FPC-2 FUEL CATALYST
FUEL EFFICIENCY TESTS FOR
AUSTRALIAN RAILROAD GROUP (ARG)
FORRESTFIELD, WESTERN AUSTRALIA

August, 2006

Prepared by:

Fuel Technology Pty Ltd
2 Tipping Road
KEWDALE WA 6105
Australia

Tel: (08) 9353 1016
Fax: (08) 9353 1013
E-mail fueltech@iinet.net.au

ABN 83 100 293 490

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EXECUTIVE SUMMARY

The FPC Catalysts manufactured and marketed by Fuel Technology Pty Ltd have proven in laboratory and field testing to reduce fuel consumption in the range **3%** to **8%** under comparable load conditions and to also substantially reduce carbon emissions.

Following discussions with ARG Manager Locomotive Standards and Projects, Mr Karl Amsuss, it was agreed that an FPC-2 fuel efficiency study should be conducted on a Q Class locomotive operating between Koolyanobbing mine and the Port of Esperance.

The test locomotive was treated with FPC-2 Combustion Catalyst at each refuelling via an injection pump and small Catalyst storage tank mounted near locomotive fuel tanks.

The test locomotive showed a **5.6%** improved fuel efficiency following Catalyst treatment of fuel.

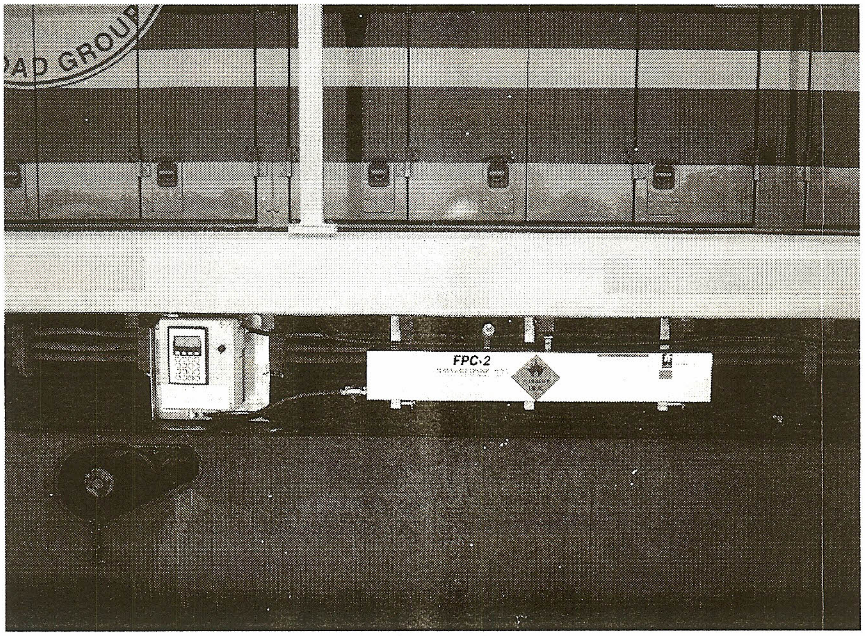
INTRODUCTION

Baseline (untreated) fuel efficiency tests were conducted on Q Class locomotive #305 on 9th February 2006, employing the Carbon Mass Balance (CMB) test procedure.

Fuel Technology Pty Ltd supplied on loan an injection system and small FPC storage tank fitted near locomotive's fuel tank requiring refuelling personnel to punch into key pad, litres of fuel added allowing automatic calibrated addition of the Catalyst. (*Photograph No 1*)

Treated tests were conducted on locomotive #305 on 12 August 2006. The results of this study are documented in this report.

Photograph No 1



TEST METHOD

Carbon Mass Balance (CMB) is a procedure whereby the mass of carbon in the exhaust is calculated as a measure of the fuel being burned. The elements measured in this test include the exhaust gas composition, its temperature and the gas flow rate calculated from the differential pressure and exhaust stack cross sectional area. Whilst this is an engineering standard test (AS2077-1982) in field testing we are unable to comply with the procedure in relation to employing a chassis dynamometer. However, in the case of Locomotives, the alternator/generator substitutes as a mechanism to apply and measure load.

The Carbon Balance formulae and equations employed in calculating the carbon flow are contained in the *Appendix*. "Measurements using Carbon Balance Techniques".

INSTRUMENTATION

Precision state of the art instrumentation is used to measure the concentrations of carbon containing gases in the exhaust stream and other factors related to fuel consumption and engine performance. The instruments and their purpose are listed below. (*Photograph No 2 depicts CMB test in progress*)

Measurement of exhaust gas constituents HC, CO, CO_2 and O_2 by Horiba-Mexa 4 gas infra red gas analyser.

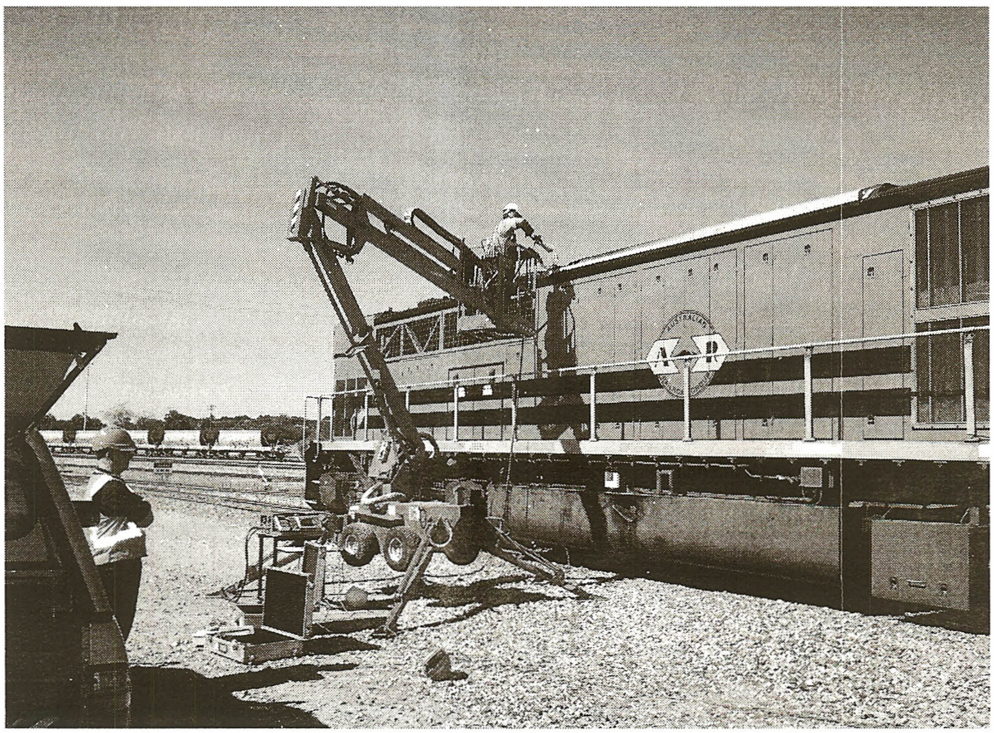
Temperature measurement by Fluke Model 52K/J digital thermometer.

Exhaust differential pressure by Air Instruments Model MP Precision Micromanometer.

Ambient pressure determination by use of Thommen 2000 TX altimeter/barometer.

The Horiba infra red gas analyser was serviced and calibrated prior to each series of engine efficiency tests.

Photograph No 2



TEST RESULTS

1. Fuel Efficiency

A summary of the CMB fuel efficiency results achieved in this test program are provided in Table 1 and also graphically in Graph 1.

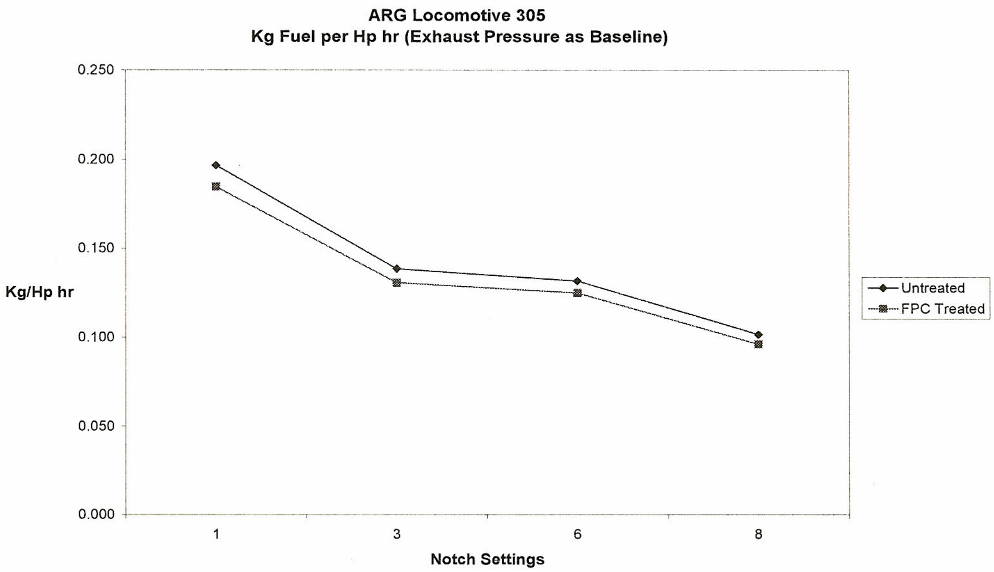
Due to differing access modes to exhaust stack between untreated and treated tests, positioning of CMB probe was not identical. This has the effect of producing differing exhaust pressures but will not affect exhaust gas percentage recordings. For this reason we have assumed similar exhaust pressure readings for treated tests to those of untreated at identical loads.

TABLE 1

LOCOMOTIVE 305

Notch	Carbon Flow grms/sec	Carbon Flow kg/hr	Measured Hp	kg/Hp	% Change
Idle untreated	5.99	21.56	0.15	143.76	
Idle FPC treated		0		#DIV/0!	#DIV/0!
1 untreated	10.389	37.40	190.22	0.197	
1 FPC treated	9.825	35.37	191.60	0.185	-6.1
3 untreated	34.272	123.38	890.35	0.139	
3 FPC treated	32.346	116.45	891.11	0.131	-5.7
6 untreated	73.436	264.37	2008.02	0.132	
6 FPC treated	69.598	250.55	2005.86	0.125	-5.1
8 untreated	101.162	364.18	3585.86	0.102	
8 FPC treated	96.123	346.0428	3599.99	0.096	-5.4
Average untreated				0.189	
Average FPC treated				0.179	**-5.6**

GRAPH 1



The computer printouts of the calculated CMB test results, together with raw data sheets, are contained in the *Appendix*.

The engine performance data logged during each test sequence is summarised in Table 2. The raw data sheets are contained in the *Appendix*.

Excluding idle mode which was not CMB tested, treated engine horsepower results correlate well with the baseline in that the variation is less than 1%.

TABLE 2

Baseline Test Date: 9/02/2006
Treated Test Date: 12/08/2006

Unit No. 305	Engine	Notch	EMD Rack (inches)	Lube Oil Pressure	Water Temp; °C	RPM	Main Gen Volts	Total Amps	Gen. Output Watts (Volts x Amps)	Engine HP (Watts/746)	HP % Change
(baseline) (treated)		Idle			80 82	343 343	5 5	22 16	110 80	0.15 0.11	-27.3%
(baseline) (treated)		1			80 82	343 343	505 277	281 516	141,905 142,932	190.22 191.60	0.7%
(baseline) (treated)		3			82 84	490 490	615 611	1080 1088	664,200 664,768	890.35 891.11	0.1%
(baseline) (treated)		6			83 85	729 729	938 930	1597 1609	1,497,986 1,496,370	2,008.02 2,005.86	-0.1%
(baseline) (treated)		8			83 85	905 904	1283 1274	2085 2108	2,675,055 2,685,592	3,585.86 3,599.99	0.4%

2. <u>Greenhouse Gas Reduction</u>

Assuming that the average **5.6%** measured improved fuel efficiency was applied to the total ARG diesel consumption of 50 ML per annum, this would translate to a **7,533 tonnes per annum reduction in CO_2 emissions** based on the formula outlined in Worksheet 1 of the *"Electricity Supply Business Greenhouse Change Workbook"*, our estimate is based on the following calculations:-

	(50,000 KL x 38.6 x 69.7)	÷	1000	=	134,521 tonnes
- 5.6%	(47,200 KL x 38.6 x 69.7)	÷	1000	=	126,988 tonnes

CO_2 reduction by application FPC-2

134,521 - 126,988 = 7,533 tonnes

CONCLUSION

These carefully controlled engineering standard test procedures conducted on ARG Q Class locomotive provides clear evidence of reduced fuel consumption at differing notch settings in the range 5.1% to 6.1%, **averaging 5.6%.**

A fuel efficiency gain of **5.6%** over the entire ARG fleet would reduce CO_2 emissions by **7,533 tonnes per annum**. This could equate to an economic benefit if and when a mechanism for emissions trading is established in Australia under the Kyoto greenhouse gas protocol.

Additional to the fuel economy benefits measured and a reduction in greenhouse gas emissions, a significant reduction over time in engine maintenance costs will be realised following introduction of FPC-2. These savings are achieved by lower soot levels in lubricating oil produced by more complete combustion of the fuel thereby reducing wear rates and resulting in less carbon build-up in combustion areas. FPC also acts as an effective biocide. Experience in North America has also demonstrated a substantial reduction in track wayside fires following introduction of the Catalyst to the fuel supply.

Appendix"B"

Raw Data Sheets