PM	# of Surveys	1	2	3	4	1	2	3	1	2	3	1	2	3	1	2	3								
1	40	8/28/2007			7	3	4			5	2		4	3		3	4		3	4									
2	39	8/30/2007	X		14	9	5			6	8		10	4		11	3		13	1									
3		8/30/2007		X	10	6	4			8	2		7	3		7	3		10										
4	33	9/4/2007		X	8	8				6	2		8			7			3	4									
5	51	9/18/2007	X		9	8	1			6	3		9			6	3		9										
6		9/18/2007		X	16	12	4			11	5		13	3		12	4		16										
7	no surveys given in Q1FY08																												
8	no surveys given in Q2FY08																												
9	no surveys given in Q3FY08																												
10	no surveys given in Q4FY08																												
11	unknown	12/30/2008	X		21	18	3			20	1		18	2	1	16	5		19	1	1								

Survey Results: Rev 3 [2007-9-30]

Data since inception of the program, all vehicles

Report Date			12/31/2009																					
Automaker			Ford Motor Company																					
Vehicle Unique Identifier			Bus H594			Tally of Answers to Questions																		
						Overall Comfort?				Smoothness ?			Noise Level?			Overall Ride?			Environmental Importance?					
						Very Good	Good	OK	Not Good	Smother	Same	Rougher	Quieter	Same	Noisier	Better	Same	Worse	Very	No Opinion	Not			
#	# of Passengers	Date of Ride	AM	PM	# of Surveys	1	2	3	4	1	2	3	1	2	3	1	2	3	1	2	3			
12	unknown	12/30/2008		X	12	7	4	1		7	5		11	1		9	3		12					
13		1/5/2009	X		15	8	7			11	4		12	3		7	7	1	11	2	2			
14		1/5/2009		X	3	3				3			3			3			3					
15		1/6/2009	X		14	10	4			8	6		7	7		6	3		7	2				
16		1/26/2009	X		5	4	1			3	2		5			3	2		5					
17		1/26/2009		X	6	5	1			4	2		5	1		5	1		6					
18		2/2/2009	X		23	17	5	1		16	5	1	17	5		17	5		20	2				
19		2/2/2009		X	5	4	1			2	3		5			5			5					
20		2/9/2009	X		11	7	4			9	2		11			9	2		11					
21		2/9/2009		X	1	1				1			1			1			1					
22	no surveys given in Q3FY09																							
23	no surveys given in Q4FY09																							
24																								
25																								

Footnotes:

Not all passengers complete survey cards.
 Many of the passengers on this route are from foreign countries.
 The surveys are a written format. Some passengers do not read or write English.
 Not all passengers completing the survey answered every question.
 Survey responses are tallied by hand.
 Total passenger counts are recorded manually and are not recorded by time of day.
 The total passenger count is recorded above once for a given date.

Survey Results: Rev 3 [2007-9-30]

Data since inception of the program, all vehicles

Report Date			12/31/2009																		
Automaker			Ford Motor Company																		
Vehicle Unique Identifier			Bus H595																		
			Tally of Answers to Questions																		
						Overall Comfort?				Smoothness ?			Noise Level?			Overall Ride?			Environmental Importance?		
						Very Good	Good	OK	Not Good	Smoothen	Same	Rougher	Quieter	Same	Noisier	Better	Same	Worse	Very	No Opinion	Not
#	# of Passengers	Date of Ride	AM	PM	# of Surveys	1	2	3	4	1	2	3	1	2	3	1	2	3	1	2	3
1	33	8/22/2007	X		12	11	1			7	5		9	3		9	1		10		
2		8/22/2007		X	12	11	1			9	3		12			11	1		12		
3	7	8/24/2007	X		6	6				4	1	1	4	1	1	4	1	1	6		
4	36	9/6/2007	X		6	6				4	2		6			4	2		6		
5		9/6/2007		X	5	3	2			2	3		2	3		3	2		5		
6	70	9/20/2007	X		20	13	6	1		13	6		17	2	1	19			19		
7	no surveys given in Q1FY08																				
8	no surveys given in Q2FY08																				
9	no surveys given in Q3FY08																				
10	49	9/5/2008		X	25	21	4			22	3		20	5		15	2		16	1	
11	no surveys given in Q1FY09																				
12		1/27/2009	X		1	1				1			1			1			1		
13		1/27/2009		X	3	3				3			3			3			3		
14		2/3/2009	X		51	35	15	1		33	18		39	9	1	37	13	1	46	3	1

Survey Results: Rev 3 [2007-9-30]

Data since inception of the program, all vehicles

Report Date					12/31/2009																			
Automaker					Ford Motor Company																			
Vehicle Unique Identifier					Bus H595		Tally of Answers to Questions																	
						Overall Comfort?				Smoothness ?			Noise Level?			Overall Ride?			Environmental Importance?					
						Very Good	Good	OK	Not Good	Smother	Same	Rougher	Quieter	Same	Noisier	Better	Same	Worse	Very	No Opinion	Not			
#	# of Passengers	Date of Ride	AM	PM	# of Surveys	1	2	3	4	1	2	3	1	2	3	1	2	3	1	2	3			
15		2/3/2009		X	8	5	2			4	1	1	4	1		7		1	8					
16	no surveys given in Q3FY09																							
17	no surveys given in Q4FY09																							
18																								
19																								
20																								
21																								
22																								
23																								
24																								
25																								

Footnotes:

Not all passengers complete survey cards.
 Many of the passengers on this route are from foreign countries.
 The surveys are a written format. Some passengers do not read or write English.
 Not all passengers completing the survey answered every question.
 Survey responses are tallied by hand.
 Total passenger counts are recorded manually and are not recorded by time of day.
 The total passenger count is recorded above once for a given date.

Passenger Comments: Rev 3 [2007-9-30]

Data since inception of the program, all vehicles

	Report Date	12/31/2009	
	Automaker	Ford Motor Company	
	Vehicle Unique Identifier	Bus H594	
#	Date of Comment	Time of Comment	Comment
1	8/28/2007		Driver Comment - Bus was on almost 9 hours. Less than 1/2 tank fuel or 2,600 psi. A little very little sluggish on freeway coming back to yard.
2	8/30/2007	10:00 AM	Just make it bigger
3	8/30/2007	10:47 AM	Very comfortable
4	8/30/2007	10:50 AM	Thank you... from Hawaii
5	8/30/2007	11:00 AM	Seating well planned - not too congested. Comfortable!
6	8/30/2007	11:00 AM	Very nice, comfortable, friendly and convenient
7	8/30/2007	11:45 AM	Very cheap
8	8/30/2007	1:00 PM	Thank you for bringing us Downtown in a climate bus!
9	8/30/2007	1:30 PM	Thank you!
10	8/30/2007	1:30 PM	Very good ride and clean air, comfortable.
11	8/30/2007	1:30 PM	Air, ride, clean, hospitality driver. No health issues 100% At from Hawaii.
12	8/30/2007	2:22 PM	It seemed clean
13	9/4/2007	12:20 PM	Nice to have seatbelts for all passengers
14	9/4/2007	12:20 PM	I work on a fleet of busses similar and the ride and comfort is equal to or better than std EUSO conversions.
15	9/4/2007	12:45 PM	Nice convenient service
16	9/4/2007	2:45 PM	Thanks for this type of bus
17	9/4/2007	2:45 PM	From Michigan. Get rid of D Bus
18	9/6/2007	11:00 AM	Nice quiet cool ride.
19	9/6/2007	12:00 PM	The driver was very excellent in explaining what the hydro 10 is and gave demonstration of its power and smoothness.
20	9/6/2007	1:00 PM	Nice ride; good to know that it's great for the environment too. We need more vehicles like this.
21	9/6/2007		Driver Comment - no front drivers A/C
22	9/18/2007	2:00 AM	Oahu visitor. I like this bus its an energy saver no gas/likely cheap!!
23	9/18/2007	2:10 PM	Way to go Ford.
24	9/18/2007	2:10 PM	Lovely to travel on.
25	no surveys given in Q1FY08		

Passenger Comments: Rev 3 [2007-9-30]

Data since inception of the program, all vehicles

	Report Date	12/31/2009	
	Automaker	Ford Motor Company	
	Vehicle Unique Identifier	Bus H594	
#	Date of Comment	Time of Comment	Comment
26	no surveys given in Q2FY08		
27	no surveys given in Q3FY08		
28	no surveys given in Q4FY08		
29	12/30/2008	9:30 AM	Very nice
30	12/30/2008	10:00 AM	For me this bus is very important.
31	12/30/2008	10:30 AM	Need more room
32	12/30/2008	11:00 AM	Very good
33	12/30/2008	11:15 AM	Very good ride
34	12/30/2008	12:50 PM	The bus is always nice and clean, just needs more seats
35	12/30/2008	1:00 PM	Buses could be a bit larger, sometimes not enough seats
36	12/30/2008	2:30 PM	Keep up the good work
37	1/5/2009	8:20 AM	Very good
38	1/5/2009	10:55 AM	I like the bus but not enough people can fit
39	1/5/2009	11:00 AM	Very good ride
40	1/6/2009	11:00 AM	Very nice
41	1/26/2009	9:12 AM	Great, good for the environment
42	1/26/2009	12:30 PM	Provide a ramp for the handicapped
43	1/26/2009	1:00 AM	Add some more seats
44	2/2/2009	9:08 AM	Too small
45	2/2/2009	9:15 AM	Excellent
46	2/2/2009	9:15 AM	Everything should run on hydrogen! Right on!!!
47	2/2/2009	10:50 AM	Is very important
48	2/9/2009	10:30 AM	We need more environmentally friendly public transportation
49	no surveys given in Q3FY09		
50	no surveys given in Q4FY09		

Footnotes:

- (1) Data may be collected manually (via driver logs). Electronic copies should be submitted on a quarterly basis.

Passenger Comments: Rev 3 [2007-9-30]

Data since inception of the program, all vehicles

	Report Date	12/31/2009	
	Automaker	Ford Motor Company	
	Vehicle Unique Identifier	Bus H595	
#	Date of Comment	Time of Comment	Comment
1	8/22/2007	8:36 AM	Very good service
2	8/22/2007	10:30 AM	Better than the others
3	8/22/2007	10:30 AM	If possible, auto air condition (temperature) would be nice. (This time air was too cold.)
4	8/22/2007	11:20 AM	Very clean and comfortable!
5	8/22/2007	11:20 AM	Very good initiative
6	8/22/2007	11:40 AM	Air in bus feels cleaner
7	8/22/2007	12:20 PM	A must! (Doubled checked Very Important for the environment question.)
8	8/22/2007	12:20 PM	Thank you for working with the environment
9	8/22/2007	12:45 PM	I enjoyed the ride. Very comfortable seating.
10	8/22/2007	1:00 PM	Change machine. Thank you for making the environment cleaner.
11	8/22/2007	1:20 PM	Great idea!
12	8/22/2007	1:25 PM	Good work!
13	8/22/2007	1:25 PM	Great!
14	8/22/2007	1:30 PM	It's great!
15	8/22/2007	2:30 PM	Excellent! (Doubled checked Very Important for the environment question.)
16	8/22/2007		Driver Comment - Fuel tank full drove 52 miles. A little less than half a tank left.
17	8/24/2007		Driver Comment - Had to take out of service because of check engine light.
18	9/20/2007	10:20 AM	Need more seats facing the front instead of the side!
19	9/20/2007	11:30 AM	We had group 13 - one seat was low and hot.
20	9/20/2007	11:30 AM	Nice.
21	9/20/2007	11:30 AM	Very compact - We like it.
22			
23			
24			
25	no surveys given in Q1FY08		
26	no surveys given in Q2FY08		
27	no surveys given in Q3FY08		

Passenger Comments: Rev 3 [2007-9-30]

Data since inception of the program, all vehicles

	Report Date	12/31/2009	
	Automaker	Ford Motor Company	
	Vehicle Unique Identifier	Bus H595	
#	Date of Comment	Time of Comment	Comment
28	9/5/2008	2:00 PM	Not enough seats
29	9/5/2008	3:10 PM	I like this bus
30	no surveys given in Q1FY09		
31	1/27/2009	11:30 AM	The bus is very good
32	1/27/2009	2:30 PM	Awesome bus, way to go
33	2/3/2009	9:30 AM	Very good
34	2/3/2009	10:00 AM	Cool ride
35	2/3/2009	10:30 AM	Good
36	2/3/2009	10:38 AM	Very nice
37	2/3/2009	10:45 AM	Very good
38	2/3/2009	10:46 AM	Great!
39	2/3/2009	11:00 AM	I love the bus
40	2/3/2009	12:25 PM	I liked it
41	2/3/2009	12:30 PM	Better temperature in the bus
42			
43			
44			
45			
46			
47			
48			
49			
50			

Footnotes:

(1) Data may be collected manually (via driver logs). Electronic copies should be submitted on a quarterly basis.