AUTOMOTIVE TESTING AND DEVELOPMENT SERVICES, INC.

REPORT ON SAE J1321 TYPE II FUEL CONSUMPTION TEST

Conducted for Mitsubishi Fuso Truck Of America, Inc.

Photo courtesy of Mitsubishi Fuso Truck of America, Inc.

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ABSTRACT

Automotive Testing and Development Services, Inc. (ATDS) was contracted by Mitsubishi Fuso Truck of America, Inc. to conduct a fuel economy comparison test between a 2012 Mitsubishi Fuso Fe160 and an 2011 Isuzu NPR-HD operating under identical test conditions. Testing was conducted between the dates of 3 to 10 January 2012 on a course of 97.4 miles in length, representing a mix of city, suburban, and highway driving conditions. Testing was conducted in strict accordance to the SAE J1321 Fuel Consumption Test Procedure-Type II. Under identical conditions and equivalent configurations, the 2012 Mitsubishi Fuso Fe160 had a 8.45% fuel economy advantage over the competing truck, well above the 1% test accuracy for the SAE J1321 procedure.

The MFTA Fe160 showed a 8.45% advantage in fuel economy when operated in the same configuration as the NPR, which would produce a savings to the end-user of $2914.07 for every 100,000 miles driven using a price of $4.25 for diesel fuel. When the MFTA "Eco mode" was engaged, the Fe160 showed an advantage of 13.8%, which produces an expected savings of $4,532.85 for every 100,000 miles driven. When the "Eco mode" is combined with the roof fairing, the Fe160 showed an advantage of 16.6%, which translates into a savings of $5,319.39 for every 100,000 miles driven in the Fe160. All these savings are computed from this test in which the trucks were heavily loaded on a route using a variety of road types.

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INTRODUCTION

Fuel economy is a major factor in a potential buyer's decision process when selecting truck purchases. Even a small improvement in fuel economy makes a significant difference when compounded with multiple units over many miles of operation. The purpose of this test program was to quantify the difference in fuel economy between the MFTA Fe160 and the Isuzu NPR HD when being operated under nearly identical conditions. Figure 1 shows both the MFTA Fe160 and Isuzu NPR-HD used in testing.

The procedure chosen for the test was the SAE Fuel Consumption Test Procedure-Type II, also known as SAE J1321. The trucks provided by MFTA for the test were a 2012 MFTA Fe160 and a 2011 Isuzu NPR HD. The trucks were retrofitted with a portable fuel tank installed in the box of each truck to provide a safe position for the tank and to aid in removing the tank for weighing after each run. In order to make the test as equitable as possible, the Fe160 was modified from its original configuration to more closely resemble the control truck. The Fe160 was delivered with a roof fairing and is manufactured with an "Eco mode" setting, each of which would improve fuel economy over the NPR, which lacked any aerodynamic fairings or economy settings. Neither the fairing nor the "Eco mode" was used in the initial phase of this test to make the trucks equal.

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Figure 1: MFTA Fe160 and Isuzu NPR-HD Trucks used in fuel test program without roof fairing.

TEST PROCEDURE

All equipment used in the test has been well maintained and kept with current calibration standards by ATDS. Equipment included, two 15-gallon portable fuel tanks modified with quick disconnect connections, a portable digital scale calibrated after each run, a Race Logic GPS data logger, a weather station able to measure temperature, relative humidity, barometric pressure, wind speed and wind direction, and ballasts used to attain a weight just under their GVWR.

The Fe160 fairing was removed during the first phase of the testing process to match the body style of the NPR and the "Eco mode" on the Fe160 was turned off during the initial phase of the test.

Each vehicle was ballasted to an identical weight of 14,490 pounds, just under their GVWRs of 14,500 pounds, with a combination of solid and liquid ballast, had a front end alignment to set the steerer tires to manufacturer's specifications, and each was serviced prior to the start of testing. During testing each truck operated on a 15-gallon portable fuel tank, which was measured and refueled to a fixed volume after each run. Figure 2 shows a fuel tank being weighed before a run. The portable digital scale was used to weigh each tank before and after refueling. The same drivers remained with both the Fe160 and NPR vehicles during the duration of the testing. Each truck was operated with the same HVAC settings, for all runs with windows up and AC operating on identical settings. Every effort was made to operate both trucks under as close to identical conditions as possible.

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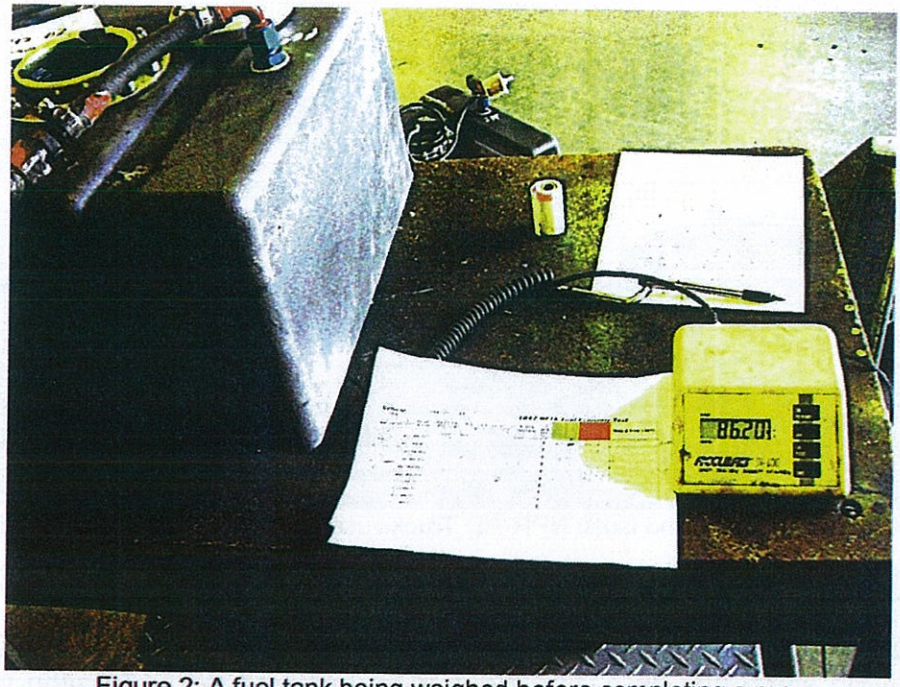

Figure 2: A fuel tank being weighed before completing a run.

Both trucks were equipped with automatic transmissions and were operated solely in the Drive setting and no engine exhaust braking was used. Both trucks are equipped with Diesel Emissions Fluid reservoirs and those were topped off prior to the beginning of the testing and the amount used was computed. All fuel used was commercial grade ultra-low sulfur #2 diesel dispensed from barrels stored at the ATDS facility. Refueling at ATDS was chosen to allow more control over engine idle times and to provide more time for careful tank weighing. Any accessories that could draw auxiliary power were used in an identical manner in both trucks during all stages of the test program. Mirrors and windows were kept in the same position for the duration of the test. Tire pressures were adjusted prior to the first run of each day and set to five psi below the manufacturers' recommended cold inflation pressure.

When each truck was fueled, the GPS data loggers were started to record the run, and upon a signal, each truck was started simultaneously. The trucks drove the assigned route together and as identically as possible to provide a fair comparison. When the run was complete each truck parked, idled until both drivers were signaled to shut off the engines. The GPS data loggers were shut down and the tanks removed for weighing, that weight was recorded, and then each tank was refueled with another full weight taken. Two runs were possible each day with each run being done under equivalent conditions as much as possible.

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TEST ROUTE

As shown in Figure 3 below, the test route is comprised of city sections (heavy traffic with much stop and go conditions), suburban sections (higher speeds, some stops with longer drives between them), and highway sections (high speed roads with long stretches with no stops). Each run consisted of almost 98 miles driving done as two laps around a 48.7 miles course. The vehicles followed each other with enough distance between trucks to eliminate any wind advantage to the rear truck, and the trucks alternated leading after each lap. As both trucks are not limited to truck speed limits on the highways, normal car speed limits were followed an all runs since those speed limits are what would be followed by the end-user of these vehicles.

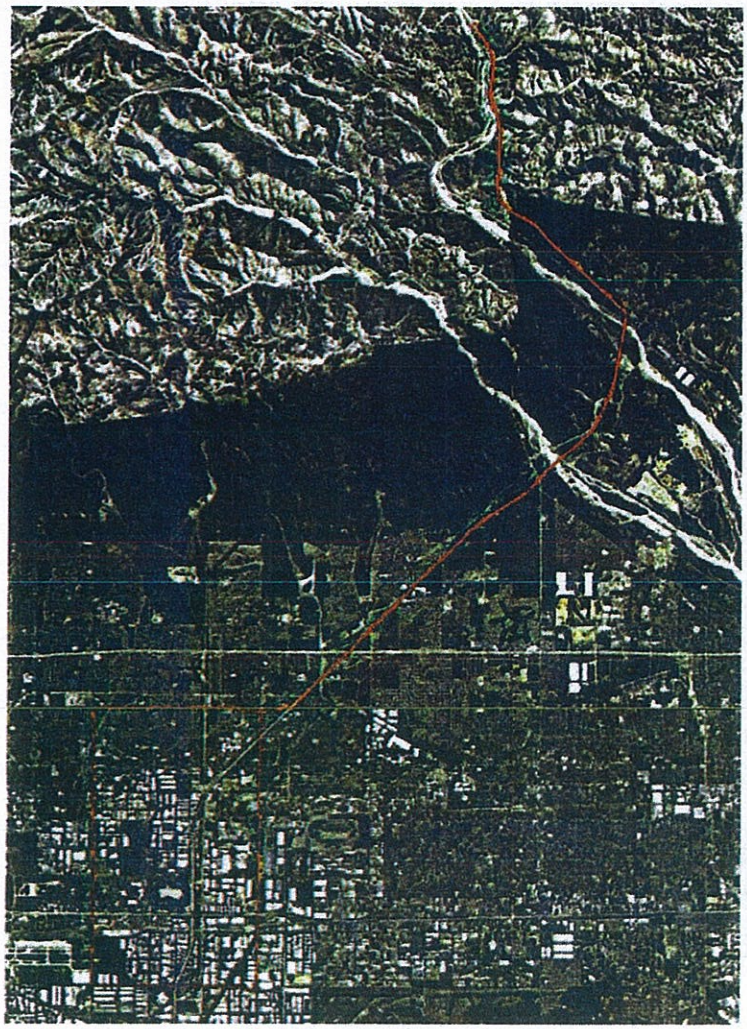

Figure 3: Arial view of the route used.

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RESULTS

The following tables shows the recorded times, miles, and weights for the six runs conducted using identical test conditions.

Table 1: Data recorded during test and calculated values for Fuso Fe160.

Fe160 Date	Run #	Start Time	End Time	Weight Out	Weight In	Miles	Fuel Used	MPG
3-Jan-12	1	8:42	11:40	86.00	32.65	97.9	7.675	12.755
3-Jan-12	2	13:20	16:07	85.30	30.25	97.9	7.920	12.362
4-Jan-12	3	7:30	10:10	85.90	29.55	97.9	8.107	12.076
4-Jan-12	4	11:10	14:00	85.35	29.75	97.9	7.999	12.239
5-Jan-12	5	7:30	10:00	85.50	29.25	97.8	8.092	12.085
5-Jan-12	6	10:45	13:30	86.20	30.20	97.9	8.056	12.152
							Average	12.280

Table 2: Data recorded during test and calculated values for Isuzu NPR-HD.

NPR Date	Run #	Start Time	End Time	Weight Out	Weight In	Miles	Fuel Used	MPG
3-Jan-12	1	8:42	11:40	86.25	28.20	97.9	8.351	11.723
3-Jan-12	2	13:20	16:07	85.65	26.30	97.9	8.538	11.466
4-Jan-12	3	7:30	10:10	86.00	25.90	97.9	8.646	11.323
4-Jan-12	4	11:10	14:00	86.30	24.45	97.9	8.898	11.002
5-Jan-12	5	7:30	10:00	86.10	24.85	97.8	8.812	11.110
5-Jan-12	6	10:45	13:30	86.00	25.65	97.9	8.682	11.276
							Average	11.317

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SAE J1321 Filtered Data

The raw test data collected was filtered using the specification requirement that valid runs on a given unit repeat in time ± 0.5%. The filtered runs include run one, five, and six. Table 3 shows the miles per gallon calculations for both filtered and unfiltered runs.

Table 3: Filtered and unfiltered miles per gallon data for both trucks.

	MPG	Difference	% Difference
Fe160	*12.280*		
NPR	*11.317*	*0.963*	*8.52%*
Fe160 Filtered	*12.331*		
NPR Filtered	*11.370*	*0.961*	*8.45%*

Projecting the savings in fuel for the MFTA Fe160 over the Isuzu NPR-HD to 100,000 miles with a standard fuel price of $4.25 per gallon, table 4 was generated showing the gallons of fuel used, amount paid, and difference in price.

Table 4: Price comparison of fuel projected to 100,000 miles at a standard fuel price of $4.25/gal.

	Gal. per 100K miles	Price at $4.25/gal	Difference
Fe160	8143.02	$34607.87	
NPR	8836.50	$37555.15	$2947.27
Fe160 Filtered	8109.69	$34466.21	
NPR Filtered	8795.36	$37380.28	$2914.07

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Additional testing was conducted to compare features the MFTA Fe160 had available (roof fairing and "Eco mode") to the Izusu NPR without the features.

Table 5: Different fuel advantage features compared to baseline.

	Increase in MPG	% Difference
Fuso Advantage Eco OFF, with Fairing	1.13	10.0%
Fuso Advantage Eco ON, No Fairing	1.57	13.8%
Fuso Advantage Eco ON, with Fairing	1.88	16.6%

DATA REVIEW and ANALYSIS

ATDS conducted six runs with the vehicles in power mode. Three runs did not pass the data filter of +/- 0.5% and were discarded from any calculations. The three remaining runs were acceptable in all facets and produced a fuel economy advantage of 8.45% for the MFTA Fe160.

MFTA asked ATDS to conduct additional testing to compare the other modes possible with the Fe160. Two runs were completed with the Fe160 using "Eco mode" against the NPR in power (or standard) mode and two runs with the Fe160 in "Eco mode" and with the roof fairing mounted. When utilizing the "Eco mode" the Fe160 produced a fuel economy advantage of 13.8% over the NPR. When the "Eco mode" and the roof fairing were both used the fuel economy advantage of the Fe160 increased to 16.6% over the NPR.

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QUALITY ASSURANCE
INSP: DL ON: 2-7-12
COMMENTS:

February 2, 2012

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Appendices

SAE J1321 Type II Fuel Consumption Test

Conducted For Mitsubishi Fuso Truck of America, Inc.

Test Data Mitsubishi Fuso Fe160

Run #	Date	Distance	(MY2012 FE) Raw MPG	Comments
1	3-Jan-12	97.9	12.755	Power vs power phase
2	3-Jan-12	97.9	12.362	
3	4-Jan-12	97.9	12.076	
4	4-Jan-12	97.9	12.252	
5	5-Jan-12	97.9	12.085	
6	5-Jan-12	97.9	12.152	
				End of power vs power phase, no fairing
7	6-Jan-12	97.9	12.987	Fe ECO vs NPR power phase, no fairing
8	6-Jan-12	97.9	12.779	ECO vs power, no fairing
9	9-Jan-12	91.0	13.401	Fairing ON, ECO ON. Run went across weigh scale, changed route distance.
10	9-Jan-12	78.0	12.435	Fairing on, Eco OFF.
11	10-Jan-12	97.9	12.994	Fairing on, ECO ON.
12	10-Jan-12	97.9	12.463	Fairing on, Eco OFF.
				Filtered Average
		Average for power phase	12.280	12.331
		Average for ECO ON, no fairing	12.883	
		Average for ECO ON with fairing	13.198	
		Average for ECO OFF with fairing	12.449	

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Test Data Izusu NPR

Run #	Date	Distance	Competitive Truck (MY 2011 Isuzu NPR) Raw MPG	Competitive Truck (MY 2011 Isuzu NPR) % vs Control
1	3-Jan-12	97.9	11.723	91.9%
2	3-Jan-12	97.9	11.466	92.8%
3	4-Jan-12	97.9	11.323	93.8%
4	4-Jan-12	97.9	11.002	89.8%
5	5-Jan-12	97.9	11.110	91.9%
6	5-Jan-12	97.9	11.276	92.8%
7	6-Jan-12	97.9	10.976	84.5%
8	6-Jan-12	97.9	11.773	92.1%
9	9-Jan-12	90.0	11.564	86.3%
10	9-Jan-12	76.0	10.808	86.9%
11	10-Jan-12	97.9	12.328	94.9%
12	10-Jan-12	97.9	11.361	91.2%
				Filtered Average
		Average	11.317	11.370
		Fuso Advantage power mode	0.964	MPG
			8.5%	advantage
		Fuso Advantage Eco Mode	1.57	MPG
			13.8%	advantage
		Fuso Advantage Eco w/fairing	1.88	MPG
			16.6%	advantage
		Fuso Advantage Eco OFF w/fairing	1.13	MPG
			10.0%	advantage

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Calculations

	Gallons per 100,000 miles	Price @ $4.25/gal	Difference Between FE and NPR	
FE (all runs)	8143.029	$34,607		
NPR (all runs)	8836.506	$37,555	$2,947	Advantage FE
FE SAE Filtered	8109.697	$34,466		
NPR SAE Filtered	8795.360	$37,380	$2,914	Advantage FE
FE ECO ON	7762.139	$32,989	$4,566	Advantage FE
FE Fairing	8032.548	$34,138	$3,417	Advantage FE
FE ECO ON and Fairing	7577.070	$32,203	$5,352	Advantage FE

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