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Summary of Wear Metals Data J.R. Simplot Co./Smoky Canyon Mine

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and
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May 9, 1994

I. Introduction

In June of 1993, J.R. Simplot Company's Smoky Canyon Mine began a field trial of FPC-1® Fuel Performance Catalyst. The trial was designed to determine the effect of the catalyst upon fuel consumption, smoke emissions, oil soot levels and subsequent wear metals reduction.

Fuel consumption testing was conducted first using the Carbon Mass Balance technique with the equipment operating under steady-state engine conditions. Fuel consumption for the fleet tested was reduced on average by 8.79%. The following table shows the equipment tested and the percentage fuel consumption reduction for each individual piece of equipment:

				%Change/Fuel
Unit#	Type	Engine	<u>RPM</u>	Consumption
88	CAT 785 Haul Truck	3512	1800	- 7.70
91	CAT 785 Haul Truck	3512	1800	- 9.75
92	CAT 785 Haul Truck	3512	1800	-12.23
P10	CAT 16G Patrol	3406	1800	-11.01
P12*	CAT 16G Patrol	3406	1800	- 0.25

^{*} P12 accumulated only approximately 80 hours of operation.
(The balance of equipment had accumulated between 500-700 hours)

Smoke density was also measured during the fuel consumption test using the Bacharach Smoke Spot Method. Again, under steady-state engine conditions, smoke density was reduced 14.5% after FPC-1® fuel treatment. This was consistent with the observations of mechanics and operators who indicated that smoke was less dense and lighter colored after treatment with FPC-1®.

II. Oil Analysis Study

The oil analysis required a much longer period of time, and is still underway. However, data compiled during the first 9 months indicate a definite reduction in wear metals and therefore engine wear.

The oil sample data provided begins in July 1992 and the analysis is being performed by the Chevron LIFE Program on samples drawn approximately every 250 hours of operation. The "baseline" oil sample data (untreated fuel) covers approximately 4,000 hours of equipment operation (7/92-6/93). The "treated" data covers a period of approximately 3,000 hours of equipment operation (7/93-2/94).

Prior oil analysis studies indicate soot and wear metals increase for a short period of time after initial FPC-1® treatment. Soot levels are not analyzed for or reported at Smoky Canyon (Total Solids are measured) and therefore could not be tracked. Wear metals did appear

J.R. Simplot Oil Study Smoky Canyon Mine 5/2/94

II. (Cont.)

to increase briefly in some equipment immediately after treatment but then began to trend lower and in most cases are continuing to trend lower (See Table 1).

Of particular note is the effect of FPC-1® upon the rate of engine wear. The rate of engine wear can be calculated from the relationship between total iron in the oil sample (parts per million iron) and the number of hours the engine operated on the oil change when the oil sample was taken. The simple calculation reveals a parts per million iron per hour of engine operation (Fe ppm/hr). Table 1 below summarizes the wear rate data in terms of iron wear per hour of operation, and calculates a percent change over the base fuel:

Table 1: Average Rate of Iron Wear/Hour (Fe ppm/hr)

Unit No.	Base <u>Fuel</u>	Treated Fuel (1)	% Change	Treated Fuel (2)	% Change
13870	.112	.109	- 2.7	.093	-17.0
13880	.134	.103	-23.1	.082	-38.8
13890	.099	.077	-19.8	.076	-20.8
13900	.164	.116	-29.3	.128	-22.0
13910	.112	.105	- 3.7	.090	-17.4
AVE>	.124	.102	-17.7%	.094	-24.2%
13920(3)		.105		.099	
Notes:	(1)	Average of all data treatment occurred		PC-1®	
	(2)	Same as (1) except after treatment exc	first 1200 hours	ormal "carbon	
	(3)	Only two data poin made.		valid comparison c	ould not be

Oil analysis studies conducted earlier reveal FPC-1® not only reduces soot mass in the motor oil over the same oil change interval, but also soot particle size. The reduced mass and particle size would reduce abrasion and slow viscosity change.

J.R. Simplot Oil Study Smoky Canyon Mine 5/2/94

A similar comparison was made on copper (Cu) wear metal levels. The data appears to be less consistent than the iron wear metals and there were several major "spikes" that occurred in several pieces of equipment both before and after treatment with FPC-1® (See data summary tables in Appendices). Per discussion with Glayd Christensen it was agreed that these spikes would be removed from the averages for a more valid comparison. The data in Table 2 below makes this comparison:

Table 2: Average Rate of Copper Wear/Hour (Cu ppm/hr)

Unit No.	Base <u>Fuel</u>	Treated Fuel (1)	%Change	Treated Fuel (2)	% Change
13870	.038	.046	+21.0	.041	+ 7.9
13880	.093	.040	-57.0	.024	-74.2
13890	.125	.037	-68.1	.035	-69.8
13900	.143	.066	-53.8	.070	-51.0
13910	.081	.031	-61.2	.026	-67.5
AVE>	.096	.044	-54.2%	.039	-59.4%
13920(3)		.030		.028	
Notes:	(1)	Average of all data treatment occurred		FPC-1®	* *
	(2)	Same as (1) except after treatment exc		ormal "carbon	
	(3)	Only two data poir made.	• •	o valid comparison	could not be

III. Conclusion

The Simplot Smoky Canyon Mine wear metal study will be continued until the data shows stability has been reached in the motor oil between oil changes. However, the data generated to-date demonstrate a significant reduction in engine wear as evidenced by reductions in both iron (Fe) and copper (Cu) wear metal levels.

J. R. Simplot Oil Analysis Smokey Canyon Mine 5/2/94

Iron levels have been reduced up to 24.2% and copper levels have been reduced up to 59.4%. Further, in most cases the trend is one that appears to still be declining. For graphic representation of this see the charts in the Appendices.

Oil Analysis Summary

Unit #: 13870 CAT 785 Haul Truck

Date	Fe	_Cu	_F	Ir/Oil	_Fe/Hr	Cu/Hr	
7/21/92	95	40		862	.110	.046	
8/10/92	34	12		250	.136	.048	
8/24/92	7	3		250	.028	.012	
9/28/92	41	11		250	.164	.044	
10/29/92	50	14		500	.100	.028	
11/18/92	30	8		250	.120	.032	
12/08/92	24	5		234	.102	.021	
1/08/93	29	6		250	.116	.024	
1/25/93	21	5		250	.084	.020	
2/08/93	85	41		- (n	o hours r	reported)	
_	24	13	(1)	250	.096	.052	
3/05/93	27	11		250	.108	.044	
3/30/93	31	15		250	.124	.060	
4/17/93	32	15		250	.128	.060	
5/15/93	36	306		250	.144	1.224	(2)
6/04/93	30	911		250	.120	3.644	(2)
	FPC-1®	Fuel Treat	ment(6/10/	93)		
7/07/93	32	420		250	.128	1.680	(2)
8/11/93	33	19		250	.132	.076	
8/22/93	27	11		250	.108	.044	
9/18/93	40	209		250	.160	.836	(2)
10/07/93	32	596		250	.128	2.384	(2)
10/28/93	26	121		254	.102	.476	(2)
11/14/93	28	54		234	.120	.231	(2)
11/23/93	18	16		232	.078	.069	
12/11/93	26	11		241	.108	.046	
1/01/94	24	9		242	.099	.037	
1/20/94	19	7		231	.082	.030	
2/05/94	14	5		226	.062	.022	
		Av	erage	es			
	В	efore Treat	ment=	=	.112	.038	
	A	fter Treatm	ent =	=	.109	.046	
	A	fter Treatm	ent v	vith			
		first 1200	hour	cs			
		removed=			.093	.041	

⁽¹⁾ Assumed 250 hours on oil sample(2) Not included in averages as they are "spikes" and obviously outside the statistical range of data.

Oil Analysis Summary

Unit #: 13880 CAT 785 Haul Truck

Data	T.o.	Cu	IIm /0:1	Ec /II.	Cha /IIaa
Date	<u>Fe</u> 45	<u>Cu</u> 50	<u>Hr/Oil</u> 250	<u>Fe/Hr</u>	Cu/Hr
0 (04 (02		84		.180	.200
8/04/92	30		250	.120	.336 (2)
8/24/92	24	118	250	.096	.472 (2)
9/14/92	29	338	250	.116	1.352 (2)
9/28/92	26	185	250	.104	.740 (2)
10/24/92	44	71	238	.185	.298 (2)
11/16/92	37	37	250	.148	.148
12/04/92	38	23	443	.086	.052
12/28/92	31	13	(1) 250	.124	.052
2/11/93	40	31	250	.160	.124
3/05/93	26	14	250	.104	.056
3/26/93	41	31	250	.164	.124
4/12/93	34	22	228	.149	.096
5/01/93	33	22	250	.132	.088
5/27/93	36	24	250	.144	.096
	FPC-1®		ment(6/10/9		
6/25/93	41	17	250	.164	.068
7/28/93	51	23	500	.102	.046
8/13/93	30	16	250	.120	.064
9/18/93	36	16	250	.144	.064
10/12/93	28	13	250	.112	.052
10/28/93	20	6	232	.086	.026
11/17/93	23	7	. 236	.097	.030
11/23/93	15	4	255	.059	.016
12/17/93	16	6	281	.057	.021
1/15/94	19	6	234	.081	.026
2/12/94	26	6	229	.114	.026
		Av	rerages		
		efore Treat		.134	.093
	A	fter Treatm	nent =	.103	.040
	A	fter Treatm	ent with		
		first 1200	hours		
		removed=		.082	.024

⁽¹⁾ Assumed 250 hours on oil sample(2) Not included in averages as they are "spikes" and obviously outside the statistical range of data.

Oil Analysis Summary

Unit #: 13890 CAT 785 Haul Truck

Date	Fe	_Cu	<u>H</u> :	r/Oil	_Fe/Hr	Cu/Hr
7/09/92	33	29		250	.132	.116
7/09/92	32	68		250	.128	.272
8/02/92	24	34		250	.096	.136
8/24/92	32	28		250	.128	.112
9/08/92	27	20		250	.108	.080
10/03/92	29	38		259	.112	.147
10/12/92	23	67		250	.092	.268
11/09/92	23	76		250	.092	.304
11/18/92	19	60		250	.076	.240
12/21/92	19	26		250	.076	.104
1/12/93	21	15		250	.084	.060
2/01/93	14	10		250	.056	.040
2/22/93	23	10		250	.092	.040
3/17/93	24	8		259	.093	.031
4/12/93	27	16	(1)	250	.108	.064
4/29/93	27	12		250	.108	.048
5/22/93	27	14		250	.108	.056
	FPC-1®	Fuel Trea	atment(6/10/9	93)	
7/01/93	15	5		250	.060	.020
7/20/93	25	14		250	.100	.056
8/11/93	19	5	(1)	250	.076	.020
8/16/93	21	14		250	.084	.056
8/27/93	19	12		250	.076	.048
9/18/93	18	11		250	.072	.044
10/03/93	18	11		226	.080	.049
10/24/93	18	9		243	.074	.037
11/18/93	19	8		239	.079	.033
12/04/93	21	9		225	.093	.040
12/29/93	20	10		232	.086	.043
1/15/94	14	6		227	.062	.026
2/10/94	18	4		226	.080	.018
3/01/94	14	6		243	.058	.025
		A	Average	s		
	Be	efore Trea	atment=		.099	.125
	Af	ter Treat	tment =		.077	.037
	Af	ter Treat	tment w	ith		
		first 120	00 hour	S		
		removed=			.076	.035

⁽¹⁾ Assumed 250 hours on oil sample

Oil Analysis Summary

Unit #: 13900 CAT 785 Haul Truck

D-1-	77.0	Q ₂ .	IIm (0 ± 3	TI o /II	On /IIn
<u>Date</u>	<u>Fe</u>	<u>Cu</u>	Hr/Oil	<u>Fe/Hr</u>	<u>Cu/Hr</u>
7/31/92	45	272	250	.180	1.088 (2)
8/20/92	31	144	250	.124	.576 (2)
9/08/92	25	36	250	.100	.144
9/28/92	42	283	250	.168	1.132 (2)
10/24/92	40	155	250	.160	.620 (2)
11/16/92	38	47	250	.152	.188
12/04/92	32	19	(1) 250	.128	.076
12/21/92	31	20	250	.124	.080
1/11/93	24	20	250	.096	.080
2/01/93	36	28	250	.144	.112
3/05/93	45	30	250	.180	.120
4/12/93	78	73	233	.335	.313
5/01/93	49	46	250	.196	.184
5/22/93	48	46	250	.192	.184
6/10/93	47	24	250	.188	.096
	FPC-1®	Fuel Treat	tment(6/10/9:	3)	
6/21/93	22	12	250	.088	.048
6/25/93	14	6	250	.056	.024
7/20/93	38	28	250	.152	.112
7/24/93	14	10	250	.056	.040
8/22/93	32	18	250	.128	.072
9/18/93	28	23	250	.112	.092
10/07/93	34	28	250	.136	.112
10/24/93	24	12	213	.113	.056
11/17/93	29	13	262	.111	.050
11/23/93	14	8	257	.054	.031
12/17/93	30	16	251	.120	.064
1/07/94	31	14	241	.129	.058
2/19/94	56	22	225	.249	.098
, , , , , , , , , , , , , , , , , , , ,					
		A.	verages		
	В	efore Treat	tment=	.164	.143
	A	fter Treat	ment =	.116	.066
	A	fter Treati	ment with		
		first 120	0 hours		
		removed=		.128	.070

⁽¹⁾ Assumed 250 hours on oil sample(2) Not included in averages as they are "spikes" and obviously outside the statistical range of data.

Oil Analysis Summary

Unit #: 13910 CAT 785 Haul Truck

<u>Date</u>	Fe	_Cu	Hr/Oil	<u>Fe/Hr</u>	Cu/Hr
7/01/92	28	13	250	.112	.052
***	28	14	239	.117	.058
8/10/92	20	11	250	.080	.044
8/31/92	21	12	250	.084	.048
9/17/92	21	10	250	.084	.040
10/29/92	32	629	250	.128	2.516 (2)
11/18/92	27	247	250	.108	.988 (2)
12/14/92	20	45	230	.087	.196
2/01/93	39	43	250	.156	.172
2/19/93	20	19	250	.080	.076
3/22/93	26	97	250	.104	.388 (2)
4/02/93	27	23	250	.108	.092
4/26/93	40	20	250	.160	.080
5/17/93	35	18	250	.140	.072
6/07/93	34	11	250	.136	.044
	FPC-1®	Fuel Treat	ment(6/10/93	3)	
6/25/93	32	9	250	.128	.036
8/3/93	62	<1	500	.124	.002
8/16/93	29	149	250	.116	.596 (2)
9/04/93	36	63	250	.144	.252 (2)
9/28/93	33	22	250	.132	.088
10/07/93	24	11	250	.096	.044
10/24/93	20	7	231	.086	.030
11/14/93	20	9	234	.085	.022
11/28/93	20	5	225	.089	.029
12/26/93	29	7	239	.121	.017
1/15/94	17	4	234	.073	.017
1/29/94	12	3	250	.048	.012
2/18/94	27	5	225	.120	.022
		Average			
		efore Treat		.112	.081
		fter Treatm		.105	.031
	A	fter Treatm			
		first 1200	hours		
		removed=		.090	.026

⁽¹⁾ Assumed 250 hours on oil sample(2) Not included in averages as they are "spikes" and obviously outside the statistical range of data.

Oil Analysis Summary

Unit #: 13920 CAT 785 Haul Truck

Date	Fe	<u>Cu</u>	Hr/Oil	Fe/Hr	<u>Cu/Hr</u>
3/26/93	31	98	250	.124	.392
4/17/93	33	32	250	.132	.128
	FPC-1®	Fuel Treat	ment(6/10/93)	
6/21/93	21	7	250	.084	.028
7/07/93	26	8	250	.104	.032
7/24/93	37	14	250	.148	.056
8/11/93	23	6	250	.092	.024
8/27/93	37	8	250	.148	.032
9/18/93	35	8	250	.140	.032
10/12/93	29	7	250	.116	.028
10/24/93	21	5	205	.102	.024
11/07/93	22	7	246	.089	.028
11/22/93	18	5	230	.078	.022
12/26/93	31	10	231	.134	.043
1/15/94	17	6	242	.070	.025
2/03/94	16	5	234	.068	.021
2/19/94	23	7	237	.097	.029

Unit # 13910		T			<u> </u>											
CAT 785 Haul T	ruck															
Date: Iro	n: ·															
7/1/92	0.112					r.R. S	implot	Oil A	nalvs	sis Sr	ımm	arv				
	0.117					,,,,,,,	iii piot		and J	,	******	ar j				
8/10/92	0.08															
8/31/92	0.084		0.16													
9/17/92	0.084		0.10			1		Λ								
10/29/92	0.128					Λ										
11/18/92	0.108					Λ					٨					
12/14/92	0.087	· ·	0.14	-	-	-+			\		/					
2/1/93	0.156										/ \					
2/19/93	0.08				\					\ 1		\				
3/22/93	0.104		0.12							1		+				
4/2/93	0.108	٦.								V		\		/\		
4/26/93	0.16			\								\		/ \	\	
5/14/93	0.14		0.1			1										
6/7/93	0.136		0.1				/									
6/25/93	0.128	/hr		\		V	/					/	\		1	
8/3/93	0.124	_ m	0.08				V									
8/16/93	0.116	Iron (ppm/hr)	0.08													
9/4/93	0.144	ron													\	
9/28/93	0.132														\	
10/7/93	0.096		0.06		***************************************										_	+
10/24/93	0.086														/	J
11/14/93	0.085															Y
11/28/93	0.089		0.04	-												
12/26/93	0.121															
1/15/94	0.073															
1/29/94	0.048		0.02													
2/18/94	0.12			1												
	0.108785714 Mean															
(0.027025855 ST Dev		Ο		1 1 1	1i	1 1 1	1	1_1_1	11				1 1	- 1	L!
			0						1 1	1 1	1			1 1		
				7/1/92 8/10/92 8/31/92	9/17/92 [0/29/92 [1/18/92	93	93	/93 /93	93	8/3/93	93	/93	93	93	94	794
				7/1,	9/17/92 10/29/92 11/18/92	2/1/93	3/22/93 4/2/93	4/26/93 5/14/93	6/7/93	8/3/93 8/16/93	9/4/93	10/7/93	10/24/93 11/14/93	11/28/93 12/26/93	1/15/94	2/18/94
				8 8	90, 110, 51	7, 6	3 60 3	4 6	~ ₆	8	5 6	7	11	11, 12,	7 7	5
								Da	ate							
, and 100																

Unit # 13900			
CAT 785 Haul	Truck		•
Date: Ir	on (ppm/hr)		
7/31/92	0.18		J.R. Simplot Oil Analysis Summary
8/20/92	0.124		J.K. Shiplot On Analysis Summary
9/8/92	0.1		
9/28/92	0.168		
10/24/92	0.16	0.35	
11/16/92	0.152		A
12/4/92	0.128		
12/21/92	0.124	0.3	
1/11/93	0.096	0.3	
2/1/93	0.144	į i	
3/5/93	0.18		
4/12/93	0.335	0.25	
5/1/93	0.196		
5/22/93	0.192		
6/10/93	0.188	_	
6/21/93	0.088	(bbm/r) 0.2	
6/25/93	0.056	/ma	
7/20/93	0.152	Id)	
7/24/93	0.056		
8/22/93	0.128		
9/18/93	0.112		
10/7/93	0.136		
10/24/93	0.113	0.1	
11/17/93	0.111		
11/23/93	0.054		
12/17/93	0.12		\bigvee
1/7/94	0.129	0.05	
2/19/94	0.249		
-0	0.141821429 Mea		
	0.059030471 ST I	Dev 0	
			7/31/92 8/20/92 9/8/92 9/8/92 10/24/92 11/16/92 12/21/92 2/1/93 3/5/93 4/12/93 5/1/93 5/1/93 5/1/93 5/1/93 1/24/93 8/22/93 10/7/93 10/7/93 11/17/93 11/17/93 11/17/93
			7/31/92 8/20/92 9/8/92 9/8/92 10/24/92 11/16/92 12/21/93 2/1/93 3/5/93 5/10/93 6/10/93 6/21/93 6/21/93 10/24/93 10/24/93 11/17/93 11/17/93 11/17/93
			2 8 9 9 11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
			Date

Unit # 13890					
CAT 785 Hau	l Truck				
Date:	(ron (ppm/hr)				
7/9/92	0.132				J.R. Simplot Oil Analysis Summary
7/23/92	0.128				J.K. Simplot On Analysis Summary
8/2/92	0.096				
8/24/92	0.128				
9/8/92	0.108			0.14	14
10/3/92	0.112				
10/12/92	0.092				
9-Nov	0.092			0.12	12 / /
11/18/92	0.076			0.12	12
12/21/92	0.076				
1/12/93	0.084				
2/1/93	0.056		ν,	0.1	0.1
2/22/93	0.092			37.12	/ / /
3/17/93	0.093				
4/12/93	0.108				
4/29/93	0.108		Iron (ppm/hr)	0.08	08
5/22/93	0.108		m/		
7/1/93	0.06		dd)		
7/20/93	0.1		on	0.00	oc V \
8/11/93	0.076		1	0.06	00
8/16/93	0.084				
8/27/93	0.076				
9/18/93	0.072			0.04	04
10/3/93	0.08				
10/24/93	0.074				
11/18/93	0.079				
12/4/93	0.093			0.02	02
12/29/93	0.086				
1/15/94	0.062				
2/10/94	0.08				
3/1/94	0.058			0	0 +
	0.086178571			1	7 4 7 7 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8
	0.017828511				7/9/92 8/2/92 9/8/92 (0/12/93 1/12/93 4/12/93 5/22/93 7/20/93 9/18/93 1/15/94 3/1/94
					7/9/92 8/2/92 9/8/92 10/12/93 1/12/93 4/12/93 5/22/93 7/20/93 8/16/93 9/18/93 12/4/93 1/15/94
	Nade to the Control of the Control o				Date
					Date
		i			

Unit # 13880									*															
CAT 785 Hau																								
Date:	Iron (ppm/hr)									_					_	_	~							
	0.18								J.F	R. S	Simp	lot	Oil	An	aly	sis	Sur	nm	ary					
8/4/94	0.12																							
8/24/92	0.096																							
9/14/92	0.116			0.2 -																				
9/28/92	0.104																							
10/24/92	0.185							٨																
11/16/92	0.148			0.18	 			-		-				7.5										
12/4/92	0.086				1																			
12/28/92	0.124			0.16	1								Λ			Λ.							ett choode out i en o	
2/11/93	0.16			0.10					\		Λ					/								
3/5/93	0.104							'			/\		\	\	/	' \								
3/26/93	0.164			0.14	+			 	1		/-			_	+				A					
4/12/93	0.149									1	/ \			\vee				,	/ \					
5/1/93	0.132									/		\						/	\					
5/27/93	0.144			0.12	+		$\overline{}$		+	-		1					+-	—						
6/25/93	0.164] 4				1					\bigvee					1/	/		\				/
7/28/93	0.102		Iron (ppm/hr)	0.1		\backslash						γ					V							
8/13/93	0.12			0.1		V			1											\	Λ			
9/18/93	0.144		ror						V											\vee	/ \			
10/12/93	0.112			0.08	_																	 		/
10/28/93	0.086		1																				/	
11/17/93	0.097																							
11/23/93	0.059		1	0.06																		_		
12/17/93	0.057		1																					
1/15/94	0.081			0.04																				
2/12/94	0.114																							
	0.121076923	Mean	1																					
	0.034515994	ST Dev		0.02 -	-																			
						×																		
			1	^	1	1 1	1	1	1 1	1	1	1	1	1 1	1	1	J.	1	1	1 1	1	ï	1	1 1
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			1		94	26	92	92	35	92	93	33	2, 29	93	93	93	93	93	33	93	93	93	6 3	7
			1		8/4/94	9/14/92	9/28/92	10/24/92	12/4/92	12/28/92	2/11/93	3/5/93	2/20/93	5/1/93	5/27/93	6/25/93	7/28/93	8/13/93	9/18/93	10/28/93	11/17/93	11/23/93	12/17/93	2/12/94
					oo à	6	16	10/	12	12/	2/	<i>c c</i>	9 4	ς.	5/	/9	1/	8	9/	10/.	11/	11/	12/	2/2
			1										1	Date							100 (10)	0 8	20. 60	
			1										•	_ 400										
			1																					
				-	-		Topic Common or Co.		-	1	-	Address of the second		-	****		MENTAL PROPERTY.	-				THE RESERVE OF THE PERSON NAMED IN	1	- Company of the Comp

Unit # 13870																-						-	
CAT 785 Hat																							
	Iron (ppm/hr)																						
7/21/92	0.11							J.R	. Sir	mple	ot O	il A	Ana	lysi	s S	ımı	nary	7					
8/10/92	0.136																						
8/24/92	0.028																						
9/28/92	0.164			0.18																			_
10/29/92	0.1																						
11/18/92	0.12																						
12/8/92	0.102			0.16	-	\											Λ						_
1/8/93	0.116					/\											\setminus						
1/25/93	0.084					11																	
	0.096			0.14	-	+						-/				-+							-
3/5/93	0.108				1 /									-	1		\						
3/30/93	0.124		٠.		1/1)	\		/		\						
4/17/93	0.128			0.12	+/	++					/		\			+			/				
5/15/93	0.144				/ /	1		\wedge		/	/					\bigvee)	\ /	/ \				
6/4/93	0.12		$\overline{\mathbf{c}}$			1	/ \									٧		$\backslash /$	\	1	\		
7/7/93	0.128		/ hr	0.1	+	1	/ <u>v</u>			/								· ·	+		+		_
8/11/93	0.132		md					1	\ /										1	/	/		
8/22/93	0.108		<u>d</u>						\vee										\				
9/18/93	0.16		Iron (ppm/hr)	0.08	+									180 Y. F		· · · · · · · · · · · · · · · · · · ·				√		+	
10/7/93	0.128		I																			\	
10/28/93	0.102																					,	
11/14/93	0.12			0.06	+	 																	_
11/23/93	0.078				1																		
12/11/93	0.108			0.04	\																		
1/1/94	0.099			0.04	1																	4 99 15	estra A
1/20/94	0.082	· _			\ \ \																		
2/5/94	0.062			0.02																			
	0.11062963			0.02																			_
	0.028618375	ST Dev																					
				0		1 1	1 1	1	1 1	L i	_1	1	1 1	1		_1_	1 1	1	Ī		ı	1	
					1111	1		1				1				1	T	1	1		1	1	٦
					7/21/92 8/10/92 8/24/92	192	92 /92	/93	56/07/1	/93	3/30/93	4/11/93	93	/93	8/11/93	8/27/93	93	/93	93	93	/94	1/20/94	44
					/21, /10, /24,	9/28/92	11/18/92	1/8/93	Š	3/5/93	/30/	11/	6/4/93	7/7/93	/11	777	10/7/93	10/28/93	11/14/93 11/23/93	12/11/93	1/1/94	/20/	46/5/7
					2 8 8	9/01	11 7	•	7	8.1	6 3	4 v	<u> </u>		∞	ò ò	\(\times\)	10/	11/	12/		7	•
												D	ate										
													15										
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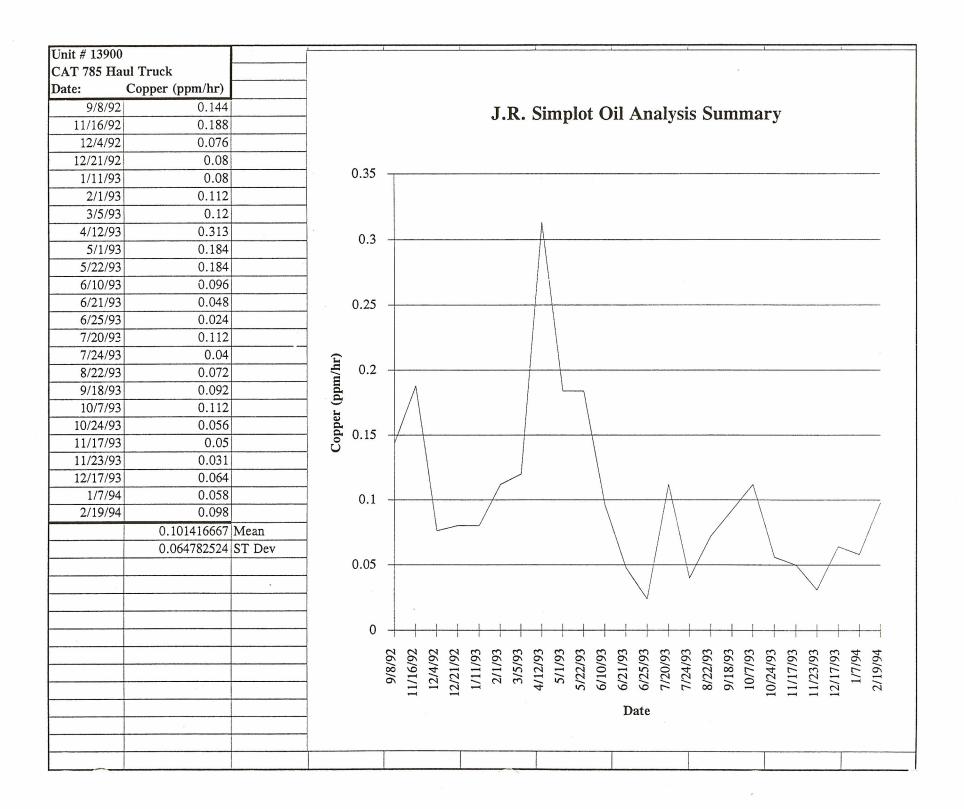
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Unit # 13920 CAT 785 Haul Ti	nek																	
Date: Iron		-																
3/26/93	0.124																	
4/17/93	0.132						J.R	. Sin	nplo	t A	nalv	sis S	umi	nary	V			
6/21/93	0.084						0 124		P				-		,			
7/7/93	0.104																	
7/24/93	0.148		0.16 -															
8/11/93	0.092		0.10															
8/27/93	0.148								_									
9/18/93	0.14		0.14	,			\wedge											
10/12/93	0.116		0.14 -				$\overline{}$		\neg	1								
10/24/93	0.102						/ \			\					\wedge			
11/7/93	0.089			/ \			/ - '	\							/\			
11/22/93	0.078		0.12 -	1	\	/	<i></i>	1	/		_				7			
12/26/93	0.134					/		\ /			\				/ \	\		
1/15/94	0.07							\ /										
2/3/94	0.068		0.1 -		_	-/-		-\/-			-		\		/	1		
2/19/94	0.097	ır.			\ /			V						/				
0	.103119168 Mean	Iron (ppm/hr)			\vee											\		
- 0	.032842264 ST Dev	dd)	0.08 -											4			/	
		ıı ıı																
		Ir																
			0.06 -			···									***			
			0.04 -															
			0.02 -												***			
			A3347999 vs. 575557															
			0 -															
												1						
			20/9/12	4/17/93	6/21/93	7/7/93	7/24/93	8/11/93	8/27/93	9/18/93	10/12/93	10/24/93	11/7/93	11/22/93	12/26/93	1/15/94	2/3/94	2/19/94
			90	/17	/21	717	/24	/11	127	/18	/12	/24	17	122	126	/15	2/3	//19
			"	, 4	9		7	∞	∞		10	10		11	12	-		2
										D	ate							
										_								

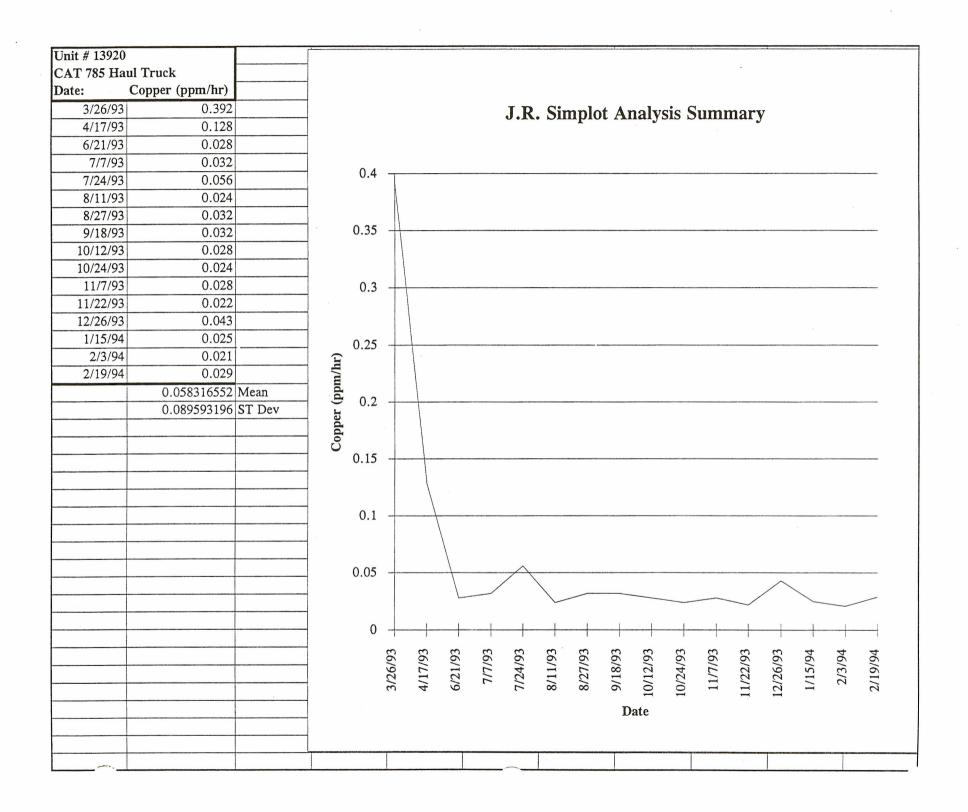
nit # 13870							A														
AT 785 Haul T	L.																				
ate: Cop	pper (ppm/hr)																				
7/21/92	0.046								J.R	. Sir	nplo	ot C	il An	alysi	s Su	mm	ary				
8/10/92	0.048																				
8/24/92	0.012																				
9/28/92	0.044			0.08														-			
10/29/92	0.028																				
11/18/92	0.032	8														Λ					
12/8/92	0.021			0.07												/			÷		
1/8/93	0.024			0.07												$/ \top$		Λ			
1/25/93	0.02														/	1		/\			
	0.052														/			/ \			
3/5/93	0.044			0.06	-									7			-	1			
3/30/93	0.06													/			\ ,	/ \			
4/17/93	0.06													/			\ /	1	\		
8/11/93	0.076		1	0.05									A-				1/		-		
8/22/93	0.044		<u>E</u>			1								/			\/				
11/23/93	0.069] /m				٨										V				
12/11/93	0.046		dd	0.04			\wedge														
1/1/94	0.037		Copper (ppm/hr)	0.04				\													
1/20/94	0.03		dd			1															
2/5/94	0.022		ပိ						^											/	\
	0.04075	Mean	1	0.03	+		+-	$\overline{}$	$\overline{}$			-									+-
	0.01731405		1						1	\											
			1			\				\ _	\wedge			ŝ							\
			1	0.02	-							V_									
						\ /															
			1			\bigvee															
				0.01		γ															
			1	0.01																	
			1																		
			1	193								1	ĩ I								
			1	0	+	+					+-	+	+				+		+		+
			1		25	75	32	35	92	35	93	93	33	93	93	93	93	93	93	75	74 75
			1		7/21/92	8/10/92	9/28/92	10/29/92	11/18/92	12/8/92	1/8/93	1/25/93	3/5/93	3/30/93	4/17/93	8/11/93	8/22/93	11/23/93	12/11/93	1/1/94	1/20/94 2/5/94
			1		7/7	% %/8	7/6	7/01	[1]	12	_	1/,	6	3/3	4/	/8	3/8	11/2	12/	—	1/2
		The second secon	-					-					Date					-			
			1										Date								
			1																		
			+		Ι		T					Т			T				*****		

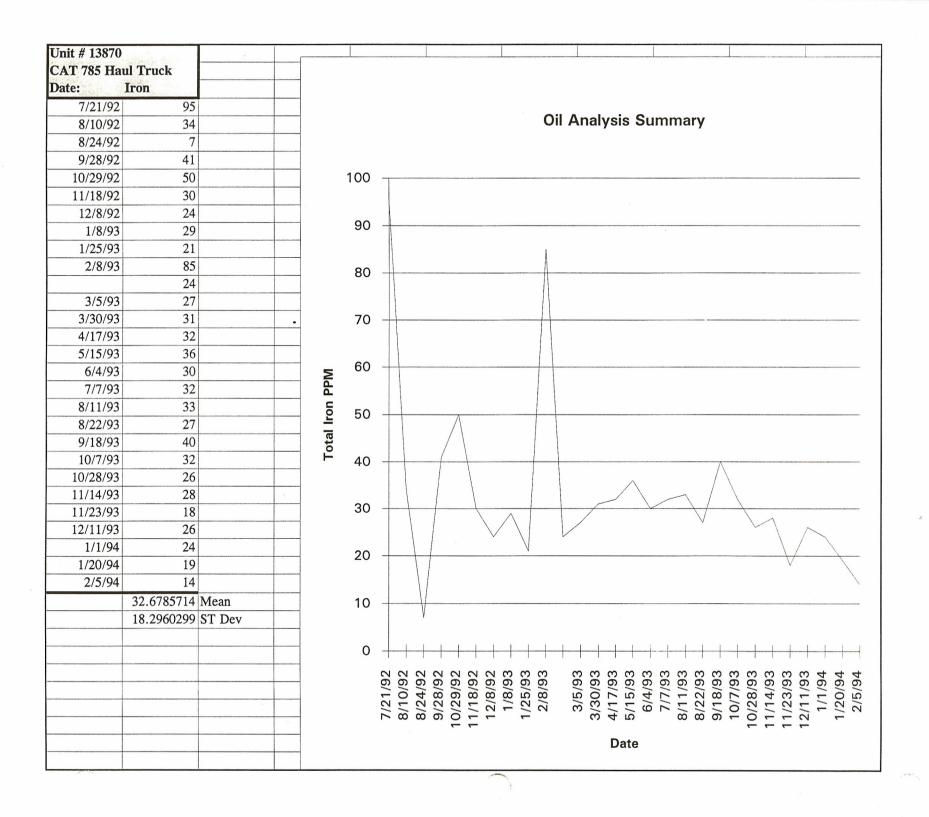
Date Copper (ppm/hr)	Jnit # 13880				
1/16/92					•
11/16/92	Date: Co				
12/4/92					J.R. Simplot Oil Analysis Summary
12/28/92	11/16/92				
2/11/93	12/4/92	0.052			
2/11/93	12/28/92	0.052		0.:	.2
3/26/93	2/11/93	0.124		n	
4/12/93	3/5/93	0.056			
5/1/93	3/26/93	0.124		0.1	18 +
5/27/93	4/12/93	0.096		*	
Siz193	5/1/93	0.088		0.1	16
7/28/93	5/27/93	0.096		0.1	10
8/13/93	6/25/93	0.068			
8/13/93	7/28/93	0.046		0.1	14
10/12/93	8/13/93	0.064	A		
10/28/93	9/18/93	0.064			
2/12/94 0.026 0.070238095 Mean 0.04 0.047453034 ST Dev 0.04 0.02 0.02 0.04 0.02 0.04 0.02 0.04 0.02 0.06 0.07 0.08 0.09 0.09 0.09 0.09 0.09 0.09 0.09	10/12/93	0.052		을 0.1	12 + \
2/12/94 0.026 0.070238095 Mean 0.04 0.047453034 ST Dev 0.04 0.02 0.02 0.04 0.02 0.04 0.02 0.04 0.02 0.06 0.07 0.08 0.09 0.09 0.09 0.09 0.09 0.09 0.09	10/28/93	0.026		m/I	
2/12/94 0.026 0.070238095 Mean 0.04 0.047453034 ST Dev 0.04 0.02 0.02 0.04 0.02 0.04 0.02 0.06 0.07 0.08 0.09 0.09 0.09 0.09 0.09 0.09 0.09	11/17/93	0.03		idd	
2/12/94 0.026 0.070238095 Mean 0.04 0.047453034 ST Dev 0.04 0.02 0.04 0.05 Mean 0.04 0.07 0.08 Mean 0.09 0.09 0.09 0.09 0.09 0.09 0.09 0.0	11/23/93	0.016		o.	.1
2/12/94 0.026 0.070238095 Mean 0.04 0.047453034 ST Dev 0.04 0.02 0.02 0.04 0.02 0.04 0.02 0.04 0.02 0.06 0.07 0.08 0.09 0.09 0.09 0.09 0.09 0.09 0.09	12/17/93	0.021	***************************************	dd	
2/12/94 0.026 0.070238095 Mean 0.04 0.04 0.04 0.05 0.04 0.004 0.002 0.004 0.005 0.004 0.005 0.005 0.005 0.006 0.007 0.	1/15/94	0.026		ပိ 0.0	08
0.04 0.04 0.05 0.06 0.07 0.07 0.08 0.09 0.09 0.002 0.002 0.002 0.002 0.002 0.002 0.002 0.002 0.002 0.003 0.00	2/12/94	0.026			
0.04 0.04 0.05 0.06 0.07 0.07 0.08 0.09 0.09 0.002 0.002 0.002 0.002 0.002 0.002 0.002 0.002 0.002 0.003 0.00		0.070238095	Mean		
11/16/92 12/28/92 12/28/93 4/12/93 4/12/93 5/27/93 6/25/93 8/13/93 10/12/93 11/17/93 11/123/93 11/13/93 11/13/93				0.0	36
11/16/92 12/28/92 2/11/93 3/26/93 4/12/93 4/12/93 5/17/93 6/25/93 6/25/93 10/12/93 10/12/93 11/17/93 11/17/93 11/17/93 11/12/94					
11/16/92 12/28/92 2/11/93 3/26/93 4/12/93 4/12/93 5/17/93 6/25/93 6/25/93 10/12/93 10/12/93 11/17/93 11/17/93 11/17/93 11/12/94				0.0	04
11/16/92 12/4/92 12/28/92 2/11/93 3/26/93 4/12/93 5/17/93 6/25/93 7/28/93 10/12/93 10/12/93 11/17/93 11/17/93 11/17/93 11/17/93 11/17/93				0.0	J4
11/16/92 12/4/92 12/28/92 2/11/93 3/26/93 4/12/93 5/17/93 6/25/93 7/28/93 10/12/93 10/12/93 11/17/93 11/17/93 11/17/93 11/17/93 11/17/93					
11/16/92 12/4/92 12/28/92 2/11/93 3/26/93 4/12/93 5/17/93 6/25/93 7/28/93 10/12/93 10/12/93 11/17/93 11/17/93 11/17/93 11/17/93 11/17/93				0.0	02
11/16/92 12/4/92 12/28/92 2/11/93 3/26/93 3/26/93 4/12/93 5/1/93 5/27/93 6/25/93 10/12/93 10/12/93 11/17/93 11/17/93 11/17/93					
11/16/92 12/4/92 12/28/92 2/11/93 3/26/93 3/26/93 4/12/93 5/1/93 5/27/93 6/25/93 10/12/93 10/12/93 11/17/93 11/17/93 11/17/93			***************************************		
			***************************************	,	0 + + + + + + + + + + + + + + + + + + +
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					16/3 16/3 11/3 11/3 11/3 11/3 12/3 13/3
					117 127 127 127 127 127 177 177 177 177
Date					
					Date
		4		Τ	

Unit # 13890		1	
CAT 785 Haul		_	
	opper (ppm/hr)	_	
7/9/92	0.116		J.R. Simplot Oil Analysis Summary
7/23/92	0.272		
8/2/92	0.136		
8/24/92	0.112	0.35	
9/8/92	0.08		
10/3/92	0.147		
10/12/92	0.268		
11/9/92	0.304	0.3 -	Α
11/18/92	0.24		
12/21/92	0.104		
1/12/93	0.06		
2/1/93	0.04	0.25	
2/22/93	0.04		
3/17/93	0.031		
4/12/93	0.064	ır.	
4/29/93	0.048	0.2	
5/22/93	0.056	[dd]	
7/1/93	0.02	Copper (ppm/hr)	
7/20/93	0.056	d 0.15	
8/11/93	0.02	ට වී	
8/16/93	0.056		
8/27/93	0.048		
9/18/93	0.044	0.1 -	
10/3/93	0.049		
10/24/93	0.037		
11/18/93	0.033		
12/4/93	0.04	0.05 -	
12/29/93	0.043		
1/15/94	0.026		V V
2/10/94	0.018	0	
3/1/94	0.025	0 -	
	0.075321429 Mean	ع ` و	2
	0.075252195 ST Dev		8/2/92 8/2/92 9/8/92 10/12/92 1/12/93 4/12/93 5/22/93 7/20/93 8/16/93 9/18/93 12/4/93 1/15/94
] `	01 11 1 1 2 4 4 2 7 7 10 10 10 10 10 10 10 10 10 10 10 10 10
			Date

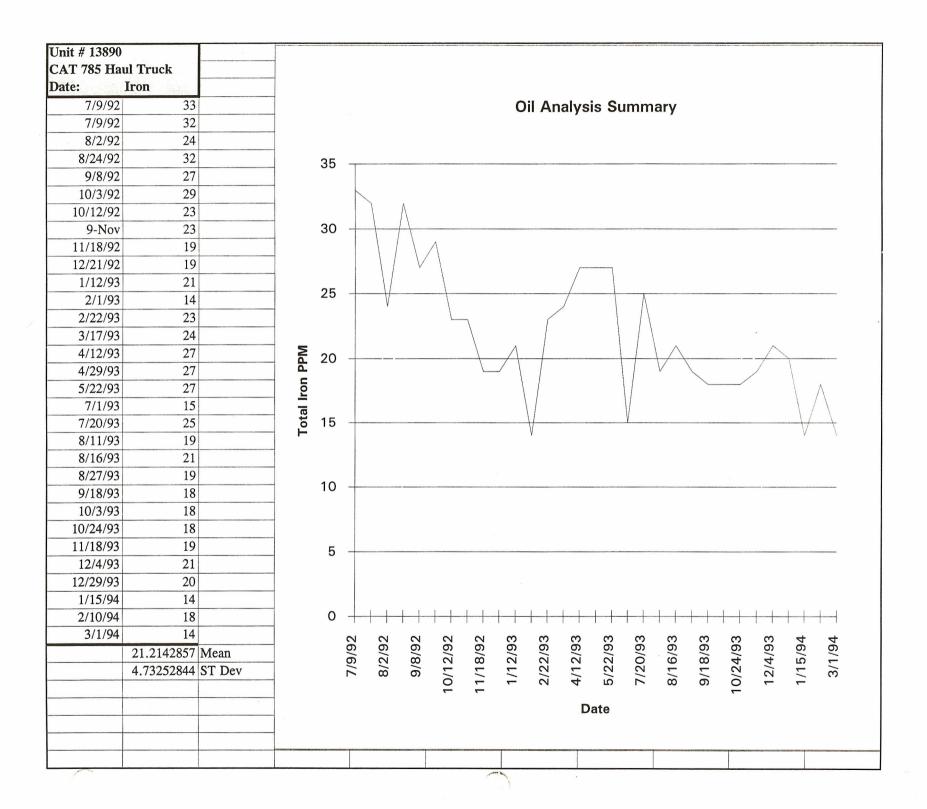


Jnit # 13910			
CAT 785 Haul			•
Date: Co	pper (ppm/hr)		
7/1/92	0.052		J.R. Simplot Oil Analysis Summary
	0.058		
8/10/92	0.044		
8/31/92	0.048	0.2	
9/17/92	0.04	0.2	Λ
12/14/92	0.196		
2/1/93	0.172	0.18	
2/19/93	0.076		
4/2/93	0.092	9 0 4 6	
4/26/93	0.08	0.16	
5/14/93	0.072	-	
6/7/93	0.044	0.14	
6/25/93	0.036	0.17	
8/3/93	0.002		
9/28/93	0.088	<u> </u>	
10/7/93	0.044	□ d/n	
10/24/93	0.03	ıdd o	
11/14/93	0.022	O.1	
11/28/93	0.029	Copper (ppm/hr) 0.15	
12/26/93	0.017	ට 0.08	
1/15/94	0.017		
1/29/94	0.012		
2/18/94	0.022	0.06	
	0.056217391 Mean		
	0.047381389 ST Dev	0.04	
		0.04	
		0.02	
		0	
			92
		7	7/1/92 8/31/92 8/31/92 9/17/92 2/193 2/193 4/26/93 6/7/93 6/7/93 8/3/93 10/24/93 11/14/93 11/12/94 11/12/94
			8/11/92 8/31/92 8/31/92 9/17/92 12/14/93 2/19/93 4/26/93 6/7/93 6/7/93 9/28/93 10/7/93 11/128/93 11/128/93
			Date
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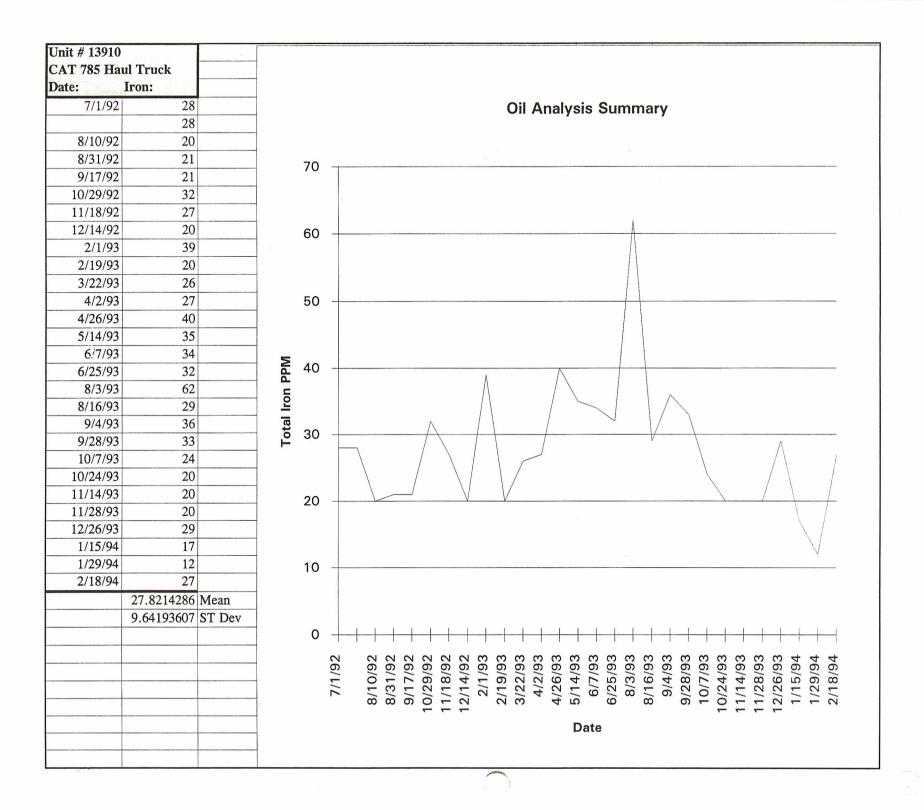




Unit # 13880 CAT 785 Haul T	r		
Date: Iro			
Jate. Ho	45	_	Oil Analysis Summary
8/4/94	30	-	Oil Allalysis Sullillary
8/24/92	24		
9/14/92	29	-	
9/28/92	26	60	
10/24/92	44	-	
11/16/92	37		
12/4/92	38	-	
12/28/92	31	50	0 ————
2/11/93	40		
3/5/93	26		
3/26/93	41	-	
4/12/93	34	40	
5/1/93	33	40	
5/27/93	36	_	
6/25/93	41	_ ₽	
7/28/93	51		
8/13/93	30	<u> 5</u> 30	
9/18/93	36	Total Iron PPM	
10/12/93	28	To To	
10/28/93	20		
11/17/93	23	20	
11/23/93	15		
12/17/93	16		
1/15/94	19		
2/12/94	26		
	31.5 Mean	10	0 +
ç	9.2444578 ST Dev		
			8/4/94 8/24/92 9/14/92 9/128/92 10/24/92 11/16/92 12/28/93 3/5/93 3/5/93 5/1/93 5/1/93 5/1/93 1/1/23/93 1/1/23/93 1/1/23/93 1/1/23/93 1/1/23/93
			4 4 4 7 7 7 7 8 4 7 7 7 8 7 7 8 7 7 8 7 7 8 7 7 8 7 7 8 7 7 7 7 7 8 7
			8/4/94 8/24/92 9/14/92 10/24/92 12/28/92 2/11/93 3/5/93 3/5/93 3/5/93 6/25/93 6/25/93 6/25/93 10/12/93 10/12/93 11/17/93 11/12/93
			Date
			Duto



Unit # 13900			
CAT 785 Hau	l Truck		
Date: 1	ron:		
7/31/92	45	Oil Analysis Summary	
8/20/92	31	on / manyolo oumman /	
9/8/92	25		
9/28/92	42	80 —	
10/24/92	40	80	
11/16/92	38		
12/4/92	32		
12/21/92	31	70	
1/11/93	24		
2/1/93	36		
3/5/93	45	60	
4/12/93	78		
5/1/93	49		
5/22/93	48	50	
6/10/93	47		
6/21/93	22		
6/25/93	14		
7/20/93	38	Total Iron PPM 40	
7/24/93	14		
8/22/93	32	P / / / / / / / / / / / / / / / / / / /	
9/18/93	28	30	
10/7/93	34		
10/24/93	24		
11/17/93	29	20	
11/23/93	14		
12/17/93	30	V	
1/7/94	31	10	
2/19/94	56	10	
	34.8928571 Mean		
	13.7472941 ST Dev		
		0 + + + + + + + + + + + + + + + + + + +	
			D 4 4
		7/31/92 8/20/92 9/8/92 9/28/92 10/24/92 12/1/93 2/1/93 3/5/93 6/10/93 6/21/93 6/21/93 6/21/93 1/24/93 10/24/93 10/24/93	1/7/93 1/7/94 2/19/94
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		2 3 2 1 1 2 1 4 2 2 2 2 1 1 1 1 1 1 1 1 1 1	2 0
		Date	



Init # 13920 CAT 785 Ha	AND DESCRIPTION OF ACTIVATION OF THE PARTY O																		
Control of the Contro	Iron:																		
3/26/93									0	ΙΔn	alve	ie Q.	ımm	arv					
4/17/93									O	I All	aiys	is St	4111111	ai y					
6/21/93		A-10-10-10-10-10-10-10-10-10-10-10-10-10-																	
7/7/93				40															
7/24/93	37			40 -					-										7
8/11/93																			
8/27/93								\wedge											
9/18/93	35			35 -				-/+			1	-							
10/12/93	29				1			/ \			/								
10/12/93	21							/ \											
11/7/93				30 -	[<u> </u>	\										
11/22/93						\	/		\ /	31.		\				/\			
12/26/93	31					\	/		\ /			\				/ \			
1/15/94	17			25 -		\			\ /			\	\			/	\		
2/3/94	16		_	20 -															
2/19/94	23		ğ			\ /	/		V				\		/				/
	25.2730551	Mean				\vee							_						/
	7.97888864		Total Iron PPIM	20											1		_		/-
			tal												\vee			/	/
			ို														_		
			1	4 =															
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All of the second secon				15 -															
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				10 - 5 -						_						- 86/9	5/94	3/94	9/94
				10 - 5 -						_						./26/93	/15/94	2/3/94	1/19/94
				10 -		6/21/93	7/7/93	7/24/93	8/11/93	8/27/93	9/18/93	10/12/93	10/24/93	11/7/93	11/22/93	12/26/93	1/15/94	2/3/94	2/19/94
				10 - 5 -						_	9/18/93					12/26/93	1/15/94	2/3/94	2/19/94
				10 - 5 -						_	9/18/93	10/12/93				12/26/93	1/15/94	2/3/94	2/19/94
				10 - 5 -						_	9/18/93	10/12/93				12/26/93	1/15/94	2/3/94	2/19/94

Unit # 13870						
CAT 785 Haul						
	ron (ppm/hr)			~.		
7/21/92	0.11			J.R. Simplot	Oil Analysis Sun	nmary
8/10/92	0.136					
8/24/92	0.028					
9/28/92	0.164	0.18				
10/29/92	0.1					
11/18/92	0.12					
12/8/92	0.102	0.16				Λ
1/8/93	0.116		\setminus			\wedge
1/25/93	0.084					
	0.096	0.14				
3/5/93	0.108		1			/
3/30/93	0.124		/	/		/
4/17/93	0.128	0.12			V \	\
5/15/93	0.144			\wedge	\bigvee	\ /\
6/4/93	0.12	· ·		/ \	V	$\bigvee \setminus \bigwedge$
7/7/93	0.128	Lon (ppm/hr)	- V V			* /
8/11/93	0.132	md		\ /		
8/22/93	0.108	d) 1		\bigvee		\/
9/18/93	0.16	5 0.08				
10/7/93	0.128					
10/28/93	0.102					
11/14/93	0.12	0.06				
11/23/93	0.078					
12/11/93	0.108					
1/1/94	0.099	0.04				
1/20/94	0.082		V			
2/5/94	0.062	0.00	,			
	0.11062963 Mean	0.02				
	0.028618375 ST Dev					
			1 1 1 1 1 1	1 (1 1 1		
		0	+ + + + + + + +			
			2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	93 93 93	88 88 88 88 88 88 88	93 93 93 94 94 94
			8/10/92 8/24/92 9/28/92 10/29/92 11/18/92	1/8/93 1/25/93 3/5/93 3/30/93	5/15/93 5/15/93 6/4/93 7/7/93 8/11/93	9/18/93 10/7/93 10/28/93 11/14/93 11/23/93 1/1/94 1/20/94 2/5/94
			8/10/92 8/24/92 9/28/92 10/29/92 11/18/92	1/1 1/2 33/3	74 / 5 / 8 / 8 / 8 / 8 / 8 / 8 / 8 / 8 / 8	9/18/93 10/7/93 10/28/93 11/14/93 11/23/93 1/1/94 1/20/94 2/5/94
	E.:				Date	
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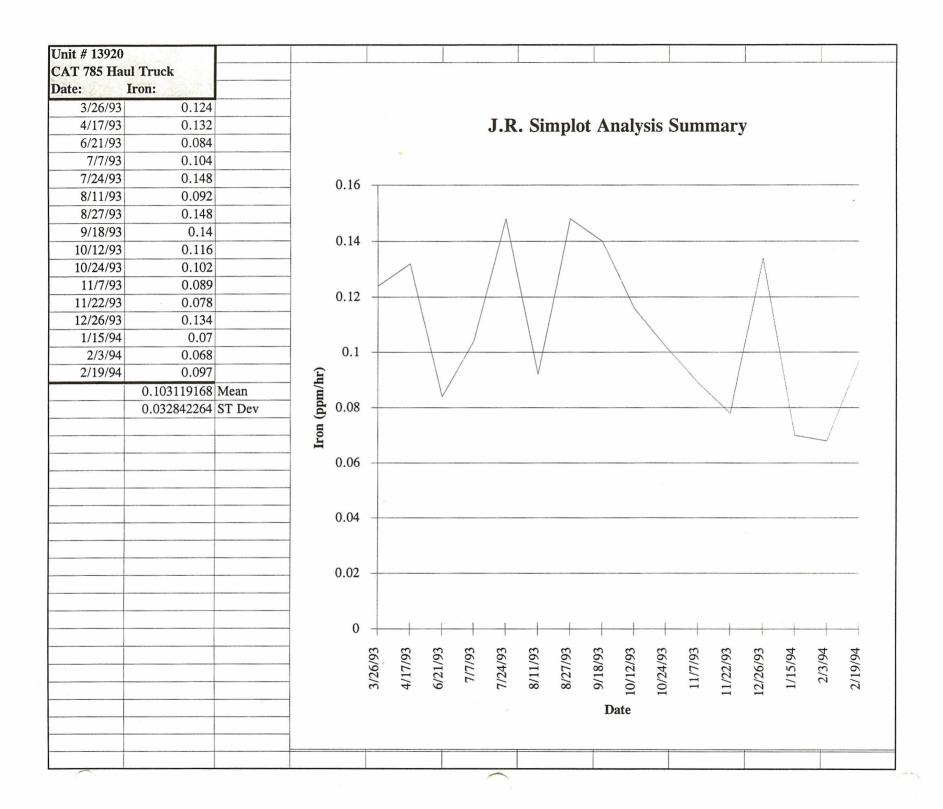
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Unit # 13880	ıl Tenele		-																								
CAT 785 Hau Date:			-																								
Jale.	Iron (ppm/hr) 0.18		-							T	D	Sin	nnl	at C);I	Δnc	l v	ric	Siii	mn	ary	7					
8/4/94	0.18		-							J	17.	וווט	uhi	Ji C	/11		цу	610	Sul		iaij	,					
			_																								
8/24/92	0.096		-																								
9/14/92	0.116			0.2	T																						
9/28/92	0.104																										
10/24/92	0.185		-	0.18					Λ																		
11/16/92	0.148		_	0.16																							
12/4/92	0.086									V																	
12/28/92	0.124		_	0.16	+				1	-			Λ	-	<u></u>			A									
2/11/93	0.16		4							\			1		/		/	/ \									
3/5/93	0.104		4									/			/	(٨						
3/26/93	0.164		_	0.14	+				-	+			+	+		\	/-				1						
4/12/93	0.149		_										\			\vee				/	/ \						
5/1/93	0.132		_	0.12						1										_/	/						
5/27/93	0.144		F	0.12			\wedge				,							-		/							,
6/25/93	0.164		Iron (ppm/hr)				/ \	V		1	/		\						1/	/		\					
7/28/93	0.102		udd	0.1	-	/	/	٧			1		· · · · · · ·						V			_					
8/13/93	0.12		_ l) u			V					\/											1	\ /	1			
9/18/93	0.144		[Lo]								V												V	\			
10/12/93	0.112			0.08	+																			+		/	
10/28/93	0.086		_																					/			
11/17/93	0.097		_	0.06																							
11/23/93	0.059			0.00															2							/	
12/17/93	0.057																										
1/15/94	0.081			0.04																							
2/12/94	0.114																										
	0.121076923																										
	0.034515994	ST Dev		0.02	-																						
				0	\perp																	1					
				U		T	Т	T			1		-	T	T							T					
					8/4/94	8/24/92	9/14/92	9/28/92	/92	/92	12/4/92	2/11/93	3/5/93	3/26/93	4/12/93	5/1/93	5/27/93	6/25/93	7/28/93	8/13/93	/93	10/12/93	/93	5 5	12/17/93	1/15/94	2/12/94
					3/4/	/24	/14,	/28	10/24/92	11/16/92	2/4,	2/128/92	3/5/	126	12	5/1,	127,	125,	/28	/13	9/18/93	77	10/28/93	11/11/95	171	15/	112
					•	8	6	6	10	11/		177	1	3,	4	71	2	9	7	∞	6	10	10,	11/	12)	1	2
		X H													D	ate											
					XIII X					SOMEON OF	Cartical constant		an and a second							urama.	No all March Street, St	_		шрионея		Q4400000000000000000000000000000000000	
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Unit # 13890	¥24,							T									
CAT 785 Hau																	
	ron (ppm/hr)																
7/9/92	0.132						J.R.	Simp	lot Oil	Ana	lvsis	Sun	nma	rv			
7/23/92	0.128										•			•			
8/2/92	0.096																
8/24/92	0.128			0.14													
9/8/92	0.108			0.14													
10/3/92	0.112																
10/12/92	0.092				1) 1	\											
9-Nov	0.092			0.12		1											-1
11/18/92	0.076																
12/21/92	0.076					M											
1/12/93	0.084				\ \ /		\		/								
2/1/93	0.056			0.1	+-V-		1				Λ						•
2/22/93	0.092				, v						Λ				Λ.		
3/17/93	0.093										//						
4/12/93	0.108			0.00			\	Λ			\	\wedge					
4/29/93	0.108		Iron (ppm/hr)	0.08				\mathcal{I}			1		/	\ /	,	1 1	
5/22/93	0.108		bm					\					\bigvee			\ /\	
7/1/93	0.06		<u>a</u>					\			\/					\/ \	
7/20/93	0.1		ron	0.06							<u> </u>						į
8/11/93	0.076		Ţ	0.00				V								1	lo:
8/16/93	0.084																
8/27/93	0.076																
9/18/93	0.072			0.04												Marita in calculate a con-	-
10/3/93	0.08																
10/24/93	0.074																
11/18/93	0.079																
12/4/93	0.093			0.02	-												
12/29/93	0.086																
1/15/94	0.062																
2/10/94	0.08			0		1 1	1 1 1	1 1 1		1 1	1 1	1 1		1 1			1
3/1/94	0.058			0 -							1-1-	1 1					1
	0.086178571			3	76	/92	792	/93	93	93	/93	/93	/93	/93	/93	92 92	,
	0.017828511	ST Dev		00/0/1	8/2/92	9/8/92	10/12/92	1/12/93	2/22/93	5/22/93	7/20/93	8/16/93	9/18/93	10/24/93	12/4/93	1/15/94	:
				,	• •	٥,	10,	1/	9 4	5/	1	8	6	10/	12	3	
		,								Date							
								T									
								<u></u>									

Unit # 13900 CAT 785 Hau Date:	ıl Truck Iron (ppm/hr)		
7/31/92	0.18		I.D. Cimerlet Oil Ameloric Comments
8/20/92	0.124		J.R. Simplot Oil Analysis Summary
9/8/92	0.1		
9/28/92	0.168		
10/24/92	0.16	0.35	
11/16/92	0.152		Į.
12/4/92	0.128		
12/21/92	0.124	0.2	
1/11/93	0.096	0.3	
2/1/93	0.144		
3/5/93	0.18		
4/12/93	0.335	0.25	
5/1/93	0.196	0.25	
5/22/93	0.192		
6/10/93	0.188		
6/21/93	0.088	1 0.2	
6/25/93	0.056	(bbm/hr) 0.2	
7/20/93	0.152	dd)	
7/24/93	0.056	8 0.15	
8/22/93	0.128	을 0.15	
9/18/93	0.112		
10/7/93	0.136		
10/24/93	0.113	0.1	
11/17/93	0.111		
11/23/93	0.054		
12/17/93	0.12		
1/7/94	0.129	0.05	v 1
2/19/94	0.249		
	0.141821429 Mean		
	0.059030471 ST De	v	
		0	
			2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
			7/31/92 8/20/92 9/8/92 9/28/92 10/24/92 11/16/92 12/21/93 2/1/93 3/5/93 5/12/93 6/10/93 6/10/93 6/10/93 9/18/93 10/74/93 11/17/93 11/17/93 11/17/93
			2 9 9 9 10 10 10 10 10 10 10 10 10 10 10 10 10
			Date

nit # 13910 AT 785 Hau	l Truck		
	ron:		
7/1/92	0.112		J.R. Simplot Oil Analysis Summary
	0.117		3.K. Shiplot On Analysis Summary
8/10/92	0.08		
8/31/92	0.084		
9/17/92	0.084	0.16)
10/29/92	0.128		
11/18/92	0.108		
12/14/92	0.087	0.14	1
2/1/93	0.156		
2/19/93	0.08		
3/22/93	0.104	0.12	2
4/2/93	0.108		
4/26/93	0.16		
5/14/93	0.14	0.1	
6/7/93	0.136	2000	· \
6/25/93	0.128	Iron (ppm/hr)	
8/3/93	0.124		
8/16/93	0.116	— (a) 0.08	3
9/4/93	0.144	u ₀ ,	
9/28/93	0.132		
10/7/93	0.096	0.00	5
10/24/93	0.086		
11/14/93	0.085		V V
11/28/93	0.089	0.04	4
12/26/93	0.121		
1/15/94	0.073		
1/29/94	0.048	0.02)
2/18/94	0.12	0.02	
	0.108785714 Mean	1	·
	0.027025855 ST Dev	7 ,	
			26
			8/11/92 8/31/92 8/31/92 10/29/92 11/18/92 2/19/93 3/22/93 4/26/93 6/71/93 6/71/93 6/71/93 10/71/93 11/14/93 11/128/93 11/128/93
			8 8 8 6 11 12 12 12 13 14 15 15 15 15 15 15 15 15 15 15 15 15 15
	7		Date



Unit # 13870 CAT 785 Haul T	ruck						er er															
the state of the s	pper (ppm/hr)																					
7/21/92	0.046								J.]	R. Si	imp	lot (Dil Aı	nalv	sis S	Sumr	narv	7				
8/10/92	0.048		1								·······································			<i>J</i>								
8/24/92	0.012		-																			
9/28/92	0.044			0.08																		
10/29/92	0.028			0.00																		
11/18/92	0.032		-													Λ						
12/8/92	0.021		_													/ \						
1/8/93	0.024			0.07	1					0								Λ				
1/25/93	0.02																	Λ				
	0.052															1	1	/\				
3/5/93	0.044			0.06	+										7	<i></i>		$-\!\!\!\!/-$	-			
3/30/93	0.06													/	/							
4/17/93	0.06																					
8/11/93	0.076			0.05										-/-			\rightarrow					
8/22/93	0.044		<u> </u>			1								/			\/		1			
11/23/93	0.069		Copper (ppm/hr)			\		Ā					\	\checkmark			V		/			
12/11/93	0.046		ıdd	0.04				Λ)			
1/1/94	0.037			0.04				7														
1/20/94	0.03		bbe			1		/ \														
2/5/94	0.022		ි			1			^													
	0.04075	Mean		0.03	+		-		$/\!\!\!/$			-+										
	0.01731405						\ /	V		/											/	
		2					\ /			\	\wedge										,	
				0.02	-		$\bot \bot$					1										
							\ /															
							\bigvee															
×:				0.01			V		200823300	200000000000000000000000000000000000000			0.10		F14 CB2-141							
		*		0.01													***************************************				19 (19) Samuel S	
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	W. 1 - W.			0	+			-			+			-	-							\dashv
					35	32	35	22 23	32	32	93	93	2	5 5	2 5	33	33	33	33	75	46	74
					7/21/92	8/10/92	8/24/92	9/28/92	5/81	12/8/92	1/8/93	1/25/93	275703	56/06/6	4/17/93	8/11/93	8/22/93	23/5	11/5	1/1/94	1/20/94	2/5/94
	***************************************				11.	./8	//8	9/28/92	11/18/92	12,	1	1/2	C	5,5	, 4	8/1	3/8	11/23/93	12/11/93	1	1/2	7
		Y						-					Date									
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															\top			T				

Unit # 13880 CAT 785 Haul	Truck																		
	opper (ppm/hr)																		
	0.2						J.R.	Sim	plot	Oil	Anal	ysis	Sum	ıma	ry				
11/16/92	0.148								•										
12/4/92	0.052																		
12/28/92	0.052		0.2 -	·															
2/11/93	0.124		0.2	Λ															
3/5/93	0.056																		
3/26/93	0.124		0.18	+															
4/12/93	0.096																		
5/1/93	0.088		0.16																
5/27/93	0.096		0.16																
6/25/93	0.068																		
7/28/93	0.046		0.14			***													
8/13/93	0.064																		
9/18/93	0.064					ī													
10/12/93	0.052	Ę.	0.12			$-\Lambda$													-
10/28/93	0.026	m/I				/\	/												
11/17/93	0.03	Copper (ppm/hr)	0.1 -			/ \													
11/23/93	0.016	er (0.1			7				\wedge									
12/17/93	0.021	dd							\										
1/15/94	0.026	ပိ	0.08	-		1													
2/12/94	0.026			\		'	\ /				\								
	0.070238095 Mean		0.01				\/					_							
	0.047453034 ST Dev		0.06				\							\					
			0.04																
			0.01																
															1				
			0.02																
			0	Ī		Ī	1 1	1	1	Ī	1 1	T	ī	ï	Ī	ī	i i	1	1
			0 -						1										
				12/4/92	12/28/92	2/11/93	3/5/93	4/12/93	/93	5/27/93	6/25/93	8/13/93	9/18/93	/93	10/28/93	/93	12/17/93	1/15/94	2/12/94
				11/16/92	/28	/11,	3/5/93	/12/	5/1/93	127,	/25, /28,	/13/	/18,	10/12/93	/28	11/17/93	11/23/93	15/	/12,
				11,	12/	7	. 6	4	71	Ś	9	8	6	10,	10)	11,	11,	1	2
	, ,]	Date								

Unit # 13890 CAT 785 Haul '	Truck	-	-
	opper (ppm/hr)		
7/9/92	0.116		J.R. Simplot Oil Analysis Summary
7/23/92	0.272		
8/2/92	0.136		
8/24/92	0.112	0.35	
9/8/92	0.08	0.33	
10/3/92	0.147		
10/12/92	0.268		
11/9/92	0.304	0.3	
11/18/92	0.24		
12/21/92	0.104		
1/12/93	0.06		
2/1/93	0.04	0.25	
2/22/93	0.04		
3/17/93	0.031		
4/12/93	0.064	E a	
4/29/93	0.048	0.2	
5/22/93	0.056	Copper (ppm/hr)	
7/1/93	0.02	i i	
7/20/93	0.056	d 0.15	
8/11/93	0.02	ි වී	
8/16/93	0.056		
8/27/93	0.048		
9/18/93	0.044	0.1	
10/3/93	0.049		
10/24/93	0.037		
11/18/93	0.033]	
12/4/93	0.04	0.05	
12/29/93	0.043		
1/15/94	0.026		. V V
2/10/94	0.018	0	
3/1/94	0.025		
	0.075321429 Mean		7
	0.075252195 ST Dev		8/2/92 8/2/92 9/8/92 10/12/93 1/12/93 4/12/93 5/22/93 7/20/93 8/16/93 10/24/93 1/15/94 3/1/94
		-	Date
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Unit # 13900 CAT 785 Haul 7 Date: Co	Truck opper (ppm/hr)			
9/8/92	0.144			J.R. Simplot Oil Analysis Summary
11/16/92	0.188			J.K. Simplot On Analysis Summary
12/4/92	0.076			
12/21/92	0.08			
1/11/93	0.08		0.35	
2/1/93	0.112			
3/5/93	0.12			
4/12/93	0.313		0.3	
5/1/93	0.184		0.5	
5/22/93	0.184			
6/10/93	0.096			
6/21/93	0.048		0.25	
6/25/93	0.024			
7/20/93	0.112			
7/24/93	0.04	E		
8/22/93	0.072	Z,	0.2	
9/18/93	0.092	udo		
10/7/93	0.112	Copper (ppm/hr)		
10/24/93	0.056	- Jac	0.15	
11/17/93	0.05		0.15	
11/23/93	0.031			
12/17/93	0.064			
1/7/94	0.058		0.1	
2/19/94	0.098		0.1	
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Unit # 13910					Tr.																
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	opper (ppm/hr)	_											_	. ~							
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6/7/93	0.072	-	0.4.																		
6/25/93	0.036	- (0.14				1	1													
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11/7/93	0.028			0.3	1															
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UHI TECHNICAL BULLETIN

No. 401

January 1993

THE EFFECT OF FPC-1° ON LUBE OIL SOOT LEVELS

Soot in lubricating oil is largely produced by inefficient combustion of diesel fuel. It is composed of the same particles as those escaping from the exhaust stack in the form of smoke. There may be some contribution to soot from lube oil burning, but this is of minor significance.

The presence of soot in the lube oil is of importance because it is a major factor in causing abrasive engine wear. The rate of soot accumulation in the lube oil depends upon the following factors:

- 1) The Rate of Soot Production. This occurs during the combustion process. Soot is formed as a result of inefficient fuel combustion.
- 2) The Rate of Gas Blowby. Soot formed during combustion is forced past the piston rings and accumulates in the lube oil. Here the soot acts like a fine grinding powder contributing to the rate of wear inside the engine.
- 3) The Rate of Soot Contaminant Removal by the Oil Filter. The rate of soot removal may be influenced by soot particle size.
- 4) The Rate of Removal and Dilution of Soot Contaminants due to Oil Burning/Make-up.

Combustion efficiency can be improved by catalysis using FPC-1* Fuel Performance Catalyst fuel treatment. Soot particulate size and mass are reduced, as are soot blowby and accumulation in the lube oil. Research indicates that the reduction in soot particle size and mass may have a positive effect on abrasive wear.

Soot and Abrasive Wear

The contribution of soot to component wear depends upon the size of the soot particles and their relationship to the minimum oil film thickness. For the same load, a bearing of smaller contact surface area will have to rely on a thinner oil film for lubrication. Abrasive wear due to soot will be more severe. For similar bearings under similar loads, the larger the soot particle size, the more severe the abrasive wear. The same applies for all sliding surfaces.

The FPC-1° catalyst has long been known to reduce soot and solids content of the lube oil, thereby reducing abrasive wear. In more severe operations, 50% reduction in liner wear has

been measured.

Wear Trends and Soot Levels

A review of oil analysis records generally shows the expected clear trend to reduced iron and lead profiles, and in most, but not all cases, reduced soot levels. Since the catalyst typically assists in reducing oil consumption by improved cleanliness in piston rings and grooves, it is essential to factor results for oil make-up, to obtain accurate assessment of performance.

Determination of Soot Particle Size and Influence

A study was undertaken to determine the effect of the FPC-1* catalyst on soot particle size. With the cooperation of a major mine operator and equipment dealer, 8 used engine oil samples from a FPC-1* treated site plus 8 anonymous samples (to act as controls) were obtained for comparison. All samples were from the same make engines using identical brands of diesel engine oil. The controls have come from sites not using FPC-1* fuel catalyst.

Microscopic examination of all samples in conjunction with a stage mounted objective micrometer permitted estimation of soot particle size. Refer to Tables I and II.

Table I
Average Soot Particle Size

Cont	rol Group	FPC	Group
Lab No.	Ave. Dia.(um)	Lab No.	Ave. Dia.(um)
11P448	.60	11N315	.1720
11P229	.42	11P544	.1720
11P437	.60	11K334	.1720
11P341	.70	11K336	.1720
11P537	.60	11L330	.1720
11P436	.42	11L314	.2025
11P230	.55	11M334	.1720
11P340	.70	11L329	.1720
Range	.4270		.1725
Average	.52 micron		.19 micron

Because of the small particle sizes encountered in the FPC-1* treated samples and the limited microscope power available, a more precise number than the one given was not possible.

The occurrence of larger soot particles was observed in both groups. The control group contained the largest soot particles observed.

Table IILargest Soot Particle Size

<u>Con</u>	trol Group	FPC	Group
Lab No.	Ave. Dia.(um)	Lab No.	Ave. Dia.(um)
11P448	1.7	11N315	1.0
11P229	1.4	11P544	0.8
11P437	2.1	11K334	1.4
11P341	1.4	11K336	1.4
11P537	2.1	11L330	0.8
11P436	1.4	11L314	1.4
11P230	1.7	11M334	1.0
11P340	1.0	11L329	1.7
Range	1.0-2.1		0.8-1.7
Average	1.6 micron		1.2 micron

The results of this study are consistent with the changes measured in exhaust gases and would appear to confirm the catalyst has the effect of reducing the diameter of the majority of the soot particles to approximately one-third (1/3rd). That is, the mass of the soot particles is reduced to one-twenty-seventh (1/27th). It also appears to provide the explanation for the reduced wear metals profiles observed by FPC-1° users.

A major Central Queensland coal mine has provided some recent documentation of the effect of FPC-1° on reduced engine wear.

FPC-1* was introduced into the fuel for the coal mines mobile fleet. Data from the mine's R&D laboratory in MacKay was used to construct wear profiles. These profiles confirmed substantial wear reductions in the range of 18% to 46% while the fleet operated on FPC-1* treated fuel.

Poor combustion can hamper engine lubrication

One of the major duties of a diesel engine oil is to keep lubricated parts free of deposits, but this function is often hampered by poor combustion, according to Mr Brid Walker regional manager of Queensland company Fuel Technology Pty Ltd.

For engine cleanliness, an oil's detergency/dispersancy package is called upon to remove and suspend deposits that exist. It must also prevent further deposits from forming on surfaces. These contaminants are suspended until they can be removed by the filter or at the next oil change.

Engine deposits can be caused by many factors, such as fouled injectors, overfuelling, incorrect timing, clogged air filters, overextended oil change intervals, altitude and temperature factors, engine condition and application. Whatever the reason, the result is the same — the oil is called on to work harder.

However, assuming good maintenance and operating practices exist, the fuel itself may not burn properly. With today's diesel fuels it's a greater problem. The slower burning fractions of diesel are associated with black smoke and deposit formations.

Deposits tend to form on combustion surfaces such as cylinder heads, valves, piston crowns, top lands, ring grooves, injectors, etc. This promotes a condition which, in itself (because of reduced cylinder compression, poor oil control, poor fuel spray patterns) causes very poor combustion.

While the oil is trying to remove deposits as they form in ring grooves etc, it is also being rapidly taxed by soot reaching it through exhaust blow-by. Soot is damaging. It's an abrasive just like valve grinding paste, only a bit slower. This reduces the oils cleaning ability, which allows deposits to build up faster, increasing blow-by and soot. Higher levels of maintenance are required and operating efficiency and engine life are reduced quite measurably. According to Mr Walker, "lubrication is a bandaid remedy to a combustion problem".

A major Central Queensland coal mine has provided some recent insight into this. In conjunction with Fuel Technology, a combustion catalyst was introduced into the fuel for the mobile fleet. Mr Walker used data from the mine's research and development laboratory in Mackay to construct wear profiles. Substantial wear reductions were noted (in the range 18-46 per cent). Mr Walker said: "With less soot being produced and reaching the lube oil, abrasive wear can be reduced dramatically. The oil can then cope better with keeping ring grooves cleaner and reducing blow-by.

This was confirmed in the fleet of 12 Cummins-powered coal haulers, which

showed an average 58 per cent reduction in oil consumption.

Inspection of a Cat 3412 engine from a Cat 992C loader bore testimony to the benefits of an efficient burn. The engine displayed a complete absence of sludge, with valve covers and sump pan in very clean condition. Cylinder heads, piston crowns exhaust manifolds and turbochargers were coated with a light fluffy layer of soot, which easily wiped off to expose bare metal. Valve part numbers could be clearly read.

Injectors were clean and free of deposits. Inlet and exhaust ports were totally free of any hard deposits. Slight inlet valve stem deposits were noted and these showed signs of erosion. Piston top land deposits were moderate, while rings were free in their grooves and skirts exhibited no varnish.

Overall, the description is one of a very clean engine. But, considering that the engine was overhauled at a programmed change-out, with a total of almost 17,000 hours (original and untouched), its condition can only be described as exceptional. It had burnt catalyst treated fuel for approximately 2400 hours.

The mine has noticed a reduced incidence of carbon related failures during the period of catalyst use. The recent heavy rains in Central Queensland clearly quantified the cost of lost production.

ENGINE DEPOSITS



Sooty Oil High Oil Consumption Valve Failures Bore Polish

LUBRICATION IS A BANDAID SOLUTION TO A COMBUSTION PROBLEM

FTC (using the proven ferrous picrate combustion technology) is a catalyst that assists combustion.

- Engines burn very clean providing substantial fuel savings.
- Abrasive carbon deposits are eliminated.
- Engine life is extended.

FUEL TECHNOLOGY PTY LTD

Brisbane (07) 271 4138 Fremantle (09) 335 6446 or Fax (07) 271 3737

Maintenance of mine equipment saves downtime

The biggest costs to mine production occur when equipment is not being worked. That's usually during strikes, wet, weather and equipment downtime. The latter is directly in the hands of the mines maintenance people and they need to quantify that cost in terms of

dollars per unit per hour.

Consider a large open cut coal mine with daily production valued at \$1,000,000 and a 10 piece fleet of coal haulers able to work 20 hours per day. If downtime in these units causes production bottlenecks, it is costing the mine \$5000 per truck per hour! If a truck drops a valve and is down for 4½ shifts, that costs the mine \$150,000. An engine swap perhaps \$350,000-\$400.000.

Brid Walker of Fuel Technology, Brisbane, has found that a great deal of equipment downtime is due to combus-

tion problems.

While distillate is widely recognised as the major running cost in diesel fleet operations, it is also the most neglected. Walker says that to the majority of maintenance people, diesel fuel is a "black box item". Yet these same people recognise two facts:

Diesel fuel has deteriorated in quality

over the years.

• The performance of diesel engines has increased substantially.

So what happens when diesel fuel specifications limit the performance of engines?

The evidence of decreased combustion efficiency has been staring us in the

face for years.

These days, there is a high incidence of increased — deposit formation, injection fouling, ring sticking, bore polish, high oil consumption, high oil soot, black smoke and valve failures.

There is also decreased fuel efficiency,

and engine life.

Many of these symptoms are regularly perceived as oil related, because often higher quality oils and/or more frequent oil changes can reduce the problem. Additional filtration and use of detergent fuels (as offered by most fuel companies) can also reduce the severity of some of these symptoms.

However, Walker says "these are bandaid remedies to a combustion problem. Make no mistake about it, they treat the

symptom not the cause.

Walker explained that extending the final boiling point of diesel fuel and increased secondary processing has

affected combustion efficiency.

Recent oil analysis studies using the ferrous picrate combustion catalyst (a special type of fuel additive) have quantified reductions in engine wear rates, due to a clearner fuel burn and reduced accumulation of soot in the lube oil. According to Walker, "soot is a good abrasive — it works like valve grinding paste, only a bit slower."

Figure two graphically shows the response to catalyst treatment in a Cummins KTA 38 engine from a fleet of coal haulers. The wear rate is expressed as parts per million of iron per hour, and has been corrected for oil consumption.

For this unit, a wear reduction of 18% was also accompanied by reduced black smoke emissions and a 63% reduction in oil consumption. The regular incidence of valve dropping that had characterised this Cummins fleet has virtually been eliminated.

For this mine, the saving of just one valve failure has more than covered the cost of using the ferrous picrate catalyst for a whole year.

Long term ferrous picrate users have credited the catalyst with extensions in engine life of 15 to 100%, with typical high soot engines benefitting the most.

Brid Walker is regional manager of Fuel Technology Pty Ltd. PO Box 100, Darra, Queensland, 4076. Ph (07) 271

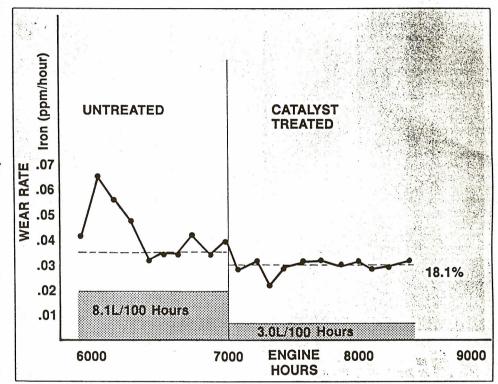


Figure one

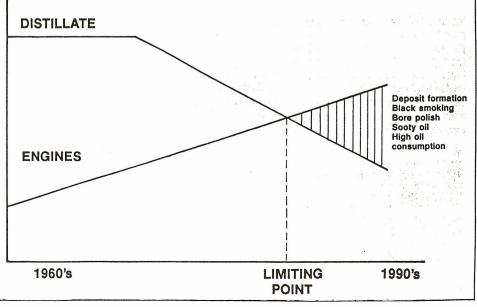


Figure two