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Evaluation of FTC-1 Combustion Catalyst at BHP-Utah Coal Ltd's Peak Downs mine by:

(i) AS2077-1982 Method for Fuel Cons.

(ii) ASTM D2156-63T for Black Smoke

(iii) Examination of Daily Fuel Usage

March, 1991

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INTRODUCTION:

FTC-1 is a combustion catalyst which, when added to liquid petroleum fuels, accelerates the chemistry of combustion, allowing the fuel to burn faster and more thoroughly. Typical fuel savings of 6-8% are generated for mobile equipment.

Because of the many variables that affect fuel consumption in the mining environment, it can be very difficult to accurately quantify these benefits using field records. For this reason, Fuel Technology Pty Ltd use the AS 2077-1982 method, which measures the amount of "burnt fuel leaving the engine" under repeatable static test conditions.

1. AS 2077-1982 METHOD OF FUEL CONSUMPTION MEASUREMENT

This method measures the amount of carbon leaving the engine via the exhaust, which is proportional to the amount of fuel entering the engine. A percentage change measured accurately reflects the same change in fuel consumption occurring.

The value of this method is threefold:

(i) Test conditions can be repeated. Any changes in climatic condition, etc is recorded so that comparisons can be made at conditions of standard temperature and pressure.

(ii) Test accurately reflects field benefits, providing that a static load is applied to the test engines.

(iii) Easy and inexpensive to conduct.

Full details of procedures appear in Appendix I.

Engines to be tested were at operating temperature, and set at 1800 rpm for the test. No load was applied! Three CH200 coal haulers

were tested prior to, and after fuel treatment. Full test data and results appear in Appendix II of this report.

Results Summary:

Table I

Hauler No	Carbon Flow Rate BASELINE	TREATED	% Change In Fuel Cons.	
24	13.604	7.626	-43.9	See Note!
25	6.019	5.089	-15.4	
64	7.863	7.034	-10.6	
Average			-13.0%	

Note: This engine was running hot during baseline test. (Exhaust temperature 386°C compared to 197°C during treated test.) It was subsequently discovered that the coolant level was low. This would have resulted in increased frictional losses and very poor baseline efficiency. The results were therefore deleted from the average.

N.B. Comments: These tests were performed at "fast idle" (1800 rpm - no load). Combustion efficiency under these conditions is less than optimum, hence the magnitude of the catalyst's action is greater. Similar tests conducted at CRA's Tarong Coal operations showed an average 12.6% fuel saving at idle, and 7.1% under static load, the latter more closely reflecting field results.

2. ASTM D2156-63T METHOD. Bacharach Smoke Patch Test

This test involves sampling a standard volume of exhaust gas, taken under test conditions as set out in AS 2077-1982. The exhaust gas sample is passed through a filter paper and the degree of discolouration caused by the particulate matter is determined against a series of standards. Copy of exhaust patches appears in Appendix III.

Results Summary:

Table II

Hauler No	Bacharach Smoke No BASELINE	TREATED	% Change
24	6.5	4.0	-38.5
25	6.0	4.0	-33.3
64	5.0	3.5	-30.0
AVERAGE			-34.3%

Comments: The improvements in emissions of exhaust particulates also confirms a fuel efficiency improvement, but of course, this procedure provides no means of quantifying it.

3. EXAMINATION OF DAILY FLEET FUEL USAGE

The total fuel usage (in litres) by mobile equipment has been monitored on a daily basis, except for weekend usage, since 19.10.90, approx. $5\frac{1}{2}$ weeks prior to commencement of fuel treatment. At this stage, equipment operating hours have not been incorporated. By graphing the daily figures, there should be sufficient statistical data to detect a trend in changed usage rate, assuming of course, that there have been no significant and sustained changes in mine operating conditions.

Any "abnormal" days, such as those caused by strikes, etc are readily detected on the graph, and only the entries in the "high density" region of the graph are useful for comparison, since these reflect typical operating days.

Typical operating conditions occurred during the untreated period (19.10.90-27.11.90) and throughout the first few weeks of fuel treatment to 20.12.90.

The graph (Appendix IV) shows an 8.5% fall in daily fuel usage

coinciding with fuel treatment. After this period, however, operating conditions changed dramatically.

With the introduction of 2 new Le Torneau 1100 loaders, the major flooding from end-Dec to January, 1991, and the increased usage of dewatering pumps, which with the new loaders, have accounted for an additional fuel usage of up to an estimated 14,500 L/day, daily fuel consumption has varied substantially.

Comments: With respect to the dewatering pumps, since their operating conditions would be reasonable steady, estimates of fuel usage can be made by the following formula:

Fuel used/day = SFC (L/KWhr) x Max Power (KW) x % Duty x op.hrs

Discussions with Hanson Sykes Pumps have indicated

SFC (spec fuel cons) = .35 L/KWhr

and % Duty = 60-70%

It could be assumed that the pumps would operate 22 hrs/day. A knowledge of what pumps were operating and on what days would provide the balance of imformation required for estimations.

Likewise, Blackwood Hodge give estimates of 120-132L/hr for the Marathon Le Torneau 1100 loaders.

CONCLUSIONS:

1. The AS 2077-1982 fuel consumption measurements demonstrated fuel savings benefits which would support a fleet benefit of 6-8%.

2. Strong reductions of 34.3% in exhaust smoke emissions further confirm a much improved engine efficiency.

3. Initial mine records have indicated an 8.5% fuel saving.

4. Daily fuel records will require adjustments for usage of pumps and new loaders to enable comparison with "original" fleet (untreated).

APPENDIX II

AS 2077-1982 RESULTS: Fuel Consumption Measurements

FUEL TECHNOLOGY PTY LTD — CARBON BALANCE RESULTS

COMPANY : BUCL - PEAK DOWNS — LOCATION : PEAK DOWNS

EQUIPMENT : EUCLID CH200 — UNIT NR. : 24
ENG. TYPE : CUMMINS — MODEL : KTTA38C
RATING : 1350 HP — FUEL :

BASELINE — DATE : 15.11.90

ENG. HOURS : 1837.7 — TEST MODE: 1800 rpm
AMB. TEMP (C) : 32 — STACK(mm): 290
BAROMETRIC(mb): 987 — FUEL DENS:

	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	AVERAGE	% ST.DEV
PRES DIFF (Pa):	60	68	67	69	70	67	5.93
EXHST TEMP (C):	378	382	387	389	392	386	1.45
HC (ppm) :	20	30	30	30	30	28.0	15.97
CO (%) :	0.01	0.02	0.02	0.02	0.01	0.016	24.23
CO2 (%) :	7.32	7.29	7.29	7.24	7.28	7.28	
O2 (%) :	9.31	9.20	9.14	9.09	9.05	9.16	
CARB FLOW(g/s):	13.017	13.790	13.637	13.725	13.849	13.604	2.48

REYNOLDS NR. : 2.83E+04

TREATED TEST — DATE : 19.3.91

ENG. HOURS : 3826 — TEST MODE: 1800 rpm
AMB. TEMP (C) : 33 — STACK(mm): 290
BAROMETRIC(mb): 1020 — FUEL DENS:

	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	AVERAGE	% ST.DEV
PRES DIFF (Pa):	54	58	59	56	59	57	3.79
EXHST TEMP (C):	189	198	198	200	200	197	2.33
HC (ppm) :	80	80	80	80	80	80.0	0.00
CO (%) :	0.04	0.04	0.04	0.04	0.04	0.040	0.00
CO2 (%) :	3.58	3.56	3.61	3.63	3.59	3.59	0.75
O2 (%) :	12.86	12.88	12.83	12.85	12.85	12.85	0.14
CARB FLOW(g/s):	7.447	7.602	7.772	7.597	7.714	7.626	1.64

REYNOLDS NR. : 3.15E+04 — TOTAL HOURS ON TREATED FUEL : 1988.3

PERCENTAGE CHANGE IN FUEL CONSUMPTION ((TREATED-BASE)/BASE*100) : -43.9 %

REMARKS:

FUEL TECHNOLOGY PTY LTD — CARBON BALANCE RESULTS

COMPANY : BUCL - PEAK DOWNS — LOCATION : PEAK DOWNS

EQUIPMENT : EUCLID CH200 — UNIT NR. : 25
ENG. TYPE : CUMMINS — MODEL : KTTA38C
RATING : 1350 HP — FUEL :

BASELINE — DATE : 15.11.90

ENG. HOURS : 1883 — TEST MODE: 1800 rpm
AMB. TEMP (C) : 30 — STACK(mm): 290
BAROMETRIC(mb): 990 — FUEL DENS:

	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	AVERAGE	% ST.DEV
PRES DIFF (Pa):	40	39	35	38	40	38	5.40
EXHST TEMP (C):	192	196	198	199	201	197	1.73
HC (ppm) :	30	20	20	20	20	22.0	20.33
CO (%) :	0.01	0.02	0.02	0.02	0.01	0.016	34.23
CO2 (%) :	3.61	3.65	3.57	3.53	3.50	3.57	1.68
O2 (%) :	12.94	12.87	12.87	12.91	12.89	12.90	0.23
CARB FLOW(g/s):	6.242	6.212	5.745	5.913	5.986	6.019	3.47

REYNOLDS NR. : 2.55E+04

TREATED TEST — DATE : 19.3.91

ENG. HOURS : 3208 — TEST MODE: 1800 rpm
AMB. TEMP (C) : 33 — STACK(mm): 290
BAROMETRIC(mb): 1020 — FUEL DENS:

	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	AVERAGE	% ST.DEV
PRES DIFF (Pa):	35	32	30	33	32	32	5.61
EXHST TEMP (C):	203	205	206	206	207	205	0.74
HC (ppm) :	10	0	20	10	20	12.0	69.72
CO (%) :	0.02	0.01	0.02	0.01	0.02	0.016	34.23
CO2 (%) :	3.30	3.21	3.31	3.27	3.28	3.27	1.19
O2 (%) :	14.62	14.52	14.49	14.48	14.47	14.52	0.42
CARB FLOW(g/s):	5.351	4.943	4.962	5.117	5.074	5.089	3.21

REYNOLDS NR. : 2.35E+04 — TOTAL HOURS ON TREATED FUEL : 1325

PERCENTAGE CHANGE IN FUEL CONSUMPTION ((TREATED-BASE)/BASE*100) : -15.4 %

REMARKS:

FUEL TECHNOLOGY PTY LTD — CARBON BALANCE RESULTS

COMPANY : BUCL - PEAK DOWNS — LOCATION : PEAK DOWNS

EQUIPMENT : EUCLID CH200 — UNIT NR. : 64
ENG. TYPE : CUMMINS — MODEL : KTTA38C
RATING : 1350 HP — FUEL :

BASELINE — DATE : 15.11.90

ENG. HOURS : 689 — TEST MODE: 1800 rpm
AMB. TEMP (C) : 32 — STACK(mm): 290
BAROMETRIC(mb): 988 — FUEL DENS:

	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	AVERAGE	% ST.DEV
PRES DIFF (Pa):	59	60	58	58	58	59	1.53
EXHST TEMP (C):	180	183	186	189	190	186	2.24
HC (ppm) :	10	20	20	10	20	16.0	34.23
CO (%) :	0.01	0.01	0.01	0.01	0.01	0.010	0.00
CO2 (%) :	3.82	3.76	3.70	3.74	3.72	3.75	1.23
O2 (%) :	14.45	14.33	14.26	14.25	14.24	14.31	0.61
CARB FLOW(g/s):	8.081	8.009	7.725	7.770	7.732	7.863	2.14

REYNOLDS NR. : 3.18E+04

TREATED TEST — DATE : 19.3.91

ENG. HOURS : 2027 — TEST MODE: 1800 rpm
AMB. TEMP (C) : 33 — STACK(mm): 290
BAROMETRIC(mb): 1020 — FUEL DENS:

	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	AVERAGE	% ST.DEV
PRES DIFF (Pa):	57	57	55	55	59	57	2.96
EXHST TEMP (C):	185	187	187	189	190	188	1.04
HC (ppm) :	10	10	20	10	10	12.0	37.27
CO (%) :	0.01	0.01	0.01	0.01	0.01	0.010	0.00
CO2 (%) :	3.38	3.37	3.36	3.29	3.40	3.36	1.25
O2 (%) :	12.54	12.50	12.48	12.48	12.42	12.48	0.35
CARB FLOW(g/s):	7.117	7.081	6.948	6.777	7.245	7.034	2.53

REYNOLDS NR. : 3.17E+04 — TOTAL HOURS ON TREATED FUEL : 1338

PERCENTAGE CHANGE IN FUEL CONSUMPTION ((TREATED-BASE)/BASE*100) : -10.6 %

REMARKS:

APPENDIX III ASTM D2156-63T, BACHARACH SMOKE PATCHES

(BHP-UTAH COAL LTD - PEAK DOWNS MINE)

HAULER No	UNTREATED (15.11.90)	BACHARACH No	TREATED (19.3.91)	BACHARACH No	% CHANGE
24		6.5		4.0	-38.5
25		6.0		4.0	-33.3
64		5.0		3.5	-30.0

APPENDIX IV

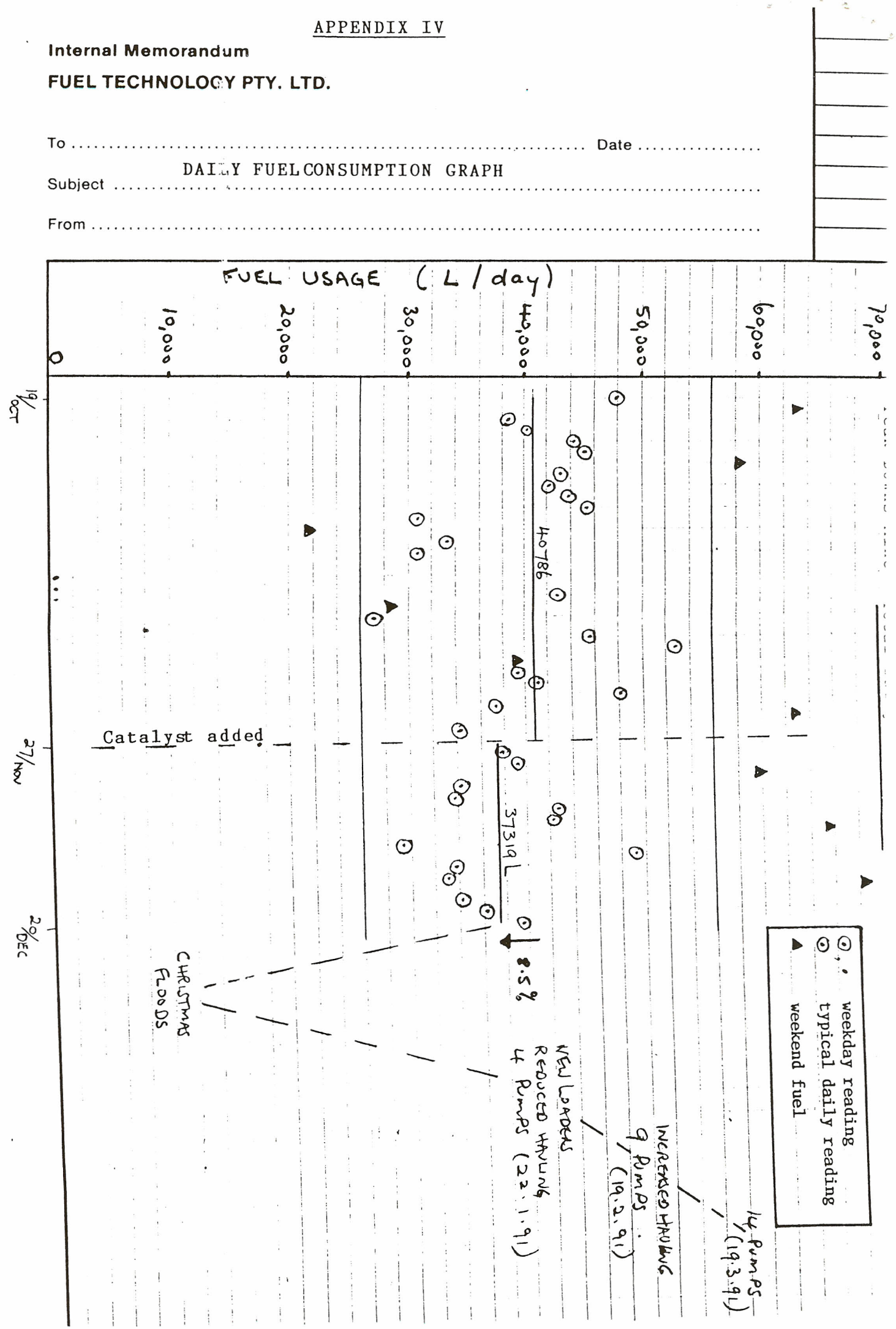
Internal Memorandum

FUEL TECHNOLOGY PTY. LTD.

To ..... Date .....

Subject DAILY FUEL CONSUMPTION GRAPH

From .....



PEAK DOWNS MINE - CATALYST FUEL CONSUMPTION TRIAL

A. ANALYSIS OF MINE DATA AS PRESENTED BY AA LITTLE.

1. The fuel improvements of 16-37% as derived from the data are higher than can be attributable to catalyst addition alone.

2. The following observations are made:

(i) The service bay fuel meter recorded explosives fuel up until 19th October, 1990. Explosives fuel use from 3.10.90-17.7.91 (39 weeks) totalled 664058 L, being an average 17,027 L/week. This figure should be used to correct the service bay fuel figures.

(ii) Unit TKH464 recorded an exceptionally large jump in consecutive meter readings from 5162 to 54525 hours (ie 3363 hrs) from 8.11.90-29.11.90. Average weekly usage rate at about that time was 81 hrs for this unit. This adjustment should be used to correct data. This error is the major reason for the extreme variation noted during Nov. '90.

(iii) The week ending 14.11.90 was marked by FEDFA disputes on 3 days. The L/hr figures for this week appear at an exceptionally low level. No cause could be found to explain this, and it is recommended that this week's data be deleted from the comparison.

(iv) The entries for estimated pump hours into the computer programme are out of sequence by 1 week, with the actual data collected.

B. METHODS OF COMPARISON.

1. To achieve better accuracy in this comparison, it is necessary to isolate data for the original fleet used prior to catalyst treatment. Two elements contained in the post-treatment data must be eliminated to enable this to be achieved.

(i) removal of fuel component due to pump usage.

(ii) removal of fuel component due to the 2 new Le Torneau L1100 loaders. Calculations were made as follows;

(i) Dewatering pumps. Following data used:

Estimated pump hours/wk..... as per data provided
Aver pump HP = 230
Duty level of engine = 75%
(not pump)
Specific Fuel Consumption = .224L/HPhr
(This is typical industry standard)

Pump Fuel = .224 x 230 x 75% x weekly pump hours

= 38.64 L/hr

(ii) The distributors of the Le Torneau L1100 loaders advise that fuel consumption is expected at 120-130 L/hr. For estimations, 120L/hr usage rate was used to adjust data.

2. The recommended corrections and above estimations are necessary to enable realistic comparison of the data. They also permit comparison of the performance of the catalyst on the "original fleet", as well as greatly reducing the variation and magnitude of the measured benefit.

	DATE	Service Bay Records L_1	Service Bay corrected for Explos L_2	Pump Fuel Estim.	Service Bay less Pump est. L_3	New Loaders Fuel Estim.	Service Bay less Pump & Loaders est L_4	Major Plant H_1	Corrected Maj. Plant Error in TKH464 H_2	Corr. Plant plus Pumps H_3	Corr. Plant less Loaders H_4	Fuel consumption (litres/hour) L_2/H_2	L_2/H_3	L_3/H_2	L_4/H_4	
OCT 90	10	266586	249559	9042	240517	–	240517	2725	2725	2959	2725	91.6	84.3	88.3	88.3	
	17	244731	227704	9042	218662	–	218662	2676	2676	2910	2676	85.1	78.2	81.7	81.7	
	24	247263	242398	9042	233356	–	233356	2621	2621	2855	2621	92.5	84.9	89.0	89.0	
	31	233220	233220	9042	224178	–	224178	2791	2791	3025	2791	83.6	77.1	80.3	80.3	
	Av											88.1	81.1	84.8	84.8	
NOV	7	207424	207424	14992	192432	–	192432	2531	2531	2919	2531	82.0	71.1	76.0	76.0	
	14	106711	106711	14992	91719	–	91719	2960	1920	2308	1920	55.6	46.2	47.8	47.8	*
	21	224255	224255	14992	209263	–	209263	3540	2500	2888	2500	89.7	77.7	83.7	83.7	
	28	200078	200078	14992	185086	–	185086	3729	2689	3077	2689	74.4	65.0	68.8	68.8	
	Av											81.8	71.1	76.0	87.9	
DEC	5	204815	204815	14992	189823	–	189823	2519	2519	2907	2519	81.3	70.5.	75.4	75.4	
	12	228882	228882	14992	213890	–	213890	2707	2707	3095	2707	84.6	74.0	79.0	79.0	
	19	205437	205437	14992	190445	4080	186365	2514	2514	2902	2480	81.7.	70.8	75.8	75.1	
	26	140727	140727	24807	115920	2400	113520	1512	1512	2154	1492	93.1	65.3	76.7.	76.1	
	Av											84.3	70.5	76.7	76.5	
JAN 91	2	105029	105029	24807	80222	2400	77822	814	814	1456	794	129.0	72.1	98.6	98.0	
	9	83429	83429	24807	58622	10320	48302	1151	1151	1793	1065	72.5	46.5	50.9	45.4	
	16	182008	182008	34390	147618	11400	136218	1920	1920	2810	1825	94.8	64.8	76.9	74.6	
	23	223533	223533	34390	189143	16560	172583	2643	2643	3553	2505	84.6	62.9	71.6	68.9	
	30	226502	226502	39181	187321	10200	177121	2473	2473	3487	2388	91.6	65.0	75.7	74.2	
	Av											91.2	62.6	73.7	71.4	
FEB	6	189850	189850	39181	150669	14640	136029	1964	1964	2978	1842	96.7	63.8	76.7	73.8	
	13	236845	236845	39181	197664	17760	179904	2949	2949	3963	2801	80.3	59.8	67.0	64.2	
	20	228440	228440	35549	192891	16080	176811	2634	2634	3554	2500	86.7	64.3	73.2	70.7	
	27	313435	313435	35549	277886	18120	259766	3352	3352	4272	3201	93.5	73.4	82.9	81.2	
	Av											88.9	65.6	75.2	72.7	
MAR	6	294837	294837	35549	259288	22200	237088	2947	2947	3867	2762	100.0	76.2	88.0	85.8	
	13	292458	292458	35549	256909	24000	232909	3442	3442	4362	3242	85.0	67.0	74.6	71.8	
	20	257740	257740	35549	222191	22320	199871	3070	3070	3990	2884	84.0	64.6	72.4	69.3	
	27	249569	249569	35549	214020	20520	193500	2792	2792	3712	2621	89.4	67.2	76.7	73.8	
	Av											89.3	68.7	77.7	75.0	
APR	3	180556	180556	35549	145007	12600	132407	1997	1997	2917	1892	90.4	61.9	72.6	70.0	

* Deleted - data well outside normal range (3 days FEDFA strike)

Internal Memorandum

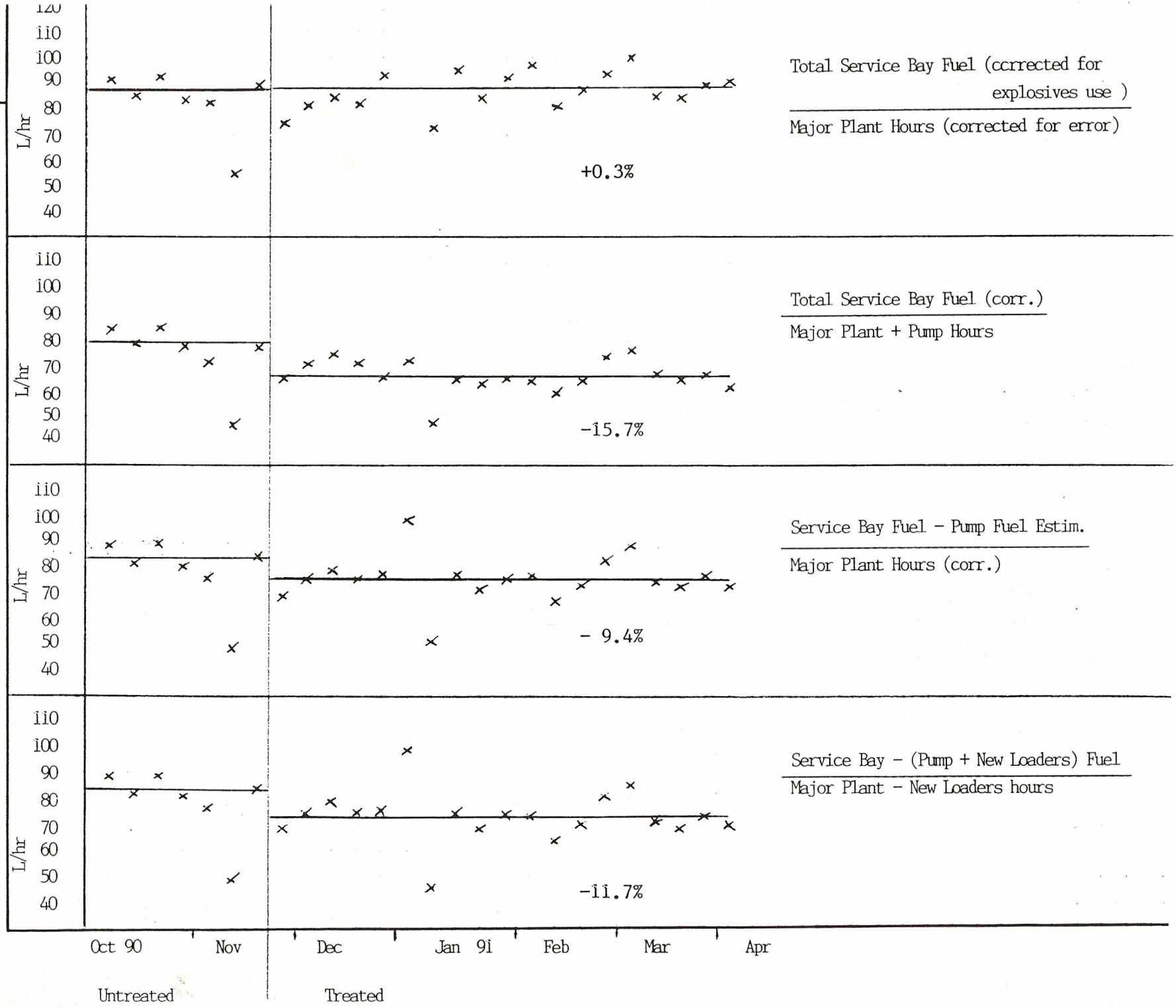
FUEL TECHNOLOGY PTY. LTD.

To ..... Date 28.8.91

Peak Downs Mine

Subject ..... Fuel Consumption Trial - FTC-1 Combustion Catalyst

From ..... Brid Walker (Methods of Analysis)



Total Service Bay Fuel (corrected for explosives use)
Major Plant Hours (corrected for error)

Total Service Bay Fuel (corr.)
Major Plant + Pump Hours

Service Bay Fuel - Pump Fuel Estim.
Major Plant Hours (corr.)

Service Bay - (Pump + New Loaders) Fuel
Major Plant - New Loaders hours