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PERILYA MINES NL.
FUEL EFFICIENCY TRIAL
FORTNUM GOLD MINE

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EXECUTIVE SUMMARY

FTC Combustion Catalyst, when dosed in liquid hydrocarbon fuel, provides a faster and more complete burn of the fuel. The action of FTC to improve combustion results in measurable efficiency gains in generating and mobile mining equipment.

Following discussions with Fortnum Gold Mine's Maintenance Supervisor, Ian Adams, a trial was conducted in the powerhouse to evaluate the fuel efficiency benefits of FTC on two Cummins KTA 50, generating units rated at 1.0 MW

Using an engineering standard Specific Fuel Consumption (SFC) test procedure on a back to back, untreated - treated test program, FTC was shown to improve genset efficiency in the order of **3.8%**.

INTRODUCTION

Since it's incorporation in 1982, Fuel Technology Pty Ltd has been supplying a ferrous iron based organo metallic Combustion Catalyst, FTC, to the mining industry to provide improved engine efficiency.

Following negotiations with site engineering management, a trial procedure was agreed upon and the test commenced on the 21th November, 1996. Genset numbers 3 and 4 were chosen as units to be treated with FTC following the baseline tests and genset number 2 to remain untreated and tested as a control unit.

This report describes the test procedure used, summarises the results and includes copies of all raw data and spreadsheets.

TEST PROCEDURE

Specific Fuel Consumption

The basis of the Specific Fuel Consumption method is to measure the absolute amount of fuel consumed against the work done by the engine over time at a constant load. From this the engine's efficiency can be calculated.

In the evaluation of FTC a series of back to back untreated (baseline) and treated tests were conducted with approximately 200 hours treatment period between to allow for engine conditioning.

Measurement of Work Done

Work done (kilowatt hours, kWh) over the test interval was recorded from the control panel instruments of each individual genset.

Measurement of Fuel Consumed

Using an Oval Flowpet fuel totalising meter, retro-fitted into the individual genset's day tank fuel supply line, the litres consumed by each unit per 10 minute interval was measured.

A fuel sample was drawn during the trial and fuel density at the observed temperature recorded. This is corrected to the industry standard of 15°C using the Institute of Petroleum Density Correction Table 53B. Because variation in fuel temperature can have a considerable effect on volumetric fuel consumption the actual fuel temperature to the engine is recorded and used to calculate the fuel density at that temperature. This density is then used to calculate the mass (kilograms) of fuel consumed.

The genset was set at a load that would be reproducible when treated tests were conducted at a later date and will remain steady during the test.

NOTE: Steady and reproducible genset load is of critical importance to ensure that the test engine efficiency is not influenced by changes in engine load during and between tests.

Each test is run for approximately 1 hour on each engine with readings of the kilowatt hours generated and litres of fuel consumed being taken at regular intervals (10 minutes). Two stop watches are synchronised at the start of each unit test to ensure readings are taken at the same time and at the nominated interval. Fuel meter readings were recorded by Fortnum powerhouse staff.

Readings are entered on to data sheets and average load, kilowatt hours produced, fuel consumed and engine efficiency (kg/kWh) are calculated for that interval. At the end of the unit test the mean for engine efficiency is calculated for comparative purposes.

During the test additional parameters are monitored and recorded such as ambient air temperature.

Generating Units Tested

Fortnum's power station consists of a mixture of generating units consisting of 3 x Cummins KTA 50 and 2 x KTTA 50 units. The base load generating units, 2, 3 and 4, consisting of Cummins KTA 50 gensets rated at 1.0 MW each, were selected by Fortnum's engineering staff for the trial based on their continuous use and efficiency of operation. Genset numbers 3 and 4 were chosen as units to be treated with FTC following the baseline tests and genset number 2 to remain untreated and tested as a control unit.

RESULTS

Specific Fuel Consumption (SFC)

Baseline SFC tests were conducted on 21th and 22th November, 1996 followed by treated tests on 17th December, 1996. Because of a dosing pump failure on genset number 3, this unit was excluded from the treated testing. Number 2 genset (Control unit) was inoperable because of HT cable insolation failure and was not available for testing. Discussions with maintenance staff resulted in agreeing to use number three unit as the control unit as it remained in an untreated condition.

Table 1 shows a summary of SFC test results based on volumetric data.

TABLE 1 - SFC test results - L/kWh

Genset No 3	Avg. Load (kW)	Avg. L/kWh
Untreated 21/11/96	696	0.2464
Untreated 17/12/96	656	0.2562
% Change from Baseline	**-5.75%**	**3.96%**

Genset No 4	Avg. Load (kW)	Avg. L/kWh
Untreated 21/11/96	710	0.2464
FTC Treated 17/12/96	668	0.2562
% Change from Baseline	**-5.88%**	**-1.52%**

As shown in the data sheets, significant temperature variations were recorded between baseline and treated tests. To take into account variations in fuel temperature and density, a fuel sample was drawn and fuel density and temperature were recorded at each test phase, and corrected to the Industry Standard for comparison of 15°C.

The temperature of the fuel entering the engine was recorded and density was corrected and calculated to that applicable at the observed temperature and volumetric measurement converted to mass (kilograms) of fuel consumed for the test interval.

TABLE II - SFC Test Results corrected for fuel density and temperature - Kg/kWh

Genset No 3	Avg. Load (kW)	Avg. kg/kWh
Untreated 21/11/96	696	0.2070
Untreated 17/12/96	656	0.2167
% Change from Baseline	**-5.75%**	**4.7%**

Genset No 4	Avg. Load (kW)	Avg. kg/kWh
Untreated 21/11/96	710	0.2070
FTC Treated 17/12/96	668	0.2167
% Change from Baseline	**-5.88%**	**-0.89%**

SFC data sheets are included in the Appendices.

It can be seen from the table that the average load varied significantly between each test phase. As load has a large influence on fuel efficiency, to account for the difference and make for a more equitable comparison, test intervals of similar loads were matched.

The following table summaries the results for each engine after matching loads.

Genset No 3	Avg. Load (kW)	Avg. L/kWh	**Avg. kg/kWh**
Untreated 21/11/96	677	0.2539	**0.2133**
Untreated 17/12/96	672	0.2500	**0.2115**
% Change from Baseline	**-0.71%**	**-1.53%**	**-0.8%**

Genset No 4	Avg. Load (kW)	Avg. L/kWh	**Avg. kg/kWh**
Untreated 21/11/96	678	0.2684	**0.2255**
FTC Treated 17/12/96	678	0.2566	**0.2170**
% Change from Baseline	**0.0%**	**-4.4%**	**-3.8%**

t-TEST SUMMARY

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

Formula:

$$t = \frac{\bar{x}_B - \bar{x}_T}{\sqrt{\frac{(n_B - 1)\,S_B^{\,2} + (n_T - 1)\,S_T^{\,2}}{(n_B - n_T - 2)} \left(\frac{1 + 1}{n_B + n_T} \right)}}$$

Hypothesis:

H_0 : $U_1 - U_2 = 0$

H_1 : $U_1 - U_2 \neq 0$

Unit No. 3

The t-test confirmed the difference in means between untreated (21/11/96) - untreated (17/12/96) was not significant at a 99% confidence level, demonstrating the unit has not altered its baseline operation.

Unit No. 4

The t-test confirmed the difference in means between untreated (21/11/96) and treated (17/12/96) tests was significant at a 95% confidence level.

T-test spreadsheets are included in the appendices.

CONCLUSION

Although field testing cannot be controlled as clinically as a laboratory test the methods used by Fuel Technology Pty Ltd have been developed based on engineering standard test procedures. In this way an it is possible to measure the benefits of FTC in Fortnum Gold Mine's actual operating environment whilst controlling the variables that influence engine efficiency.

The results measured in the Specific Fuel Consumption test showed an improved mean engine efficiency for the test engine in the order of **3.8%** after corrections for fuel temperature and density. This result was shown to be significant at a 95% confidence level by student t-test analysis.

From the Specific Fuel Consumption test FTC has been demonstrated to provide a significant gain in fuel efficiency.

APPENDIX "A"

Specific Fuel Consumption data sheets

FUEL TECHNOLOGY PTY LTD

DIESEL GENERATOR SPECIFIC FUEL CONSUMPTION LOG

Customer _____ ENGINE No 3 Date Base 17/12/96 Treated _____

Location FORTNUM GOLD MINE FROM CONTROL PANEL

ENGINE: Make: _____ ALTERNATOR:
Model: _____ Make: _____ Density @ 15°C Base _____ Treated _____
Serial No: _____ Rating: _____
Eng.Hrs: Start _____
Finish _____

Temperature °C

TIME Start Finish	T	Nom Load kW	kWh Start Finish	kWh	kW Av	Kv Volts	Amps	FUEL METER Start/Finish	Fuel Ltrs.	L/kWh	E.Gas	Air In Dry/ Wet	J.W. Out In	Fuel In		
09.40		650	4537.80			418	1100	24163.99								
	10	650	4538.07	108	648	418	1100	24192.11	28.12	0.2604						
	10	660	4538.34	108	648	418	1100	24220.33	28.22	0.2613						
	10	650	4538.61	108	648	418	1090	24248.18	27.85	0.2579						
	10	660	4538.88	108	648	418	1100	24275.99	27.81	0.2575		36.6				
	10	660	4539.16	112	672	418	1090	24303.98	27.99	0.2499						
	10	660	4539.44	112	672	418	1100	24331.99	28.01	0.2501						

ENGS 3, 2, 5

FUEL TECHNOLOGY PTY LTD

DIESEL GENERATOR SPECIFIC FUEL CONSUMPTION LOG

Customer _____ ENGINE No 3 Date Base 21/11/96 Treated _____

Location FORTNUM GOLD MINE FROM CONTROL PANEL

ENGINE: Make: CUMMINS ALTERNATOR:
Model: KTA 50 Make: _____ Density @ 15°C Base _____ Treated _____
Serial No: _____ Rating: _____
Eng.Hrs: Start _____
Finish _____
+400

Temperature °C 38·5

TIME Start Finish	T	Nom Load kW	kWh Start Finish	kWh	kW Av	Kv Volts	Amps	FUEL METER Start/Finish	Fuel Ltrs.	L/kWh	E.Gas	Air In Dry/ Wet	J.W. Out In	Fuel In		
13·15		680	3690·24			418	1100	23091·74								
	10	670	3690·53	116	696	418	1100	23120·68	28·94	0·2495						
	10	685	3690·81	112	672	418	1110	23149·38	28·70	0·2563						
	10	670	3691·09	112	672	418	1100	23178·14	28·76	0·2568						
	10	670	3691·37	112	672	418	1100	23206·72	28·58	0·2552		38·5				
	10	670	3691·65	112	672	418	1100	23234·92	28·20	0·2518						
	10	660	3691·98	132	792	418	1090	23262·50	27·58	0·2089						
					696				28·46	0·2464						

SPECIFIC FUEL CONSUMPTION GENSET TRIAL

Customer: Fortnum Gold Mine
Genset No: 3
Date: 21/11/96
UNTREATED Control Panel

Fuel Sample	Density	Temp Deg C
	0.821	42.1
Corrected	0.840	15

Run No	Time Start	Period Mins	kWh Meter	kWh 400	Avg Load kW	Fuel Meter (L)	Litres Consumed	Fuel (Lt) Per kWh	Density	Fuel (kg) Consumed	Fuel (kg) Per kWh
	13.15		3690.24			23091.74					
1		10	3690.53	116	696	23120.68	28.94	0.2495	0.840	24.31	0.2096
2		10	3690.81	112	672	23149.38	28.70	0.2563	0.840	24.11	0.2153
3		10	3691.09	112	672	23178.14	28.76	0.2568	0.840	24.16	0.2157
4		10	3691.37	112	672	23206.72	28.58	0.2552	0.840	24.01	0.2144
5		10	3691.65	112	672	23234.92	28.20	0.2518	0.840	23.69	0.2115
6		10	3691.98	132	792	23262.5	27.58	0.2089	0.840	23.17	0.1755
Mean				116	696		28.46	0.2464		23.909	0.2070
Std Dev				8	48		0.4969	0.0186		0.4174	0.0156
C.V				6.9%	6.9%		1.7%	7.5%		1.7%	7.5%

SPECIFIC FUEL CONSUMPTION GENSET TRIAL

Customer: Fortnum Gold Mine
Genset No: 3
Date: 17/12/96
TREATED Control Panel

Fuel Sample	Density	Temp Deg C
	0.831	36.5
Corrected	0.846	15

Run No	Time Start	Period Mins	kWh Meter	kWh x 400	Avg Load kW	Fuel Meter (L)	Litres Consumed	Fuel (Lt) Per kWh	Density	Fuel (kg) Consumed	Fuel (kg) Per kWh
	09.40		4537.8			24163.99					
1		10	4538.07	108	648	24192.11	28.12	0.2604	0.846	23.79	0.2203
2		10	4538.34	108	648	24220.33	28.22	0.2613	0.846	23.88	0.2211
3		10	4538.61	108	648	24248.18	27.85	0.2579	0.846	23.56	0.2182
4		10	4538.88	108	648	24275.99	27.81	0.2575	0.846	23.53	0.2179
5		10	4539.16	112	672	24303.98	27.99	0.2499	0.846	23.68	0.2114
6		10	4539.44	112	672	24331.99	28.01	0.2501	0.846	23.70	0.2116
Mean				109	656		28.00	0.2562		23.691	0.2167
Std Dev				2.0655911	12.393547		0.1559	0.0050		0.1319	0.0042
C.V				1.9%	1.9%		0.6%	1.9%		0.6%	1.9%

% CHANGE: Treated-Baseline / Baseline	kWh	Avg Load		Litres Consumed	Fuel (Lt) Per kWh		Fuel (kg) Consumed	Fuel (kg) Per kWh
	-5.75%	-5.75%		-1.62%	3.96%		-0.91%	**4.7%**

SPECIFIC FUEL CONSUMPTION GENSET TRIAL

Customer: Fortnum Gold Mine
Genset No: 3
Date: 21/11/96
UNTREATED Control Panel (Matched Genset Load)

Fuel Sample	Density	Temp Deg C
	0.821	42.1
Corrected	0.840	15

Run No	Time Start	Period Mins	kWh Meter	kWh 400	Avg Load kW	Fuel Meter (L)	Litres Consumed	Fuel (Lt) Per kWh	Density	Fuel (kg) Consumed	Fuel (kg) Per kWh
	13.15		3690.24			23091.74					
1		10	3690.53	116	696	23120.68	28.94	0.2495	0.840	24.31	**0.2096**
2		10	3690.81	112	672	23149.38	28.70	0.2563	0.840	24.11	**0.2153**
3		10	3691.09	112	672	23178.14	28.76	0.2568	0.840	24.16	**0.2157**
4		10	3691.37	112	672	23206.72	28.58	0.2552	0.840	24.01	**0.2144**
5		10	3691.65	112	672	23234.92	28.20	0.2518	0.840	23.69	**0.2115**
6		10	3691.98			23262.50					
Mean				113	677		28.64	0.2539		24.057	**0.2133**
Std Dev				1.7889	10.733126		0.2762	0.0031		0.2320	**0.0026**
C.V				1.6%	1.6%		1.0%	1.2%		1.0%	**1.2%**

SPECIFIC FUEL CONSUMPTION GENSET TRIAL

Customer: Fortnum Gold Mine
Genset No: 3
Date: 17/12/96
TREATED Control Panel

Fuel Sample	Density	Temp Deg C
	0.831	36.5
Corrected	0.846	15

Run No	Time Start	Period Mins	kWh Meter	kWh x 400	Avg Load kW	Fuel Meter (L)	Litres Consumed	Fuel (Lt) Per kWh	Density	Fuel (kg) Consumed	Fuel (kg) Per kWh
	09.40		4537.80			24163.99					
1		10	4538.07			24192.11					
2		10	4538.34			24220.33					
3		10	4538.61			24248.18					
4		10	4538.88			24275.99					
5		10	4539.16	112	672	24303.98	27.99	0.2499	0.846	23.68	**0.2114**
6		10	4539.44	112	672	24331.99	28.01	0.2501	0.846	23.70	**0.2116**
Mean				112	672		28.00	0.2500		23.691	**0.2115**
Std Dev				0	0		0.0141	0.0001		0.0120	**0.0001**
C.V				0.0%	0.0%		0.1%	0.1%		0.1%	**0.1%**

% CHANGE: **Treated-Baseline** / **Baseline**	kWh	Avg Load		Litres Consumed	Fuel (Lt) Per kWh		Fuel (kg) Consumed	Fuel (kg) Per kWh
	-0.71%	-0.71%		-2.22%	-1.53%		-1.52%	**-0.8%**

FUEL TECHNOLOGY PTY LTD

DIESEL GENERATOR SPECIFIC FUEL CONSUMPTION LOG

Customer _____ ENGINE No 4 Date Base _____ Treated 17/12/96

Location FORTNUM GOLD MINE FROM CONTROL PANEL

ENGINE: Make: _____ ALTERNATOR:
Model: _____ Make: _____ Density @ 15°C Base _____ Treated _____
Serial No: _____ Rating: _____
Eng.Hrs: Start 616.25 + 12381
Finish _____

Temperature °C

TIME Start Finish	T	Nom Load kW	kWh Start Finish	kWh	kW Av	Kv Volts	Amps	FUEL METER Start/Finish	Fuel Ltrs.	L/kWh	E.Gas	Air In Dry/ Wet	J.W. Out In	Fuel In		
07.30		665	4691.04			418	1160	23932.4								
	10	650	4691.31	108	648	418	1150	23960.11	27.71	0.2566						
	10	650	4691.59	112	672	418	1140	23988.54	28.43	0.2538						
	10	665	4691.86	108	648	418	1180	24017.11	28.57	0.2645						
	10	650	4692.14	112	672	418	1160	24046.33	29.22	0.2609		31.0				
	10	660	4692.42	112	672	418	1160	24075.32	28.99	0.2588						
	10	680	4692.71	116	696	418	1200	24104.66	29.34	0.2529						

FUEL TECHNOLOGY PTY LTD

DIESEL GENERATOR SPECIFIC FUEL CONSUMPTION LOG

Customer _____ ENGINE No 4 Date Base 21/11/96 Treated _____

Location FORTNUM GOLD MINE From Control Panel.

ENGINE: Make: CUMMINS ALTERNATOR:
Model: KTA 50 Make: _____
Serial No: _____ Rating: _____
Eng.Hrs: Start 557.1 Density @ 15°C Base _____ Treated _____
Finish _____
×400

Temperature °C 37.5

TIME Start Finish	T	Nom Load kW	kWh Start Finish	kWh	kW Av	Kv Volts	Amps	FUEL METER Start/Finish	Fuel Ltrs.	L/kWh	E.Gas	Air In Dry/ Wet	J.W. Out In	Fuel In		
10.30		760	377390			418	1150	2276132								
	10	770	377621	124	744	418	1180	2279324	31.92	0.2574						
	10	765	377853	128	768	418	1150	22825.34	32.10	0.2508						
	10	765	378084	124	744	418	1180	28856.52	31.18	0.2515						
	10	718	378512	112	672	418	1100	22887.64	31.12	0.2779		37.5				
	10	720	378541	116	696	418	1100	22917.84	30.20	0.2603						
	10	710	378569	112	672	418	1110	22947.82	29.98	0.2677						
	10	720	378597	112	672	418	1100	22977.82	30.0	0.2679						
					710				30.93	0.2619						

SPECIFIC FUEL CONSUMPTION GENSET TRIAL

Customer: Fortnum Gold Mine
Genset No: 4
Date: 21/11/1996
UNTREATED Control Panel

Fuel Sample	Density	Temp Deg C
	0.821	42.1
Corrected	0.840	15

Run No	Time Start	Period Mins	kWh Meter	kWh 400	Avg Load kW	Fuel (Lt)	Litres Consumed	Fuel (Lt) Per kWh	Density	Fuel (kg) Consumed	Fuel (kg) Per kWh
	10.30		3773.9			22761.32					
1		10	3774.210	124	744	22793.24	31.92	0.2574	0.840	26.82	0.2163
2		10	3774.530	128	768	22825.34	32.10	0.2508	0.840	26.97	0.2107
3		10	3774.840	124	744	22856.52	31.18	0.2515	0.840	26.19	0.2112
4		10	3775.120	112	672	22887.64	31.12	0.2779	0.840	26.14	0.2334
5		10	3775.410	116	696	22917.84	30.20	0.2603	0.840	25.37	0.2187
6		10	3775.690	112	672	22947.82	29.98	0.2677	0.840	25.19	0.2249
7		10	3775.970	112	672	22977.82	30.00	0.2679	0.840	25.20	0.2250
Mean				118	710		30.93	0.2619		25.983	0.2200
Std Dev				6.873	41.2380		0.8896	0.0098		0.7473	0.0083
C.V				5.8%	5.8%		2.9%	3.8%		2.9%	3.8%

SPECIFIC FUEL CONSUMPTION GENSET TRIAL

Customer: Fortnum Gold Mine
Genset No: 4
Date: 17/06/96
TREATED Control Panel

Fuel Sample	Density	Temp Deg C
	0.834	31.5
Corrected	0.846	15

Run No	Time Start	Period Mins	kWh Meter	kWh x 400	Avg Load kW	Fuel (Lt)	Litres Consumed	Fuel (Lt) Per kWh	Density	Fuel (kg) Consumed	Fuel (kg) Per kWh
	07.30		4691.04			23932.4					
1		10	4691.310	108	648	23960.11	27.71	0.2566	0.846	23.43	0.2169
2		10	4691.590	112	672	23988.54	28.43	0.2538	0.846	24.04	0.2146
3		10	4691.860	108	648	24017.11	28.57	0.2645	0.846	24.16	0.2237
4		10	4692.140	112	672	24046.33	29.22	0.2609	0.846	24.71	0.2206
5		10	4692.420	112	672	24075.32	28.99	0.2588	0.846	24.51	0.2188
6		10	4692.710	116	696	24104.66	29.34	0.2529	0.846	24.81	0.2139
Mean				111	668		28.71	0.2579		24.274	0.2181
Std Dev				3.011	18.0665		0.6055	0.0044		0.5120	0.0037
C.V				2.7%	2.7%		2.1%	1.7%		2.1%	1.7%

% CHANGE: Treated-Baseline / Baseline	kWh	Avg Load		Litres Consumed	Fuel (Lt) Per kWh		Fuel (kg) Consumed	Fuel (kg) Per kWh
	-5.88%	-5.88%		-7.17%	-1.52%		-6.58%	**-0.89%**

SPECIFIC FUEL CONSUMPTION GENSET TRIAL

Customer: Fortnum Gold Mine
Genset No: 4
Date: 21/11/1996
UNTREATED Control Panel (Matched Genset Load)

Fuel Sample	Density	Temp Deg C
	0.821	42.1
Corrected	0.840	15

Run No	Time Start	Period Mins	kWh Meter	kWh 400	Avg Load kW	Fuel Meter (L)	Litres Consumed	Fuel (Lt) Per kWh	Density	Fuel (kg) Consumed	Fuel (kg) Per kWh
	10.30		3773.90			22761.32					
1		10	3774.21			22793.24					
2		10	3774.53			22825.34					
3		10	3774.84			22856.52					
4		10	3775.12	112	672	22887.64	31.12	0.2779	0.840	26.14	0.2334
5		10	3775.41	116	696	22917.84	30.20	0.2603	0.840	25.37	0.2187
6		10	3775.69	112	672	22947.82	29.98	0.2677	0.840	25.19	0.2249
7		10	3775.97	112	672	22977.82	30.00	0.2679	0.840	25.20	0.2250
Mean				113	678		30.32	0.2684		25.476	0.2255
Std Dev				2.000	12.0000		0.5392	0.0072		0.4530	0.0060
C.V				1.8%	1.8%		1.8%	2.7%		1.8%	2.7%

SPECIFIC FUEL CONSUMPTION GENSET TRIAL

Customer: Fortnum Gold Mine
Genset No: 4
Date: 17/06/96
TREATED Control Panel

Fuel Sample	Density	Temp Deg C
	0.834	31.5
Corrected	0.846	15

Run No	Time Start	Period Mins	kWh Meter	kWh x 400	Avg Load kW	Fuel Meter	Litres Consumed	Fuel (Lt) Per kWh	Density	Fuel (kg) Consumed	Fuel (kg) Per kWh
	07.30		4691.04			23932.4					
1		10	4691.31			23960.11					
2		10	4691.59	112	672	23988.54	28.43	0.2538	0.846	24.04	0.2146
3		10	4691.86			24017.11					
4		10	4692.14	112	672	24046.33	29.22	0.2609	0.846	24.71	0.2206
5		10	4692.42	112	672	24075.32	28.99	0.2588	0.846	24.51	0.2188
6		10	4692.71	116	696	24104.66	29.34	0.2529	0.846	24.81	0.2139
Mean				113	678		28.99	0.2566		24.515	0.2170
Std Dev				2.000	12.0000		0.4037	0.0039		0.3413	0.0033
C.V				1.8%	1.8%		1.4%	1.5%		1.4%	1.5%

% CHANGE: Treated-Baseline / Baseline	kWh	Avg Load		Litres Consumed	Fuel (Lt) Per kWh		Fuel (kg) Consumed	Fuel (kg) Per kWh
	0.00%	0.00%		-4.39%	-4.40%		-3.77%	**-3.8%**

APPENDIX "B"

t-Test spreadsheets

t test: Two Sample Assuming Equal Population Variances

Company		Fortnum				
Engine#:		3				
Test:		Untreated 21/11/96				
Fuel Density (Corrected)		0.840				
Record		kW Load	Litres	kWh	L/kWh	kg/kWh
	1	696	28.94	116	0.2495	0.2096
	2	672	28.7	112	0.2563	0.2153
	3	672	28.76	112	0.2568	0.2157
	4	672	28.58	112	0.2552	0.2144
	5	672	28.2	112	0.2518	0.2115
Mean		677	28.64	112.800	0.2539	0.2133
Std Dev		10.73312629	0.276188	1.788854382	0.00314113	0.00263886
Observations						5

Test:		Treated				
Fuel Density (Corrected)		0.846				
Record		kW Load	Litres	kWh	L/kWh	kg/kWh
	1	672	27.99	112	0.2499	0.2114
	2	672	28.01	112	0.2501	0.2116
Mean		672	28.00	112.000	0.2500	0.2115
Std Dev		0	0.014142	0	0.00012627	0.00010682
Observations						2

	kg/kWh	kW Load
Mean % change	-0.8%	-0.7%
Confidence Interval	99%	
Alpha	0.005	
Degrees Of Freedom	5	
t Critical Value	4.03	
Hypothesis	H_0: $u_1 - u_2 = 0$	
	H_1: $u_1 - u_2 <> 0$	
t=	0.91	

Conclusion:

Since t= 0.91, is within the range +/- 4.03 we accept H_0 and reject H_1 and conclude that the difference between engine efficiency means is not significant at a 99 % confidence level.

t test: Two Sample Assuming Equal Population Variances

Company	Fortnum					
Engine#:	4					
Test:	Untreated 21/11/96					
Fuel Density (Corrected)	0.840					
Record		kW Load	Litres	kWh	L/kWh	kg/kWh
	1	672	31.12	112	0.2779	0.2334
	2	696	30.20	116	0.2603	0.2187
	3	672	29.98	112	0.2677	0.2249
	4	672	30.00	112	0.2679	0.2250
Mean		678	30.32	113.000	0.2684	0.2255
Std Dev		12	0.539228	2	0.00719105	0.0060412
Observations						4

Test:	Treated					
Fuel Density (Corrected)	0.846					
Record		kW Load	Litres	kWh	L/kWh	kg/kWh
	1	672	28.43	112	0.2538	0.2146
	2	672	29.22	112	0.2609	0.2206
	3	672	28.99	112	0.2588	0.2188
	4	696	29.34	116	0.2529	0.2139
Mean		678	28.99	113.000	0.2566	0.2170
Std Dev		12	0.403691	2	0.00385241	0.00325721
Observations						4

	kg/kWh	kW Load
Mean % change	-3.8%	0.0%
Confidence Interval	95%	
Alpha	0.025	
Degrees Of Freedom	6	
t Critical Value	2.45	
Hypothesis	H_0: $u_1 - u_2 = 0$	
	H_1: $u_1 - u_2 <> 0$	
t=	2.49	

Conclusion:

Since t= 2.487, is outside the range +/- 2.45 we reject H_0 and accept H_1 and conclude that the difference between engine efficiency means is significant at a 95 % confidence level.