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**REPORT ON FUEL EFFICIENCY TRIAL  
CATERPILLAR 777C TRUCKS  
BORAL CONTRACTING  
COOLJARLOO OPERATIONS**

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# ***CONTENTS***

Executive Summary	Page 1
Introduction	Page 1
Test Procedure	Page 2
Photographs	Page 3
Test Results	Page 4
Tables RD100	Page 5
Tables RD102	Page 6
Tables RD103	Page 7
Graph RD100 & RD102	Page 8
Graph RD103	Page 9
Conclusion	Page 9
Bibliography	Page 9

## **Appendices**

“T” Test Spreadsheets	Appendix “A”
Test Worksheets	Appendix “B”

## *EXECUTIVE SUMMARY*

This report outlines the fuel efficiency gains and economic benefits provided by use of Fuel Technology's FTC Combustion Catalyst in a trial comprising three Caterpillar 777C model haul trucks operating at Boral Contractors Cooljarloo operations.

Fuel efficiency gains measured ranged from a low of 7.9% to a high of 11.7% averaging **9.5%** efficiency gain.

The trial procedure enables fuel consumption measurements to be made with the truck operating under normal mine operating conditions, monitoring haul times, fuel consumed, fuel temperatures, distance traversed and payload carried.

The results of this multi haul-truck trial are reported in detail on the following pages. They confirm that:-

1. The trial data has uniformity and reproducibility providing confidence in the measuring technique and test protocol.
2. The measured difference in fuel consumption between untreated diesel baseline tests and subsequent FTC treated tests show an average 9.5% reduction in fuel consumption.

The fuel consumption reductions monitored are in line with our database of tests conducted over the past fifteen years.

## *INTRODUCTION*

This fuel efficiency study at Cooljarloo was initiated by Boral Contracting senior staff. Three available trucks were selected for testing in order to provide a more representative and accurate assessment of the fuel efficiency potential that may be provided by the FTC catalyst.

Caterpillar 777C units numbered RD100, RD102 and RD103 were selected for the trial. Baseline tests were conducted on 11<sup>th</sup> and 12<sup>th</sup> May 1998 and following a period of FTC fuel treatment, treated tests on the 22<sup>nd</sup> May, 1998.

Preceding treated tests mining was shut down for twelve (12) hours due to wet weather. RD 102 was the first truck tested following this shut down and appears to have taken several loads to reach operating temperature and true efficiency.

## ***TEST PROCEDURE***

The test procedure requires measurement of the mass of fuel consumed related to the work done in hauling a measured load of ore over a defined reproducible distance.

A start point at a given distance from the working bench is marked by a surveyor's peg and a finish point prior to dump area marked with sighting pegs. The distance between the start and finish point of the haul cycle is measured. The distance of the haul route at Cooljarloo was 720 meters.

MacNaught Model M5 flow transducers, complete with thermocouple probes, are connected to the truck's fuel tank outlet and return fuel pipelines (*Photograph No 1*). These transducers, which have been calibrated to  $\pm 0.25\%$  by a NATA Certified Laboratory, are then connected to a KEP Minitrol totaliser mounted in the truck cab. The thermocouple probes are connected to a dual reading digital thermometer also mounted in the cab workstation (*Photograph No 2*).

As the temperature of the fuel can vary relative to ambient temperature changes as well as increase significantly during a working shift, constant temperature monitoring is required to enable calculation of the mass of fuel consumed each haul.

Prior to the test commencing a fuel sample is drawn and the density measured at observed temperature and then corrected to the industry standard of 15°C by use of the Institute of Petroleum Density Correction Table, Volume VIII, Table 53B.

Following loading of the truck at each cycle, allowing the load monitor to register, the load in kilograms is recorded and the truck driven to the bottom marker and stopped. The Minitrol totaliser and stopwatch are zeroed. At the signal "GO" the driver accelerates and the test engineer activates the totaliser and stopwatch.

To avoid driver variables the truck is driven at full throttle over the haul test circuit. Fuel temperatures are recorded at the mid haul point and upon arrival at the haul finish marker the stopwatch and Minitrol totaliser readings recorded. Approximately sixteen test runs were recorded for each of the three test trucks.



Photo 1.                   McNaught transducers fitted to fuel tank measuring flow to and return from engine.

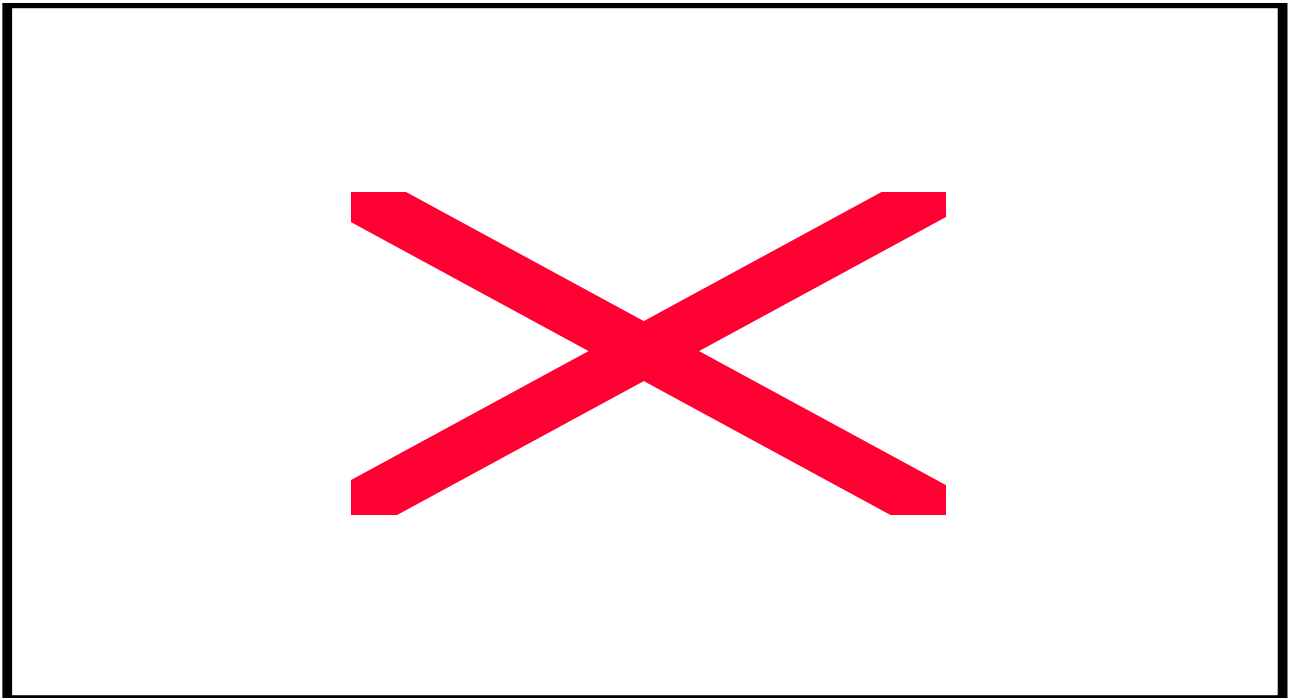


Photo 2.                   Data recording equipment set up in drivers cab. Minitrol volume recorder, digital thermometer, Stop watch and data work sheets.

## TEST RESULTS

The individual results achieved by each of the three test trucks are shown in Table I below. The results are reported as fuel consumed in kilograms/tonne (kg/t) which relates to a more accurate mass measurement compared to the usual mine operations method of recording litres/hour (L/h). However, to fully assess fuel consumed for a given amount of work done the formula:-

$$\frac{\text{Distance travelled x load carried}}{\text{Fuel consumed}}$$

should be employed, thus reporting efficiency as tonne kilometers/kilogram (t km/kg). (Koehler & Doglio, 1987)

**TABLE 1**

*Average Fuel Consumption Reductions*

<b>Unit No.</b>	<b>Truck Model</b>	<b>Fuel Consumption Reduction</b>	<b>Fuel Efficiency Gains</b>
		<b>kg/t</b>	<b>t km/kg</b>
RD100	777C	- 8.3%	+ 9.0%
RD102	777C	- 10.6%	+ 11.7%
RD103	777C	- 7.4%	+ 7.9%

Details of all data extracted during the trial program for each truck are shown in the following computer printouts. The arithmetic mean has been calculated together with the Standard Deviation and Co-efficient of Variation (C.V.)

**SPECIFIC FUEL CONSUMPTION TRUCK TRIAL**

Customer: BORAL COOLJARLOO Engine Hrs 9639  
 Date: 11/05/98 Amb; Temp; High deg; C 20.7  
 Truck No: RD100 Amb; Temp; Low deg; C 19.6  
 Make/Model Cat 777C Circuit Distance 720m  
 Truck Weight 64 Tonne

Fuel Sample	Density	Temp Deg C
	0.822	36.2
Corrected	0.837	15

**UNTREATED**

Run No	Time	Load Tonne	Haul Time		Fuel (Lt)		Fuel (Lt) Consumed	Fuel Temp		Density		Fuel (kg)		Fuel (kg) Consumed	Fuel (kg) Per Tonne	Tonne km Per kg Fuel	
			Mins	Secs	Mins	In		Out	In	Out	In	Out	In				Out
1	11.00	83	1	32	1.53	19.55	15.68	3.87	27.1	35.1	0.828	0.823	16.20	12.90	3.29	0.0224	32.1339
2	11.10	82	1	32	1.53	19.58	15.70	3.88	27.2	35.4	0.828	0.823	16.22	12.91	3.31	0.0226	31.8039
3	11.20	83	1	32	1.53	19.67	15.76	3.91	29.4	36.7	0.827	0.822	16.26	12.95	3.31	0.0225	31.9301
4	11.30	93	1	32	1.53	19.64	15.73	3.91	31.2	37.3	0.826	0.821	16.21	12.92	3.30	0.0210	34.3029
5	11.40	86	1	32	1.53	19.67	15.78	3.89	32.3	38.1	0.825	0.821	16.22	12.95	3.27	0.0218	32.9955
6	11.50	73	1	30	1.50	19.42	15.56	3.86	34.1	39.2	0.824	0.820	15.99	12.76	3.23	0.0236	30.4941
7	12.00	93	1	32	1.53	19.54	15.65	3.89	34.6	39.4	0.823	0.820	16.08	12.83	3.26	0.0207	34.7274
8	12.10	89	1	31	1.52	19.48	15.59	3.89	36.0	40.3	0.822	0.819	16.01	12.77	3.24	0.0212	33.9503
9	12.20	89	1	31	1.52	19.57	15.61	3.96	37.1	40.3	0.821	0.819	16.07	12.79	3.29	0.0215	33.4971
10	12.30	87	1	31	1.52	19.46	15.57	3.89	38.0	42.7	0.821	0.817	15.97	12.73	3.24	0.0215	33.5152
11	12.40	73	1	26	1.43	18.58	14.72	3.86	38.8	41.7	0.820	0.818	15.24	12.04	3.20	0.0233	30.8550
12	12.50	71	1	28	1.47	18.77	15.06	3.71	39.9	42.7	0.819	0.817	15.38	12.31	3.07	0.0227	31.6603
13	1.15	88	1	31	1.52	19.54	15.59	3.95	39.8	40.0	0.820	0.819	16.01	12.77	3.24	0.0213	33.7763
14	1.25	85	1	31	1.52	19.42	15.54	3.88	40.8	43.8	0.819	0.817	15.90	12.69	3.21	0.0215	33.4290
15	1.35	75	1	28	1.47	18.78	15.09	3.69	41.3	44.6	0.818	0.816	15.37	12.31	3.05	0.0220	32.7637
16	1.45	81	1	28	1.47	18.70	15.01	3.69	42.8	45.5	0.817	0.815	15.28	12.24	3.04	0.0210	34.2930
Mean		83			1.51			3.86							3.223	0.0219	32.883
Std Dev		7.01635			0.0316			0.0848							0.0891	0.0009	1.2752
C.V		8.4%			2.1%			2.2%							2.8%	3.9%	3.9%

**SPECIFIC FUEL CONSUMPTION TRUCK TRIAL**

Truck No: RD100 Engine Hrs 9813  
 Date: 22/04/98 Amb; Temp; High deg; C 16.3  
 Amb; Temp; Low deg; C 23.1

Fuel Sample	Density	Temp Deg C
	0.825	35.4
Corrected	0.839	15

**TREATED**

Run No	Time	Load Tonne	Haul Time		Fuel (Lt)		Fuel (Lt) Consumed	Fuel Temp		Density		Fuel (kg)		Fuel (kg) Consumed	Fuel (kg) Per Tonne	Tonne km Per kg Fuel	
			Mins	Secs	Mins	In		Out	In	Out	In	Out	In				Out
1	10.30	104	1	32	1.53	19.36	15.58	3.78	29.6	38.0	0.829	0.823	16.05	12.82	3.23	0.0192	37.4782
2	10.40	96	1	29	1.48	18.84	15.12	3.72	30.2	41.4	0.829	0.821	15.61	12.41	3.20	0.0200	35.9676
3	10.47	100	1	30	1.50	19.05	15.22	3.83	31.3	42.8	0.828	0.820	15.77	12.47	3.30	0.0201	35.8204
4	10.55	92	1	27	1.45	18.85	15.11	3.74	31.6	43.5	0.828	0.819	15.60	12.38	3.22	0.0207	34.8382
5	11.03	99	1	29	1.48	18.87	15.09	3.78	33.0	45.2	0.827	0.818	15.60	12.34	3.25	0.0200	36.0696
6	11.12	93	1	26	1.43	18.52	14.86	3.67	33.7	46.1	0.826	0.817	15.30	12.14	3.16	0.0201	35.7674
7	11.20	98	1	28	1.47	18.77	15.00	3.77	34.3	46.2	0.826	0.817	15.50	12.26	3.24	0.0200	35.9827
8	11.30	89	1	27	1.45	18.62	14.94	3.68	34.9	46.8	0.825	0.817	15.36	12.20	3.16	0.0207	34.8416
9	11.38	92	1	27	1.45	18.64	14.99	3.65	36.0	47.4	0.825	0.817	15.37	12.24	3.13	0.0201	35.8806
10	11.47	93	1	27	1.45	18.69	14.98	3.70	36.7	48.0	0.824	0.816	15.40	12.23	3.17	0.0202	35.6330
11	11.55	93	1	28	1.47	18.71	15.02	3.69	37.4	48.1	0.824	0.816	15.41	12.26	3.15	0.0201	35.8394
12	12.03	93	1	27	1.45	18.62	14.89	3.73	38.0	48.4	0.823	0.816	15.33	12.14	3.18	0.0203	35.5234
13	12.10	93	1	27	1.45	18.52	14.83	3.69	38.6	48.9	0.823	0.815	15.24	12.09	3.14	0.0200	35.9443
14	12.18	93	1	27	1.45	18.61	14.92	3.69	39.1	49.4	0.822	0.815	15.30	12.16	3.14	0.0200	35.9499
15	12.35	92	1	27	1.45	18.59	14.95	3.64	39.4	49.4	0.822	0.815	15.28	12.19	3.10	0.0199	36.2662
16	12.45	89	1	26	1.43	18.52	14.87	3.65	40.5	49.9	0.821	0.815	15.21	12.11	3.10	0.0203	35.5240
Mean		94			1.46			3.71							3.181	0.0201	35.8329
Std Dev		4.06151			0.0262			0.0546							0.0560	0.0003	0.5904
C.V		4.3%			1.8%			1.5%							1.8%	1.6%	1.6%

<b>% CHANGE:</b>	Load kg		Haul Time Mins		Fuel (Lt) Consumed		Fuel (kg) Consumed		Fuel (kg) Per Tonne		Tonne km Per kg Fuel
<b>Treated-Baseline</b>											
<b>Baseline</b>	13.37%		-2.97%		-3.75%		-1.30%		<b>-8.3%</b>		<b>9.0%</b>



**SPECIFIC FUEL CONSUMPTION TRUCK TRIAL**

Customer: BORAL COOLJARLOO Engine Hrs 9615  
 Date: 11/05/98 Amb; Temp; High deg; C 19.6  
 Truck No: RD102 Amb; Temp; Low deg; C 18.8  
 Make/Model Cat 777C Circuit Distance 720m  
 Truck Weight 64 Tonne

Fuel Sample	Density	Temp Deg C
	0.822	36.2
Corrected	0.837	15

**UNTREATED**

Run No	Time	Load Tonnes	Haul Time		Fuel (Lt)		Fuel (Lt) Consumed	Fuel Temp		Density		Fuel (kg)		Fuel (kg) Consumed	Fuel (kg) Per Tonne	Tonne km Per kg Fuel	
			Mins	Secs	Mins	In		Out	In	Out	In	Out	In				Out
1	14.50	75	1	26	1.43	18.47	14.88	3.59	34.2	43.0	0.823	0.817	15.21	12.16	3.05	0.0220	32.7967
2	15.03	86	1	26	1.43	19.21	15.49	3.72	35.0	45.4	0.823	0.816	15.81	12.64	3.17	0.0212	34.0420
3	15.21	83	1	26	1.43	19.17	15.53	3.64	35.2	47.1	0.823	0.814	15.77	12.65	3.13	0.0213	33.8411
4	15.33	85	1	26	1.43	19.41	15.72	3.69	35.0	48.1	0.823	0.814	15.97	12.79	3.18	0.0214	33.6899
5	15.52	77	1	27	1.45	19.53	15.70	3.83	36.3	49.5	0.822	0.813	16.05	12.76	3.29	0.0234	30.8130
6	16.10	73	1	30	1.50	20.08	16.19	3.89	37.1	50.9	0.821	0.812	16.49	13.14	3.35	0.0245	29.4035
7	16.20	68	1	26	1.43	18.74	15.19	3.55	34.9	51.3	0.823	0.811	15.42	12.32	3.10	0.0235	30.6671
8	16.30	83	1	27	1.45	19.39	15.63	3.76	36.0	51.1	0.822	0.812	15.94	12.68	3.26	0.0222	32.4658
9	16.37	70	1	26	1.43	18.86	15.26	3.61	37.0	51.5	0.821	0.811	15.49	12.38	3.12	0.0233	30.9469
10	16.49	78	1	29	1.48	19.93	16.07	3.87	38.0	51.6	0.821	0.811	16.36	13.03	3.33	0.0234	30.7148
11	16.57	76	1	28	1.47	19.44	15.66	3.78	38.4	51.9	0.820	0.811	15.95	12.70	3.25	0.0232	31.0397
12	17.08	83	1	26	1.43	19.39	15.62	3.77	38.4	52.0	0.820	0.811	15.91	12.67	3.24	0.0220	32.6707
13	17.18	63	1	24	1.40	18.39	14.58	3.82	38.0	51.8	0.821	0.811	15.09	11.82	3.27	0.0258	27.9362
14	17.28	57	1	24	1.40	18.42	14.96	3.46	38.3	52.1	0.821	0.811	15.11	12.13	2.98	0.0246	29.2355
15	17.36	73	1	25	1.42	18.53	14.97	3.56	38.6	52.4	0.820	0.811	15.20	12.13	3.07	0.0224	32.1280
16	17.46	83	1	28	1.47	19.44	15.70	3.74	37.9	52.4	0.821	0.811	15.95	12.72	3.23	0.0220	32.7531
17	17.56	81	1	28	1.47	19.398	15.731	3.67	37.7	52.4	0.821	0.811	15.92	12.75	3.17	0.0219	32.8939
Mean		76			1.44			3.70						3.190	0.0229	31.572	
Std Dev		8.28829			0.0272			0.1252						0.1071	0.0013	1.7726	
C.V		10.9%			1.9%			3.4%						3.4%	5.8%	5.6%	

**SPECIFIC FUEL CONSUMPTION TRUCK TRIAL**

Truck No: RD102 Engine Hrs 9768  
 Date: 22/05/98 Amb; Temp; High deg; C 23.4  
 Amb; Temp; Low deg; C 20

Fuel Sample	Density	Temp Deg C
	0.825	35.4
Corrected	0.839	15

**TREATED**

Run No	Time	Load Tonnes	Haul Time		Fuel (Lt)		Fuel (Lt) Consumed	Fuel Temp		Density		Fuel (kg)		Fuel (kg) Consumed	Fuel (kg) Per Tonne	Tonne km Per kg Fuel	
			Mins	Secs	Mins	In		Out	In	Out	In	Out	In				Out
1	8.03	92	1	30	1.50	19.81	15.86	3.95	23.3	35.1	0.834	0.825	16.51	13.09	3.43	0.0220	32.7882
2	8.14	92	1	30	1.50	19.76	15.80	3.95	24.3	36.0	0.833	0.825	16.45	13.03	3.42	0.0219	32.8263
3	8.23	93	1	28	1.47	19.36	15.53	3.84	25.1	37.3	0.832	0.824	16.12	12.79	3.33	0.0212	33.9517
4	8.34	103	1	30	1.50	19.82	15.85	3.98	27.3	38.7	0.831	0.823	16.47	13.03	3.43	0.0206	35.0345
5	8.43	101	1	29	1.48	19.74	15.85	3.90	29.0	40.1	0.830	0.822	16.38	13.02	3.36	0.0203	35.3888
6	8.53	114	1	31	1.52	19.87	15.91	3.95	30.0	40.9	0.829	0.821	16.46	13.07	3.40	0.0191	37.7077
7	9.03	96	1	28	1.47	19.24	15.46	3.78	31.1	41.5	0.828	0.821	15.93	12.69	3.24	0.0203	35.5529
8	9.11	96	1	28	1.47	19.27	15.48	3.79	32.0	42.3	0.827	0.820	15.94	12.70	3.25	0.0203	35.4676
9	9.20	107	1	28	1.47	19.35	15.49	3.86	32.9	42.9	0.827	0.820	16.00	12.70	3.30	0.0193	37.3520
10	9.30	95	1	28	1.47	19.25	15.46	3.80	33.7	43.4	0.826	0.819	15.91	12.66	3.24	0.0204	35.3106
11	9.38	96	1	27	1.45	19.23	15.42	3.81	34.0	43.5	0.826	0.819	15.88	12.63	3.25	0.0203	35.3987
12	9.47	92	1	26	1.43	19.09	15.40	3.69	34.8	44.0	0.825	0.819	15.75	12.61	3.15	0.0202	35.7047
13	9.57	94	1	26	1.43	19.10	15.37	3.72	34.9	44.6	0.825	0.819	15.76	12.58	3.18	0.0201	35.8152
Mean		98			1.47			3.85						3.305	0.0205	35.2537	
Std Dev		6.71011			0.0259			0.0938						0.0968	0.0008	1.4386	
C.V		6.9%			1.8%			2.4%						2.9%	4.1%	4.1%	

% CHANGE:	Load kg	Haul Time Mins	Fuel (Lt) Consumed	Fuel (kg) Consumed	Fuel (kg) Per Tonne	Tonne km Per kg Fuel
<b>Treated-Baseline</b>						
<b>Baseline</b>	28.96%	2.18%	3.85%	3.63%	-10.6%	11.7%

**SPECIFIC FUEL CONSUMPTION TRUCK TRIAL**

Customer: BORAL COOLJARLOO Engine Hrs 4460  
 Date: 12/05/98 Amb; Temp; High deg; C 26.5  
 Truck No: RD103 Amb; Temp; Low deg; C 15.1  
 Make/Model Cat 777C Circuit Distance 720m  
 Truck Weight 64 Tonne

Fuel Sample	Density	Temp Deg C
	0.822	36.2
Corrected	0.837	15

**UNTREATED**

Run No	Time	Load Tonnes	Haul Time		Fuel (Lt)		Fuel (Lt) Consumed	Fuel Temp		Density		Fuel (kg)		Fuel (kg) Consumed	Fuel (kg) Per Tonne	Tonne km Per kg Fuel	
			Mins	Secs	Mins	In		Out	In	Out	In	Out	In				Out
1	7.31	79	1	31	1.52	19.43	15.55	3.88	33.1	44.1	0.824	0.816	16.01	12.69	3.32	0.0232	31.0197
2	7.40	96	1	30	1.50	19.28	15.35	3.93	34.1	45.6	0.824	0.815	15.87	12.52	3.36	0.0210	34.2956
3	7.52	92	1	29	1.48	19.21	15.34	3.87	34.8	46.8	0.823	0.815	15.81	12.50	3.31	0.0212	33.9033
4	8.00	85	1	28	1.47	19.11	15.28	3.83	36.1	48.0	0.822	0.814	15.71	12.43	3.27	0.0220	32.7783
5	8.10	93	1	30	1.50	19.27	15.34	3.93	36.0	48.2	0.822	0.814	15.84	12.48	3.36	0.0214	33.6232
6	8.21	74	1	25	1.42	18.39	14.74	3.65	37.1	48.7	0.821	0.813	15.11	11.99	3.12	0.0226	31.8565
7	8.32	76	1	23	1.38	18.46	14.83	3.63	37.8	48.8	0.821	0.813	15.16	12.06	3.10	0.0221	32.5627
8	8.46	83	1	25	1.42	18.02	14.41	3.61	39.9	49.7	0.819	0.813	14.77	11.71	3.05	0.0208	34.6538
9	8.54	97	1	26	1.43	19.11	15.25	3.86	39.7	49.9	0.820	0.812	15.66	12.39	3.27	0.0203	35.3985
10	9.05	88	1	28	1.47	18.00	14.39	3.61	41.2	50.7	0.819	0.812	14.73	11.68	3.06	0.0201	35.8222
11	9.17	84	1	26	1.43	18.04	14.43	3.62	41.8	51.5	0.818	0.811	14.76	11.70	3.06	0.0207	34.8506
12	10.31	79	1	27	1.45	18.71	14.85	3.86	32.5	40.2	0.825	0.819	15.42	12.17	3.26	0.0228	31.5843
13	10.45	91	1	27	1.45	18.70	14.93	3.77	33.2	44.7	0.824	0.816	15.41	12.18	3.23	0.0208	34.5747
14	10.59	89	1	26	1.43	18.45	14.78	3.67	34.7	47.2	0.823	0.814	15.18	12.03	3.15	0.0206	34.9733
15	11.09	83	1	26	1.43	18.26	14.61	3.66	35.7	47.8	0.822	0.814	15.02	11.89	3.13	0.0213	33.7985
16	11.22	76	1	26	1.43	18.29	14.73	3.56	37.4	49.0	0.821	0.813	15.02	11.97	3.05	0.0218	33.0599
17	11.34	88	1	29	1.48	19.13	15.28	3.85	38.0	49.6	0.821	0.813	15.70	12.41	3.28	0.0216	33.3238
Mean		85			1.45			3.75							3.199	0.0214	33.652
Std Dev		7.10737			0.0355			0.1289							0.1148	0.0009	1.3723
C.V		8.3%			2.4%			3.4%							3.6%	4.1%	4.1%

**SPECIFIC FUEL CONSUMPTION TRUCK TRIAL**

Truck No: RD103 Engine Hrs 4641  
 Date: 22/04/98 Amb; Temp; High deg; C 20.2  
 Amb; Temp; Low deg; C 14

Fuel Sample	Density	Temp Deg C
	0.825	35.4
Corrected	0.839	15

**TREATED**

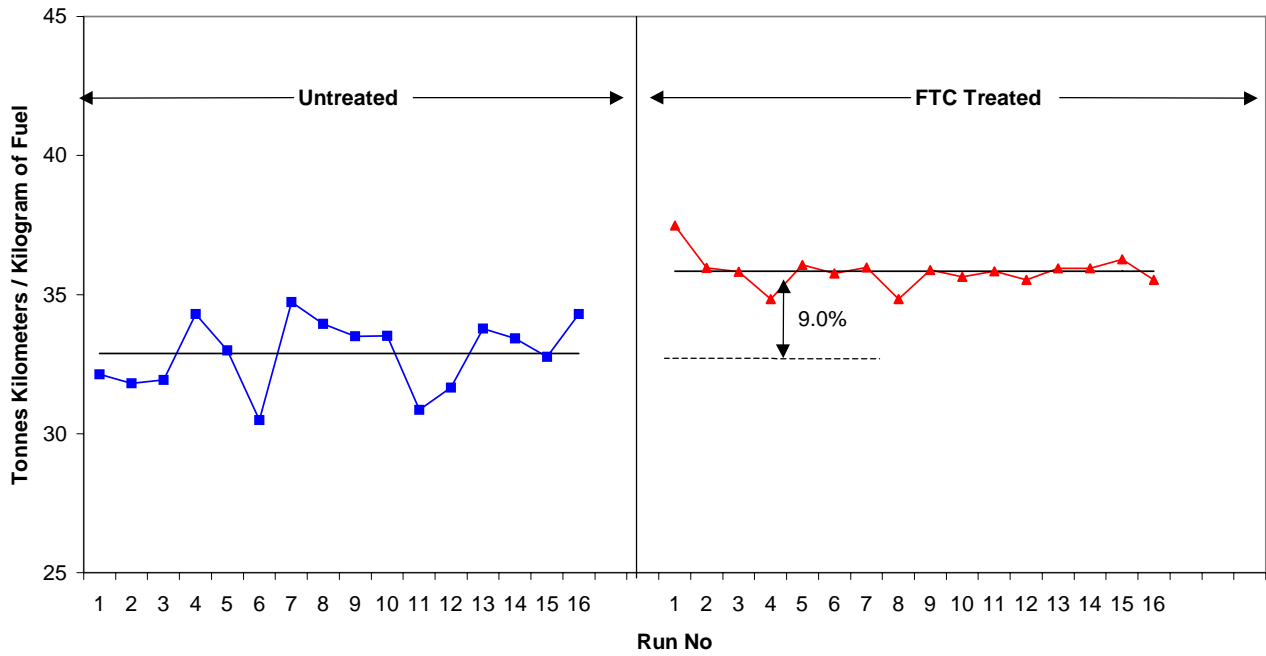
Run No	Time	Load Tonne	Haul Time		Fuel (Lt)		Fuel (Lt) Consumed	Fuel Temp		Density		Fuel (kg)		Fuel (kg) Consumed	Fuel (kg) Per Tonne	Tonne km Per kg Fuel	
			Mins	Secs	Mins	In		Out	In	Out	In	Out	In				Out
1	16.04	92	1	30	1.50	18.89	15.13	3.76	35.5	46.5	0.825	0.817	15.58	12.37	3.22	0.0206	34.9214
2	16.15	102	1	30	1.50	19.12	15.34	3.78	30.6	41.9	0.828	0.820	15.84	12.58	3.26	0.0196	36.6924
3	16.25	100	1	29	1.48	19.13	15.31	3.82	31.7	44.7	0.828	0.818	15.83	12.53	3.30	0.0201	35.7748
4	16.35	95	1	28	1.47	18.70	15.00	3.69	32.9	46.3	0.827	0.817	15.46	12.26	3.19	0.0201	35.8326
5	16.44	96	1	28	1.47	18.71	15.05	3.66	34.1	47.5	0.826	0.816	15.45	12.29	3.16	0.0198	36.4082
6	16.54	97	1	29	1.48	18.95	15.26	3.69	35.4	48.4	0.825	0.816	15.64	12.45	3.18	0.0198	36.4181
7	17.07	93	1	27	1.45	18.48	14.82	3.66	36.5	48.3	0.824	0.816	15.23	12.09	3.14	0.0200	36.0143
8	17.18	94	1	27	1.45	18.69	14.98	3.71	37.3	48.8	0.824	0.816	15.39	12.21	3.17	0.0201	35.8366
9	17.28	94	1	28	1.47	18.75	15.03	3.71	38.2	49.4	0.823	0.815	15.43	12.25	3.17	0.0201	35.8349
10	17.38	102	1	29	1.48	18.97	15.10	3.87	38.8	49.7	0.823	0.815	15.60	12.30	3.30	0.0199	36.2482
11	17.50	104	1	30	1.50	19.19	15.40	3.79	39.5	49.9	0.822	0.815	15.78	12.55	3.23	0.0192	37.4901
12	18.00	109	1	30	1.50	19.33	15.45	3.88	39.9	50.0	0.822	0.815	15.88	12.58	3.30	0.0191	37.7196
13	18.10	103	1	30	1.50	19.24	15.39	3.85	40.5	50.5	0.821	0.814	15.80	12.53	3.27	0.0196	36.7796
Mean		99			1.48			3.76							3.223	0.0198	36.3054
Std Dev		5.1739			0.0191			0.0785							0.0569	0.0004	0.7501
C.V		5.3%			1.3%			2.1%							1.8%	2.1%	2.1%

% CHANGE:	Load kg	Haul Time Mins	Fuel (Lt) Consumed	Fuel (kg) Consumed	Fuel (kg) Per Tonne	Tonne km Per kg Fuel
Treated-Baseline						
Baseline	15.29%	1.92%	0.20%	0.75%	-7.4%	7.9%

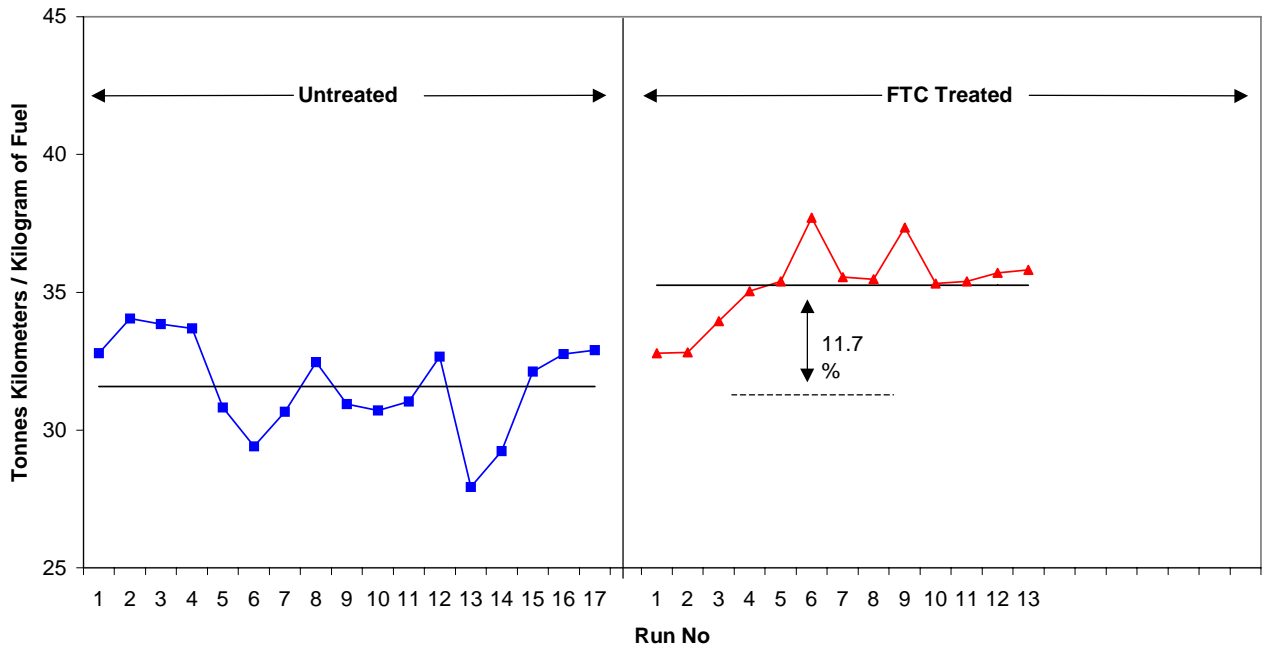
To prove the statistical significance of the difference in means between baseline and treated tests a Student t-test was performed.

t-test spreadsheets are included in the appendices.

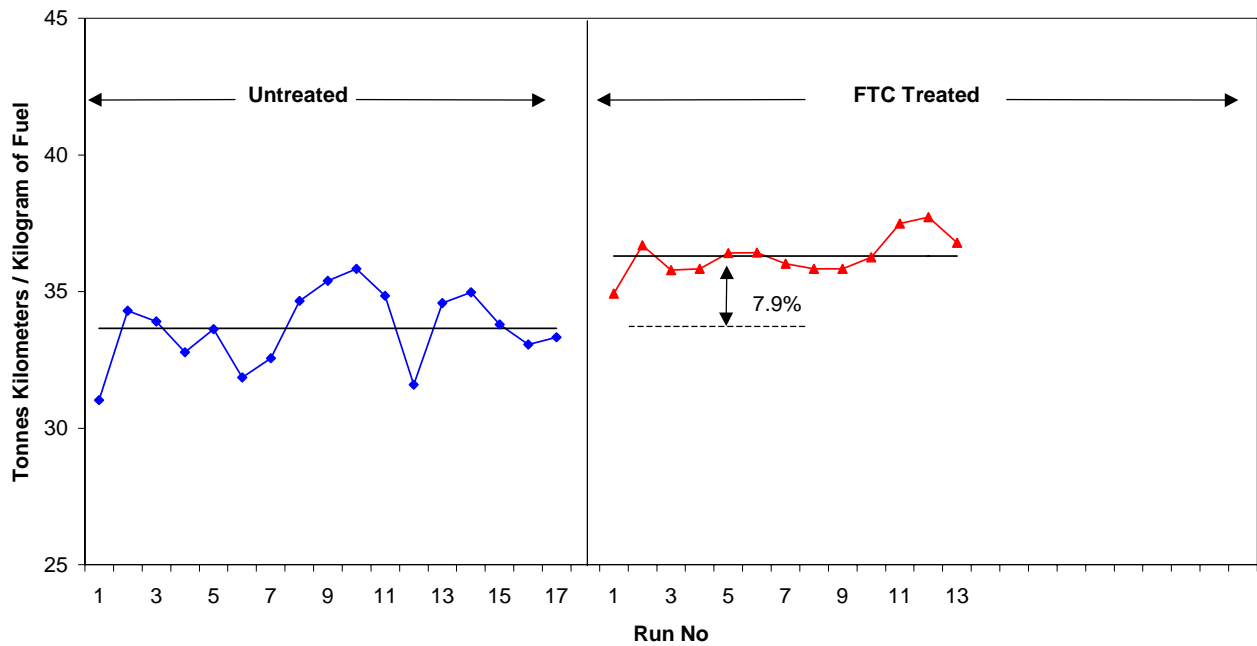
**BORAL COOLJARLOO Truck No.100**  
Efficiency Tests



**BORAL COOLJARLOO Truck No.102**  
Efficiency Tests



**BORAL COOLJARLOO Truck No.103  
Efficiency Tests**



## **CONCLUSION**

The results of this extensive multi-truck evaluation of the FTC catalyst at Boral Contracting Cooljarloo operation provides accurate and conclusive evidence of economic fuel consumption reductions.

The measured efficiency gain of the three-truck test fleet represents a **9.5%** improvement.

Efficiency gains measured in the Cooljarloo test fleet, under normal operating conditions, correlate well with other haul truck tests conducted and also static carbon balance testing on this class of equipment over the past fifteen years.

## **BIBLIOGRAPHY**

Koehler, D. & Doglio, J. (1987). SAE Technical Paper 872146: Benefits of Multifunctional Diesel Fuel Additives Demonstration in a Fleet Test. The Engineering Society For Advanced Mobility Land Sea And Space.

Appendix “A”

**“T” Test Spreadsheets**

t test: Two Sample Assuming Equal Population Variances

Company	BORAL	
Site	Cooljarloo	
Truck	RD100	
Test:	Untreated	
Record		Tonne km/ kg Fuel
	1	32.1339
	2	31.8039
	3	31.9301
	4	34.3029
	5	32.9955
	6	30.4941
	7	34.7274
	8	33.9503
	9	33.4971
	10	33.5152
	11	30.8550
	12	31.6603
	13	33.7763
	14	33.4290
	15	32.7637
	16	34.2930

Mean	32.8830
Std Dev	1.275225428
Observations	16

Test:

Record		Tonne km/ kg Fuel
	1	37.4782
	2	35.9676
	3	35.8204
	4	34.8382
	5	36.0696
	6	35.7674
	7	35.9827
	8	34.8416
	9	35.8806
	10	35.6330
	11	35.8394
	12	35.5234
	13	35.9443
	14	35.9499
	15	36.2662
	16	35.5240

Mean	35.8329
Std Dev	0.59035529
Observations	16

	Tonne km/ kg Fuel
Mean % change	9.0%
Confidence Interval	99%
Alpha	0.005
Degrees Of Freedom	30
t Critical Value	2.75
Hypothesis	H <sub>0</sub> : u <sub>1</sub> - u <sub>2</sub> = 0 H <sub>1</sub> : u <sub>1</sub> - u <sub>2</sub> <>0
t=	-8.40

Conclusion:  
 Since t= -8.40, is outside the range +/- 2.75 we reject H<sub>0</sub> and accept H<sub>1</sub> and conclude that the difference between FTC treated and untreated test means are significant at a 99 % confidence level.

t test: Two Sample Assuming Equal Population Variances

Company	BORAL	
Site	Cooljarloo	
Truck	DT102	
Test:	Untreated	
Record		Tonne km/ kg Fuel
	1	32.7967
	2	34.0420
	3	33.8411
	4	33.6899
	5	30.8130
	6	29.4035
	7	30.6671
	8	32.4658
	9	30.9469
	10	30.7148
	11	31.0397
	12	32.6707
	13	27.9362
	14	29.2355
	15	32.1280
	16	32.7531
	17	32.8939

Mean	31.6493
Std Dev	1.745992809
Observations	17

Test:

Record		Tonne km/ kg Fuel
	1	32.7882
	2	32.8263
	3	33.9517
	4	35.0345
	5	35.3888
	6	37.7077
	7	35.5529
	8	35.4676
	9	37.3520
	10	35.3106
	11	35.3987
	12	35.7047
	13	35.8152

Mean	35.2537
Std Dev	1.438620198
Observations	13

	Tonne km/ kg Fuel
Mean % change	11.4%
Confidence Interval	99%
Alpha	0.005
Degrees Of Freedom	28
t Critical Value	2.76
Hypothesis	H <sub>0</sub> : u <sub>1</sub> - u <sub>2</sub> = 0 H <sub>1</sub> : u <sub>1</sub> - u <sub>2</sub> <>0
t=	-6.03

Conclusion:  
 Since t= -6.03, is outside the range +/- 2.76 we reject H<sub>0</sub> and accept H<sub>1</sub> and conclude that the difference between FTC treated and untreated test means are significant at a 99 % confidence level.

**t test: Two Sample Assuming Equal Population Variances**

Company	BORAL	
Site	Cooljarloo	
Truck	DT103	
Test:	Untreated	
Record		Tonne km/ kg Fuel
	1	31.0197
	2	34.2956
	3	33.9033
	4	32.7783
	5	33.6232
	6	31.8565
	7	32.5627
	8	34.6538
	9	35.3985
	10	35.8222
	11	34.8506
	12	31.5843
	13	34.5747
	14	34.9733
	15	33.7985
	16	33.0599
	17	33.3238

Mean	33.6517
Std Dev	1.372349789
Observations	17

Test:

Record		Tonne km/ kg Fuel
	1	34.9214
	2	36.6924
	3	35.7748
	4	35.8326
	5	36.4082
	6	36.4181
	7	36.0143
	8	35.8366
	9	35.8349
	10	36.2482
	11	37.4901
	12	37.7196
	13	36.7796

Mean	36.3054
Std Dev	0.750053402
Observations	13

	Tonne km/ kg Fuel
Mean % change	7.9%
Confidence Interval	99%
Alpha	0.005
Degrees Of Freedom	28
t Critical Value	2.76
Hypothesis	$H_0: \mu_1 - \mu_2 = 0$ $H_1: \mu_1 - \mu_2 < 0$
t=	-6.28

Conclusion:  
 Since t= -6.28, is outside the range +/- 2.76 we reject  $H_0$  and accept  $H_1$  and conclude that the difference between FTC treated and untreated test means are significant at a 99 % confidence level



Appendix “*B*”

**Test Worksheets**