Program for Advanced Vehicle Evaluation

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Report on

SAE J1321 (TMC RP-1102) Type II Fuel Consumption Test

Conducted for

Counteract Balancing Beads
13029 8th Line
Canada L7G 454

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ABSTRACT

The purpose of the testing program described herein was to evaluate the impact on fuel economy resulting from the addition of Counteract Balancing Beads to all wheel positions on both the tractor and trailer. The product was installed in all steer, drive and trailer tires on a test vehicle. Standard unbalanced wheel assemblies served as the basis of the comparison.

Testing was conducted by the PAVE Research Institute between the dates of February 13 and February 15, 2008 on a 41.6 mile test loop on Interstate I-85 between exit 42 (the stop and start point) and exit 22 (the turn around point were test vehicles reversed direction). The TMC/SAE Type II test procedure was used, incorporating the SAE 40 mile minimum test run. The following improvement in fuel economy was observed:

- 2.2% improvement in fuel economy

Two 2004 Freightliner C120 Columbia Series tractors each pulling legally loaded standard cargo vans served as the treatment and control vehicles, both powered with identical 435 BHP Detroit Diesel 14L Series 60 engines. The research trailers utilized for this test were 48-foot long, 102-inch tall Great Dane cargo vans loaded to a gross vehicle weight of 76,500 Lbs. The target testing speed was set at 65 mph, which resulted in an average rolling speed of 57.4 mph (including reversing direction through the interchange at exit 22). At 65 mph, the engine speed was 1510 RPM with loads of up to 100%.

During testing, fuel consumption was measured in 17-gallon portable weigh tanks that only accommodated a single test run when filled to capacity. The weight of fuel consumed after each test run was measured on an Ohaus Champ II Model CH300R digital scale with a 650 pound capacity. Scale calibration was checked before and after each stage of testing. The same drivers remained with both the control vehicle and the treatment vehicle for the duration of testing.

The baseline segment of this test was conducted with all tire positions on the test truck running tires installed without balancing. The treatment segment was run with balancing beads installed in all tires on the test truck. The control truck was run without any type of tire balancing in both the baseline and treatment segments. No operational issues or check engine lights occurred during the entire test. The specification requirement that valid runs on a given unit repeat in time +/- 0.5% (14 seconds) was met on all valid T/C ratios.

SAE J1321 states that based on experience overall test accuracy for this procedure is expected to be within 1 percent. The use of the Counteract Balancing Beads in the tires on all wheel positions not only resulted in reports of a better ride by the driver, but more importantly produced a quantifiable improvement in fuel economy of 2.2%.

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INTRODUCTION

Recent historical increases in the cost of diesel fuel have resulted in an unprecedented interest in products that have the potential to improve fuel economy. At the request of Counteract Balancing Beads, the PAVE Research Institute at Auburn University recently conducted a fuel economy test utilizing class 8 diesel trucks. The purpose of the testing was to quantify any benefits derived from the addition of balancing beads to the inside of all tires on a legally loaded test truck at highway speeds.

The procedure chosen for this evaluation was the *Joint TMC/SAE Fuel Consumption Test Procedure – Type II*, also known as SAE's J1321 and TMC's RP 1102. This procedure was developed specifically to meet the needs of the trucking industry, and it is an integral part of TMC's *Guidelines for Qualifying Products Claiming a Fuel Economy Benefit* (RP 1115).

TEST PROCEDURE

Vehicle Identification

The control and treatment tractors used in the experiment were sequential serial number 2004 Freightliner Columbia series Model C120 day cabs with no aerodynamic modifications. Both units were equipped with Detroit Diesel 60 Series DDEC-IV (EGR) engines rated at 435 hp at 2,100 rpm, with odometer readings in excess of 500,000 miles. Both tractors were equipped with Eaton Fuller 9 speed manual transmissions and cruise control, which produced approximately 1500 rpm at cruise speeds. Detailed information about the test vehicles (shown in Figure 1) is provided in the Appendix.

All fuel used was ultra low sulfur #2 diesel, verified by specific gravity at the time of testing. Any accessories that would have pulled auxiliary power were used in an identical manner in both tractors during all stages of Type II testing. Mirrors and windows were maintained in the same position for all stages of operation. Tire pressures were adjusted as necessary prior to the first test run on each day to ensure that all tires were within 5 psi of the manufacturers' recommended cold inflation temperatures. Each tractor pulled standard cargo van trailers that were loaded to a GVW of 76,500 Lbs.

Figure 1 – Truck Configuration Used During the Testing Process

Test Route

As seen in Figure 2, the test route consisted of a 42 mile round trip loop along interstate 85 between milepost 22 and milepost 42, with a truck stop at exit 42 used to stage the testing operation. The exit at milepost 22 was used as a turn around point. It was determined during the planning process that traffic along this section of interstate 85 would facilitate reliable testing without significant traffic disruptions.

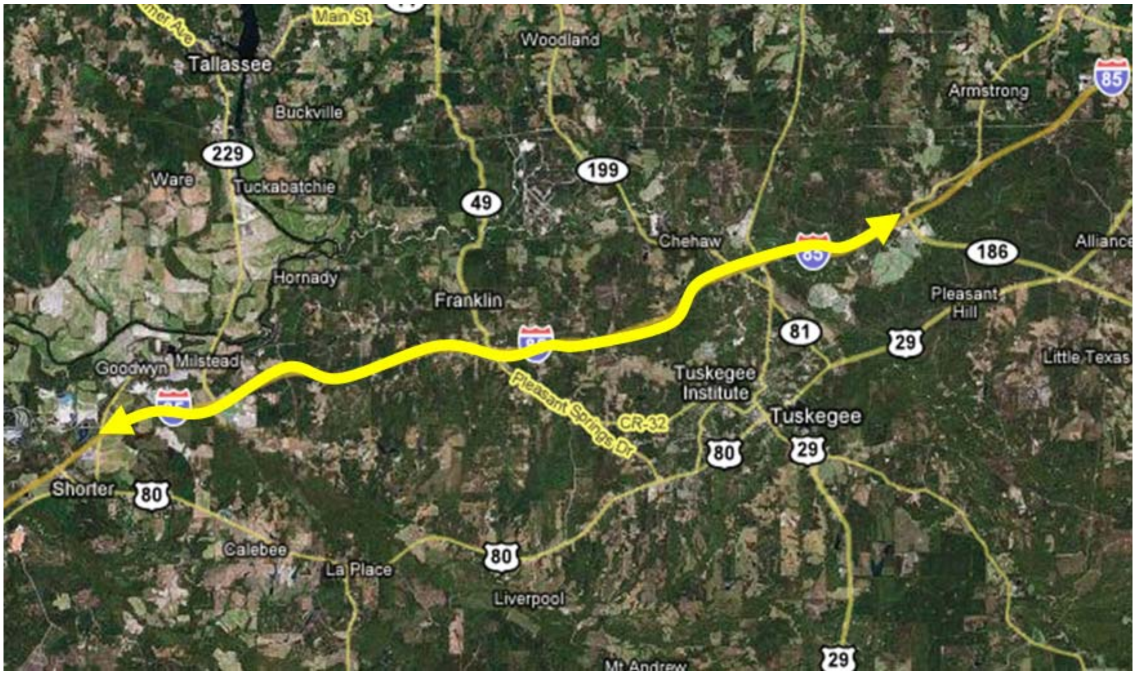

Figure 2 – Section of I-85 Used for Round Trip Type II Test Route

Each Type II test run consisted of at least 40 miles of continuous operation on the chosen test route, with vehicles spaced out in order to prevent aerodynamic interaction. The travel speed of the test vehicles was maintained at approximately 65 mph using cruise control, running in overdrive (9^{th}) gear to produce rpm levels and vehicle dynamics representative of real world duty cycles.

Research Methodology

A work plan was developed based upon the *Joint TMC/SAE Fuel Consumption Test Procedure – Type II* methodology. In this procedure, fuel consumption measurements in a test vehicle (T) are compared to measurements from a control vehicle (C) before and after treatment. The difference between the before and after T/C ratios are used to calculate a fuel savings percentage presumably resulting from the treatment. For the purpose of this study, a test run was defined as at least 40 miles of continuous driving on the interstate-based test route.

Vehicle operation was synchronized using handheld radios and digital stopwatches to ensure precisely identical duty cycles. Both trucks were outfitted with removable fuel tanks (shown in Figure 3) that were weighed between each test run in order to determine the amount of fuel consumed. The weighing process is shown in Figure 4. The T/C ratios for all test runs were calculated, and the first 3 ratios that fell within the prescribed 2 percent filtering band were used to compute an average value representing each segment of testing.

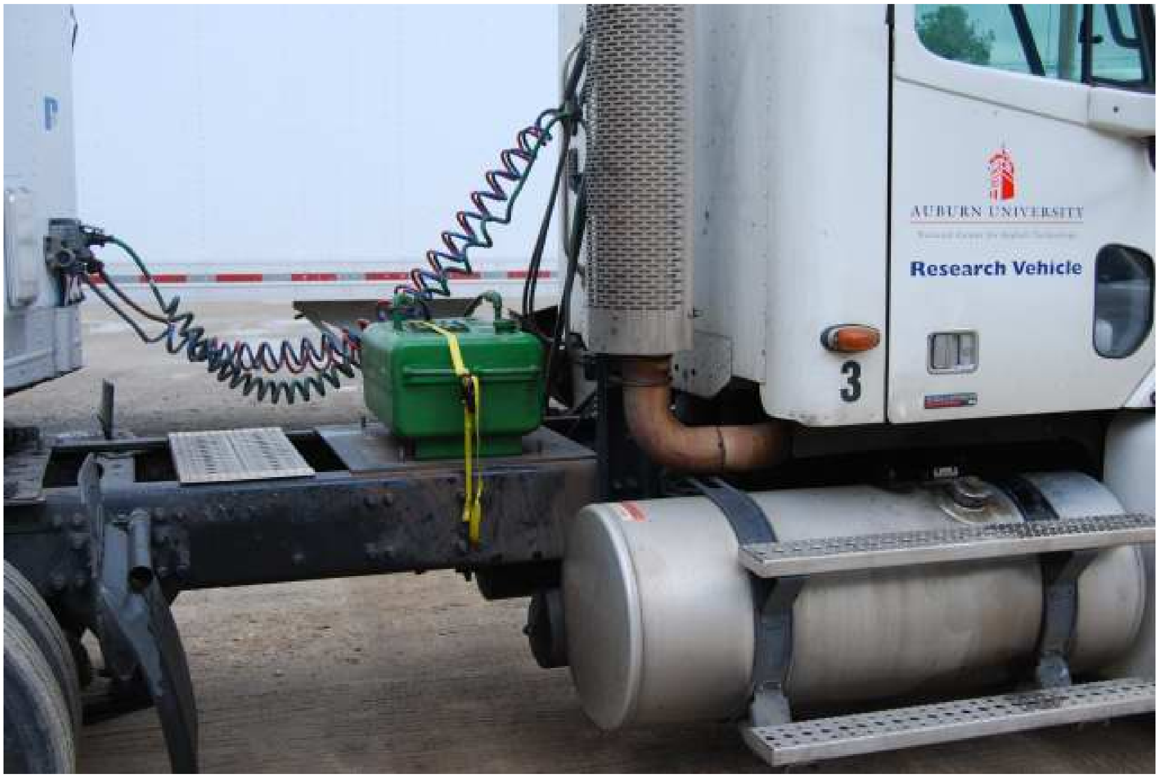

Figure 3 –Portable Weigh Tank

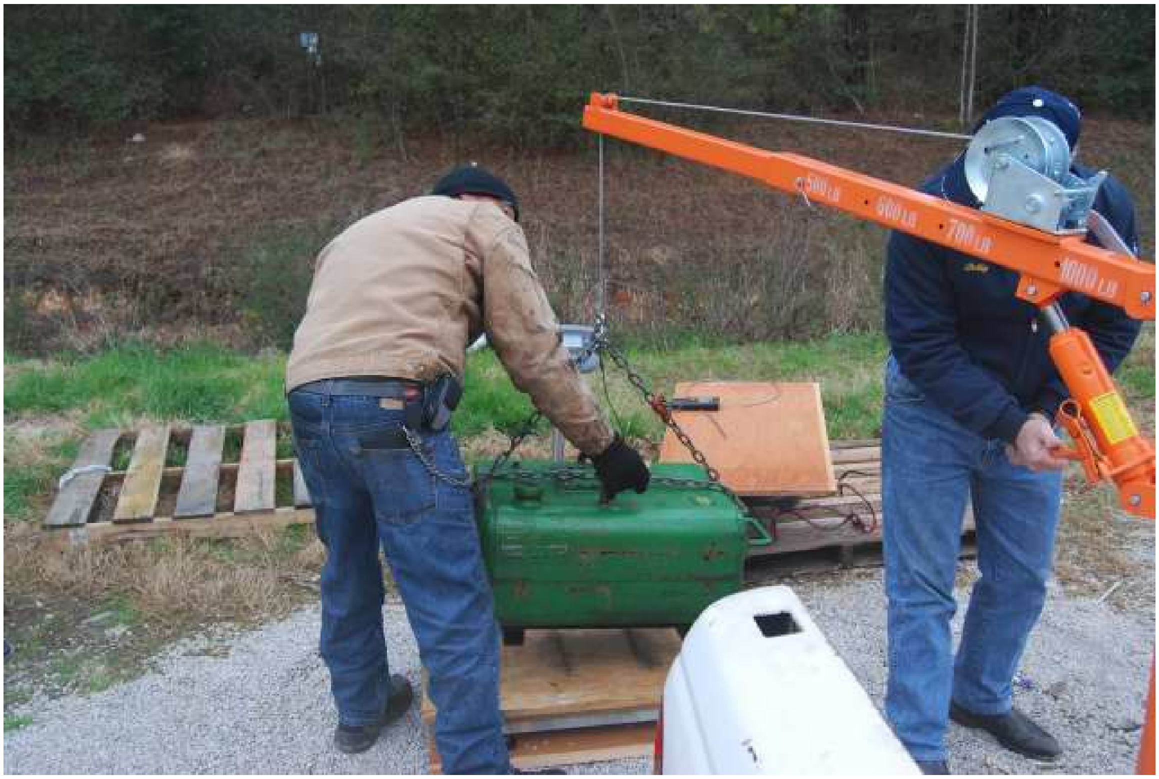

Figure 4 – Weighing Portable Tank to Within a Tenth of a Pound

During testing, fuel consumption was measured in 17-gallon portable weigh tanks that accommodated 1 test run on a single fill. The weight of fuel consumed after each 41.6-mile run was measured on an Ohaus Champ II Model CH300R digital scale with a 650 pound capacity. Scale calibration was checked before and after each stage of testing. The same drivers remained with both the control vehicle and the treatment vehicle for the duration of testing.

Test Data

All raw experimental data collected in the field during the testing process are provided in Table 1. Baseline testing was completed on February 13, 2008. Tires used during the baseline segment of the test were mounted without any type of balancing. Counteract Balancing Beads were added to all tires on the treatment vehicle in every wheel position on February 14th, as seen in Figure 5. The test segment was completed on February 15, 2008.

Run Date	Test Segment	41.6-mile Test Runs		$Fuel_T$ (lbs)	$Fuel_C$ (lbs)
2/13/2008	Baseline	1	10:45 AM	63.8	64.4
		2	11:45 AM	62.6	63.6
		3	12:50 PM	61.9	64.5
			2:48 PM	63	64.5
2/15/2008	Treatment Set	1	8:10 AM	59	63.6
		2	9:15 AM	59	61.3
		3	10:18 AM	57.9	61.3
		4	11:36 AM	58.5	60.8
		5	1:05 PM	58.4	60.6

Table 1 – Type II Test Raw Data (T=Treatment Vehicle, C=Control Vehicle)

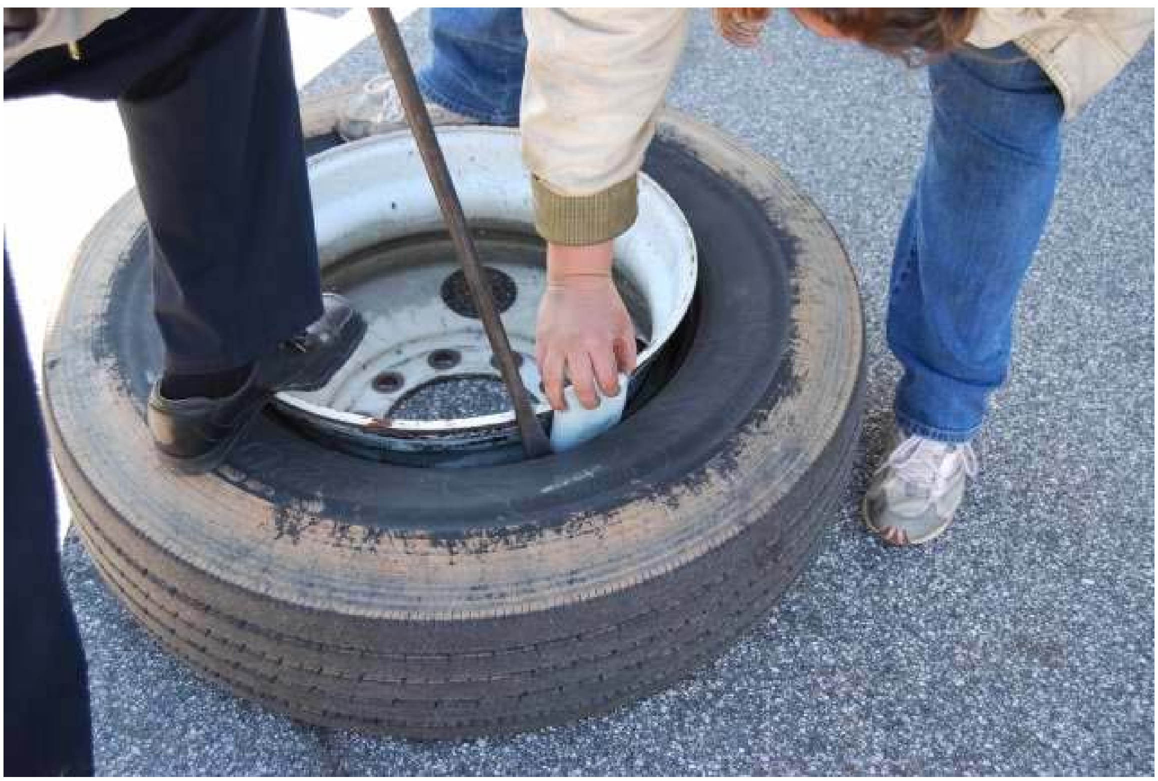

Figure 5 – Installation of Counteract Balancing Beads

Calculations

The first three runs of the baseline and test segments that passed through the statistical filter and met the requirements of the test procedure were used to compute fuel savings (in accordance with the testing specifications). The requirement that valid runs on a given unit repeat in time +/- 0.5% (14 seconds) was not met with the third baseline segment run and the first treatment segment run; therefore, in accordance with the test procedure these runs were excluded from consideration. As noted at the bottom of Table 2, it was also necessary to exclude the third treatment segment run because the air conditioning setting was inadvertently changed. Using the first three valid runs, it was determined that the installation of the Counteract Balancing Beads produced a 2.2% improvement in fuel economy.

Run Date	Test Segment	40-mile Test Runs	Mid Time	Air (°F)	Hum (%)	Wind (mph)	Wind Dir	Precip (in)	FuelT (lbs)	FuelC (lbs)	T/C (All)	T/C (Used)	T/C (Filt)	T/C (Avg)	T/C (% Improved)
2/13/2008	Baseline	1	10:45	35.8	87.4	2.507	241.1	0	63.8	64.4	0.9907	x	0.9907		
		2	11:45	34.9	83.2	3.719	253.8	0	62.6	63.6	0.9843	x	0.9843		
		3	12:50	33.7	83.7	3.62	259.2	0	61.9	64.5	0.9597	*			
		4	2:48	33.4	74.1	3.539	250.2	0	63	64.5	0.9767	x	0.9767	0.9839	Baseline
2/15/2008	Treatment Set	1	8:10	32.4	93.1	0.034	275	0	59	63.6	0.9277	*			
		2	9:15	43.6	68.01	0.309	191.3	0	59	61.3	0.9625	x	0.9625		
		3	10:18	52.9	44.39	1.331	177.4	0	57.9	61.3	0.9445	**			
		4	11:36	57.5	39.63	2.479	209.8	0	58.5	60.8	0.9622	x	0.9622		
		5	1:05	62.6	43.1	1.952	115	0	58.4	60.6	0.9637	x	0.9637	0.9628	2.20%

* - T/C ratio excluded because of time

** - T/C ration excluded because air conditioner inadvertently activated

Table 2 – Type II Fuel Economy Test Calculations

DISCUSSION OF RESULTS

It is common practice in the trucking industry to place tires into service without any type of balancing. This is due in large part to the logistical requirements of the industry and the difficulty in maintaining equipment calibrations as well as operator skill levels. No special skill or equipment was required to add Counteract Balancing Beads to test tires. The driver immediately reported the ride of the truck was noticeably smoother. Past work at the PAVE Research Institute quantified the effect of cab vibration on the postural stability of drivers, which is a contributing factor in cab exit accidents and injury.

Balancing the tires in all positions produced an improvement in fuel economy of 2.2%. This finding is well beyond the 1 percent testing accuracy stated in the J1321 procedure, and would represent a significant savings to fleets. The vendor’s assertion that lighter loaded or empty box trailers would result in greater fuel savings should be evaluated in future testing.

APPENDIX – TRACTOR SPECIFICATIONS

- Model Year – 2004
- GVW – 52,000
- Engine – Minimum 14.0 Liter 435HP @ 2100 RPM 1650 LB/FT Torque
- Batteries – (3) 12V with 2280 CCA
- Positive Post for jump starting the truck
- Compressor – Minimum of 15.9 CFM
- Clutch – Eaton Fuller 15-1/2” Adjust Free
- Exhaust – Right hand mounted vertical exhaust with 13’ 06” curved vertical chrome tailpipe.
- Coolant filter – Fleetguard or approved equivalent
- Radiator – Minimum 1350 SQ-IN
- Antifreeze – Minimum rating of –34F
- Transmission – Eaton Fuller RTOC-16909A
- Transmission – Convert transmission to 13-speed at 500,000 miles (Provide total price for parts and labor as a separate line item)
- Transmission oil cooler – Air to oil
- Front Axle – Dana Spicer E-1200I 3.5” Drop Front Axle rated at 12,000 LB
- Front Brakes – Dana Spicer 15 x 4L ES LMS Extended Lube front brakes
- Front Suspension – 12,000 LB Taper-Leaf
- Front Slack adjusters – Dana Spicer LMS Extended Lube automatic front slack adjusters
- Front shock absorbers
- Rear Axle – Dana Spicer DSH40 rated at 40,000 LB
- Rear Axle Ratio – 3.70
- Main Driveline – Dana Spicer SPL250HD
- Interaxle Driveline – Dana Spicer SPL170 XL
- Interaxle Lockout – To include indicator light
- Synthetic Oil – 50W Transmission / 75W – 90W all axles
- Rear Brakes – Dana Spicer 16.5x7L LMS extended lube
- Rear Slack Adjusters – Dana Spicer LMS extended lube automatic rear slack adjusters
- Rear Suspension – Airliner 40,000 LB extra duty
- Air Suspension Dump Valve – Manual with indicator light and warning buzzer
- Rear Shock Absorbers – Both axles
- Trailer Air Hose – 15’ coiled
- Trailer Electrical Cable – 15’ Coiled
- Wheelbase – 187”
- Frame – 7/16” x 3-11/16” x 11-1/8” steel frame with a ¼” full C-Channel frame reinforcement with a minimum RBM rating 3,432,000 lbf-in per rail
- Frame Overhang – Minimum of 57 inches
- Front Tow Hooks – Frame mounted

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- Clear Frame Rails 30” back of cab for cab guard mounting
- Air Slide 5^{th} Wheel – 24” with a vertical load capacity of 70,000 lbs and a trailing load capacity of 200,000 lbs
- Fuel Tank – 100 - gallon aluminum right hand mounted fuel tank
- Front Tires – 275/80R 22.5 14 PLY Michelin XZA2
- Front Wheels – Aluminum 10-Hub Pilot
- Rear Tires – 275/80R 22.5 14 PLY Michelin XDA H/T
- Rear Wheels – 10-Hub Pilot 5-hand steel wheels
- Cab – Minimum of 120” conventional cab
- Cab Mounts – Air ride
- Air Horn
- Utility Light – Flush mounted back of cab
- Mirrors – Dual West Coast heated mirrors with right hand remote 102” wide
- Convex Mirrors – 8” convex mirrors mounted under primary mirrors on driver and passenger sides
- Factory tinted windshield and glass
- Vent Windows
- Ash Tray and Lighter – Dash mounted
- Fire Extinguisher – Mounted left hand of drivers seat
- Heater and Defroster
- Air Conditioning
- Driver Seat – High back air ride driver seat with adjustable lumbar support and dual armrest
- Passenger Seat – High back non-suspension
- Seat Covers – Heavy duty vinyl
- Gauges – To include all standard gauges plus tachometer, trip meter, hour meter, voltmeter, air restriction indicator, low air pressure light and buzzer, primary and secondary air pressure gauges, engine coolant temperature, and engine oil pressure
- Radio – AM/FM/WB Cassette
- Trailer Brake – Hand Controlled
- Park Brake System – Two valve system with warning indicator