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FUEL EFFICIENCY & GREENHOUSE GAS REDUCTION STUDY AT BIG BELL MINESITE FOR NORMANDY MINING LTD

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Prepared by:

Fuel Technology Pty Ltd
6a Nairn Street
FREMANTLE WA 6160
(PO Box 1271)

Tel: (08) 9335 6899
Fax: (08) 9430 5403
E-mail fueltech@nettrek.com.au

ACN 063 561 151

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EXECUTIVE SUMMARY

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

Following meetings with Big Bell's Maintenance Manager, it was agreed that a fuel efficiency and greenhouse gas reduction emission study should be conducted at the power generation plant. The trial to employ three engines, one to remain untreated for control comparison and two to have their fuel supply treated with the FTC-3 Combustion Catalyst.

Two engineering standard test procedures were employed in the test program, namely:-

1. Specific Fuel Consumption tests (SFC)
2. Exhaust Emission Carbon Balance tests AS2077-1982 (CB)

The net efficiency gain (reduction in fuel consumption) measured by the two test methods was **4.0%/3.6%**. The efficiency gain measured by the Specific Fuel Consumption test translates to an annual reduction in CO_2 emissions of 2359 tonnes.

INTRODUCTION

Baseline (untreated) fuel efficiency tests were conducted on three Caterpillar 3612 alternator sets, Nos 2, 5 and 6 during the week commencing 16th August, 1999 employing the SFC and Carbon Balance test procedures.

Fuel Technology Pty Ltd has supplied, on loan, an automatic FTC catalyst metering system which was calibrated and commissioned following completion of the baseline tests. This unit injected catalyst into the fuel supply to the two treated fuel test engines, Nos 5 and 6. Engine No. 2 continued to operate on untreated fuel.

Treated tests on Units 5 and 6 and control tests on Unit No. 2 employing the SFC and Carbon Balance test procedures were conducted during the week commencing 6th September, 1999.

For all tests the engine load was set at 2.2 MW.

TEST METHODS

The Specific Fuel Consumption (SFC) test procedure employed in this efficiency study measures the absolute amount of fuel consumed against work performed by the engine over time at a constant load. From this raw data the engine's efficiency can be calculated.

This evaluation of FTC involves a series of back to back untreated (baseline) and treated fuel tests conducted approximately one month apart.

A pair of calibrated MacNaught M-10 flow transducers were used to measure fuel supplied to the engine and also fuel returning from the engine from which the net volume of fuel consumed over a ten-minute time interval can be calculated.

The flow transducers are fitted with thermocouple probes which enable measurement of fuel temperature at each transducer.

From the fuel temperature the density at that temperature is calculated. A sample of fuel was drawn and analysed and the density determined at 15°C.

Volumetric fuel flows are corrected for density and temperature and reported in mass (kg) of fuel.

A Microvip MK II energy analyser was used to measure the alternator's electrical output parameters namely:-

KWatt	kVArh	Ampere	kWh
Volt	Hours	Hz	LmA
PD Med	MVAr		

The hard copy printouts of these parameters are also included in the *Appendix*.

The Carbon Balance Measurement (CB) 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 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 power generation the alternator substitutes as a mechanism to apply a constant load.

TEST RESULTS

1. Fuel Efficiency

A summary of the fuel efficiency results achieved in this test program are detailed in the following tables.

Table 1 details the results achieved in the SFC test program comparing the tests with the control unit No. 2 with the FTC treated units Nos. 5 and 6. The results are represented graphically in Graphs 1, 2 and 3.

TABLE 1
Specific Fuel Consumption Test Results

(A) Control Test Engine

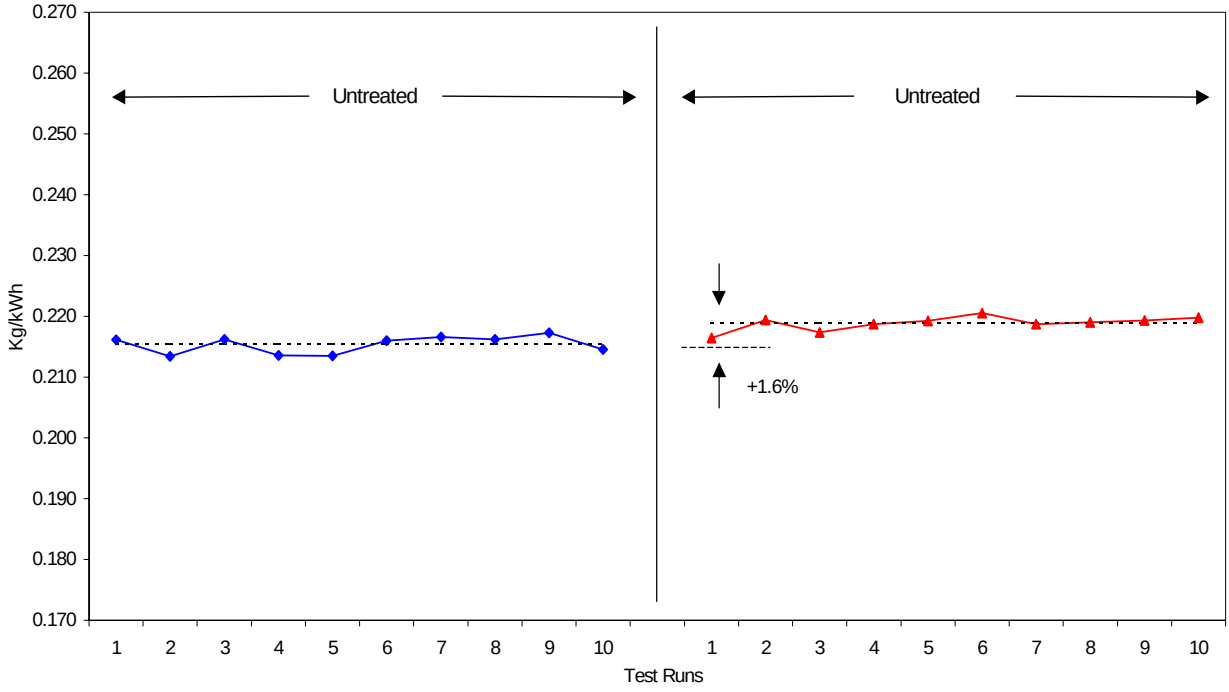
Unit No.	Baseline 19/8/99 Kg/kWh	Retest 9/9/99 Kg/kWh	Variation
2	0.2153	0.2188	+ 1.6%

(B) Treated Group

Unit No.	Baseline 19/8/99 Kg/kWh	Treated 9/9/99 Kg/kWh	Variation
5	0.2131	0.2088	- 2.0%
6	0.2170	0.2109	- 2.8%
AVERAGE	**0.2151**	**0.2099**	**- 2.4%**

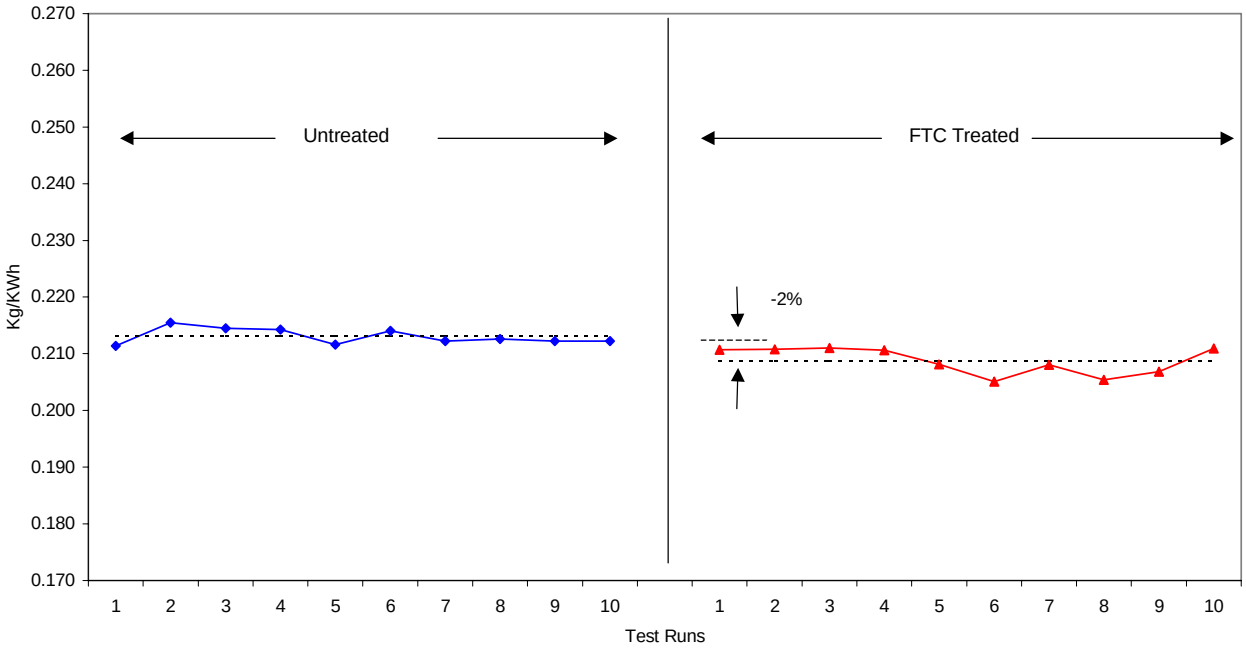
GRAPH 1

Big Bell Power Station
Genset # 2 2.2 MW

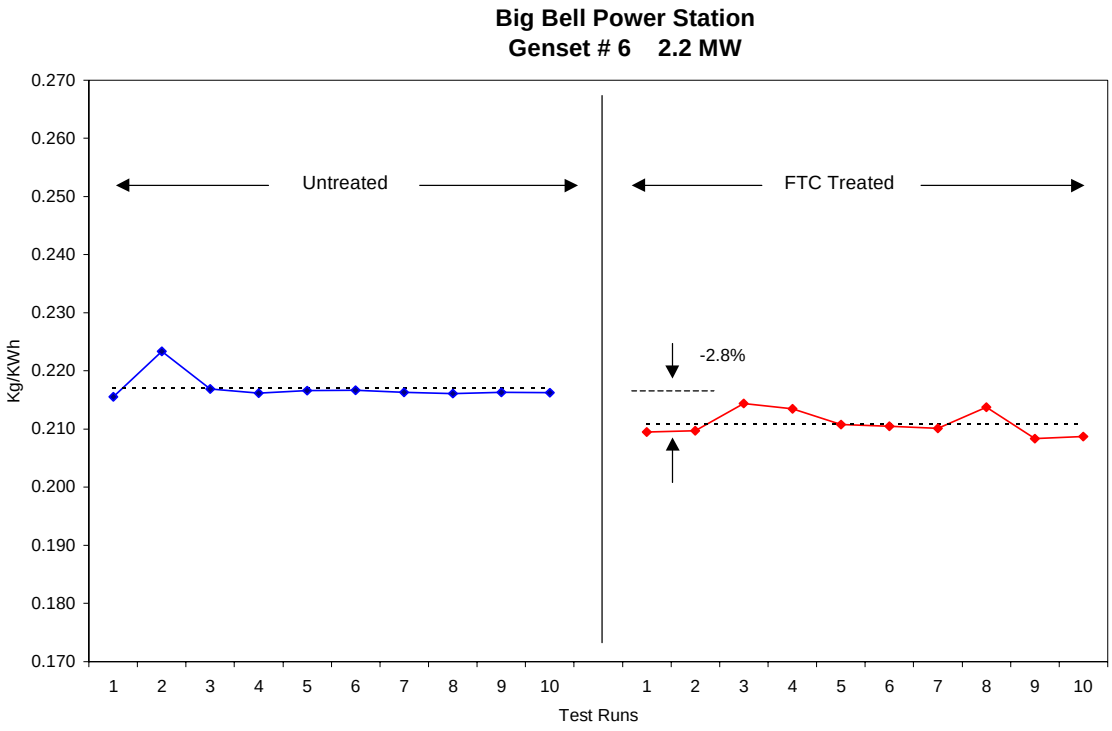


GRAPH 2

Big Bell Power Station
Genset # 5 2.2 MW



GRAPH 3



An efficiency loss of 1.6% was recorded by the untreated test engine No. 2. The net efficiency gain resulting to fuel treatment with the FTC-3 Catalyst is (2.4% + 1.6%) **4.0%**. The computer printouts of the results are contained in the *Appendix* as are the raw data sheets.

Table 2 provides results achieved in the CB test program comparing results of control engine No. 2 with FTC-3 Catalyst treated engines Nos. 5 and 6.

TABLE 2
Carbon Balance Fuel Consumption Test Results

(A) Control Test Engine

Unit No.	Baseline 19/8/99 Carbon Flow Rate	Retest 9/9/99 g/s	Variation
2 L	47.535	47.100	
2 R	50.633	50.307	
TOTAL g/s	**98.168**	**97.407**	**- 0.8%**

(B) Treated Group

Unit No.	Baseline 19/8/99 Carbon Flow Rate	Treated 9/9//99 g/s	Variation
5 L	52.153	49.685	
5 R	53.609	51.121	
TOTAL g/s	**105.762**	**100.806**	**- 4.7%**
6 L	52.059	49.843	
6 R	51.726	49.626	
TOTAL g/s	**103.785**	**99.469**	**- 4.2%**
AVERAGE # 5 & 6	**104.773**	**100.137**	**- 4.4%**

The CB test procedure provides confirmation that addition of FTC-3 Catalyst to the fuel supply of Unit Nos. 5 and 6 has resulted in a reduction in carbon flow (fuel consumption) of **3.6%**, eg (4.4% – 0.8%). The computer printouts of results and raw data sheets are contained in the *Appendix*.

A Bosch smoke test is also undertaken during conduct of the CB test and the results are shown in Table 3. Significant reductions in smoke particulates are not generally measured after only one month's running on FTC treated fuel. Three or more months running on treated fuel is usually required before major reductions in particulates are measured.

TABLE 3
Bosch Smoke Measurements

(A) Control Test Engine

Unit No.	Baseline 18/8/99	Retest 9/9/99	Variation
2 L	0.6	0.7	
2 R	0.7	0.8	
AVERAGE	**0.65**	**0.75**	**+ 15.4%**

(B) Treated Group

Unit No.	Baseline 18/8/99	Treated 9/9/99	Variation
5 L	0.6	0.6	
5 R	0.7	0.8	
AVERAGE	**0.65**	**0.7**	**+ 7.7%**
6 L	0.6	0.7	
6 R	0.8	0.6	
AVERAGE	**0.7**	**0.65**	**- 7.7%**
AVERAGE # 5 & 6	**0.675**	**0.675**	**N/C**

The Bosch Scale reads from 0.1 (very clean) to 0.9 (very dirty).

The FTC treated engines are showing no change at this early stage in particulate emissions whilst the control engine shows an increase in particulate output. The results, whilst indicating a positive reduction for the engines running on treated fuel are encouraging, it is too early in the treatment program to indicate any significant change. The Bosch smoke patches are contained in the *Appendix*.

2. Greenhouse Gas Reduction

A gross reduction of 4.0% of the current estimated annual fuel consumption of 20,400 KL translates to a 2359 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:-

	(20,400 KL x 38.6 x 74.9) ÷ 1000	=	58,979.3 tonnes CO_2 per annum
- 4.0%	(19584 KL x 38.6 x 74.9) ÷ 1000	=	56,620.1 tonnes CO_2 per annum

CO_2 reduction by application FTC-3
58,979.3 – 56,620.1 = 2359 tonnes

CONCLUSION

These carefully controlled engineering standard test procedures conducted on Caterpillar 3612 generator sets Nos 2, 5 and 6 provide clear evidence of reduced fuel consumption for the test engines Nos. 5 and 6 compared to the control engine No. 2 in the range **3.6% - 4.0%**.

The correlation between the two test procedures is very good and provides strong confidence in the accuracy of the test procedures.

A fuel efficiency gain of 4.0% as measured by the Specific Fuel Consumption test method if applied to the total fuel currently consumed by the power generation plant will result in a 2359 tonnes per annum reduction in CO_2 emissions.

Additional to the fuel economy benefits measured is a reduction in greenhouse gas emissions due to more complete combustion of the fuel. Further, the more complete combustion will translate to significant reduction over time in engine maintenance costs.

Appendix "F"

Carbon Balance Data Sheets

BOSCH SMOKE METER FILTER TEST RESULTS

Unit No.	**Baseline 18/8/99**	***Bosch No.***	**Treated 9/9/99**	***Bosch No.***
2 L		0.6		0.7
2 R		0.7		0.8
5 L		0.6		0.6
5 R		0.7		0.8

6 L	0.6	0.7
6 R	0.8	0.6