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FUEL TECHNOLOGY PTY LTD
(INCORPORATED IN VICTORIA)
29 CREMORNE STREET
RICHMOND, VICTORIA 31 21

11th November, 1986

Mr. Mike Hines,
Marine Operations Superintendent,
Shell Australia Limited,
155 William Street,
MELBOURNE, 3000.

Dear Mr. Hines,

Ref. F.T.C. Combustion Catalyst Trials

I am writing to report the results of the FTC fuel treatment trial on the M.V. Nivosa.

INTRODUCTION

Under your direction, ferrous picrate fuel treatment has been tested as a means of improving combustion efficiency and reducing fuel consumption on the M.T. Cellana, M.S. Conus and M.T. Nivosa. Although there was good evidence of improved combustion and reduced engine deposits in both the Cellana and Conus trials, it was not possible to accurately measure the specific fuel consumption of these ships.

The M.T. Nivosa is equipped with an advanced engine performance monitoring system by which instantaneous fuel consumption can be measured. Between April 21 and October 27 an 'A-B-A' trial was run to establish the levels of fuel consumption with treated and untreated bunkers. Although some of the trial data are subject to qualification, the results indicate that FTC fuel treatment reduces fuel consumption from around 130-131 grams per horsepower hour (42.3 tpd) to a level of 125-126 grams (40.7 tpd). This represents a reduction in fuel consumption in excess of 3%.

This result is slightly higher than the less precise measurements taken during the Cellana and Conus trials.

THE TRIAL

The fuel consumption trial extended over three voyages. Bunkers were first treated in Sydney in April 1986. Dosing of incoming fuel was done by constantly pouring measured amounts of FTC into the bunkers at a rate roughly consistent with fuel flow. The status of bunkers upon leaving Geelong on the outbound leg of the first voyage was that fuel in the bottom of the bunker tanks, the settling tank and holding tank was untreated while 860 tonnes of fresh bunker was well blended with FTC. The untreated fuel was sufficient to power the ship most of the outbound leg. (Refer our letter of 16th April, 1986.)

Fuel taken on in the Gulf was treated in the same manner as in Sydney. The inbound voyage returning to Geelong consumed treated fuel throughout the leg.

The second of the trial voyages took on bunker at Westernport. The fuel was reportedly dosed differently, a measured amount of FTC being charged into the hold sufficient for the entire bunker load which was then loaded. As before the ratio of FTC to fuel was approximately 1:2500. Considering the physical character of the fuel it is doubtful if the FTC was adequately dispersed throughout the bunker. This reportedly would have been the situation on the return leg also. Both legs of the second voyage were dosed but not uniformly. The engine data taken over this voyage is probably sufficient only as a rough indication of consumption levels. (Refer our letter of 28th August, 1986.).

The final voyage between Geelong and Dalian was untreated except for a small amount of fuel carried over from the previous trip. It was estimated this fuel would be consumed within a week of sailing.

In summary, the first leg of Voyage #1 was essentially "untreated". The return leg of Voyage #1 and the entire round trip of Voyage #2 was treated but not all of the fuel treatment was uniform. Voyage #3, Geelong to Dalian was essentially untreated.

Altogether the trial extended over 188 days.

THE DATA

Data from the ship's engine performance monitor and Autronica system have been entered into Tables 1 and 2.

The data is shown against the day of the year (D.O.Y.) starting at day 111 on April 21, 1986.

Table 1 shows the data as read from the records. Table 2 presents the base data subject to the following edit:

(a) The Chief Engineer reported making a correction to the shaft torque meter upon entering the Gulf on the outbound leg of Voyage #1. As is apparent from the RPM and HP values, the torque was being understated. An attempt has been made to normalise the S.F.C. by a factor of 1.0218. That value brings the average RPM/HP ratio into line with other data taken after the fault was corrected. This factor was applied to data for D.O.Y. 111-123.

(b) The engineers on Voyage #2 noted a sea temperature error and made hand-written corrections for D.O.Y. 175, 176 and 177.

(c) Data for D.O.Y. 122 and 123 has been deleted as not being representative of normal sailing. This is indicated by the HP and RPM values.

(d) Data from D.O.Y. 287 through 299 has been deleted because of an apparent specific gravity aberration. As can be seen in the tables, steps in the FTC data occur when new density is entered

into the computer usually as a result of taking on or adjusting for fresh bunker of different density to that in the tanks.

In this case, the fuel taken on at Dalian was indicated to be much lighter than that loaded in Geelong. On days 287 and 291 the S.F.C. was calculated using the old density, 945, when in fact the fuel being consumed was a blend with a density of possibly 900. On days 295 and 299 the S.F.C. was computed using 857 for the fuel density, a figure presumably attributed to the Dalian bunker. This resulted in a sharp decline in S.F.C.

(One cannot be sure of the correct figure but the density of the Dalian bunker given as 857 may be found to be closer to 897.)

(e) The readings were taken on D.O.Y. 208; one in No. 1 cylinder, another in No. 5 cylinder. Although No. 1 cylinder data serves as the trial base, the No. 5 data has been added to Table 2 to give weight to the only reading taken on the inbound leg. (The values measured also correspond to the first set of readings on the following voyage.)

THE RESULTS

The S.F.C. data from Table 1 is plotted on Figure 1 and the edited data in Table 2 is plotted on Figure 2. Figures 2a and 2b refer first (a) to D.O.Y. 148 to the end of Voyage #1 and (b) to the entire Table 2 data for Voyage #2.

Figure 2 shows a parabolic curve drawn to the best statistical fit of the Table 2 data. There are essentially four groups of data points:

1. Voyage #1 outbound leg (factored data)
2. Voyage #1 inbound leg
3. Voyage #2 outbound and return
4. Voyage #3 outbound

Data group 1 establishes a base level for untreated fuel. The mean of these factored values is 129.52 grams/hp hour.

Data from group 2 shows a declining consumption curve which reflects an anticipated engine conditioning period which levels off to the data population shown on Figure 2a. The mean of this new operating level is 125.8 grams/hp hour.

Data from group 3 has a consumption mean of 125.9 grams/hp hour (shown on Figure 2b).

Group 4 data shows two effects:
1. the step effect of changing fuel density on Day 252, and
2. between D.O.Y. 252 and roughly 260, the change in fuel consumption as a result of returning to untreated fuel (deconditioning). The new level of consumption for totally untreated fuel shown from day 257 onward calculates at a mean value of 130.7 grams/hp hour. (This value compares with the 129.5 arrived at for Voyage 41 outbound from a factored calculation.)

THE CONCLUSION

The level taken from untreated fuel consumption is conservatively 130 grams/hp hour.

The level taken for treated fuel consumption is 125.9, say 126 grams/hp hour.

The saving in fuel consumption from FTC fuel treatment is:

$$\frac{(130-126)}{130} X 100 = 3.08\%$$

This figure, 3%, compares with savings measured on large stationary engines, for example, the 18 cylinder 15 megawatt MAN burning heavy oil at the Port Hedland power station.

This demonstrated improvement in combustion efficiency is also consistent with visual evidence in many engines, including the Cellana and Conus, of cleaner combustion chambers as a result of periods run on FTC treated fuel.

THE RECOMMENDATIONS

Our recommendations are fourfold.

1. FTC fuel treatment has been demonstrated to economically reduce fuel consumption, improve engine cleanliness and significantly reduce maintenance requirements.

   We recommend you commence fuel treatment throughout your marine system including main engine and auxiliary power generation fuels. The recommended rate of FTC fuel treatment is 1:2500 for an initial period reducing to 1:3000.

2. Fuel Technology has engineering experience with design, construction and installation of automatic fuel dosing systems. We recommend that at an appropriate time we investigate with your engineers a means of automatically treating all your marine fuel systems from shore-mounted installations.

3. The improvements in engine performance demonstrated over the three years of testing in your ships has also been demonstrated in stationary and mobile equipment including power stations, mine loading and hauling equipment and in conventional road transport where fuel savings in excess of 6% are normally experienced. We recommend that Fuel Technology and your company examine the manner by which these fuel and maintenance savings (including savings in capital plant) can be made available throughout your operations.

4. Fuel Technology offers to clients a Performance Tracking Service by which the combustion performance of various types of equipment is monitored through record analysis and maintenance investigations. We have an affiliation with the analytical firm of Sharp & Howells Pty Ltd with whom we collaborate in these services.

We recommend that we continue to monitor the performance of your marine fleet and report trends in these operations and makes recommendations based on our observations and experience

CONCLUSIONS

We thank you and your organization for the assistance and direction in the conduct of the work described in this report. We would be grateful to have your comment on our findings and your response to our recommendations.

Yours faithfully,
FUEL TECHNOLOGY PTY LTD

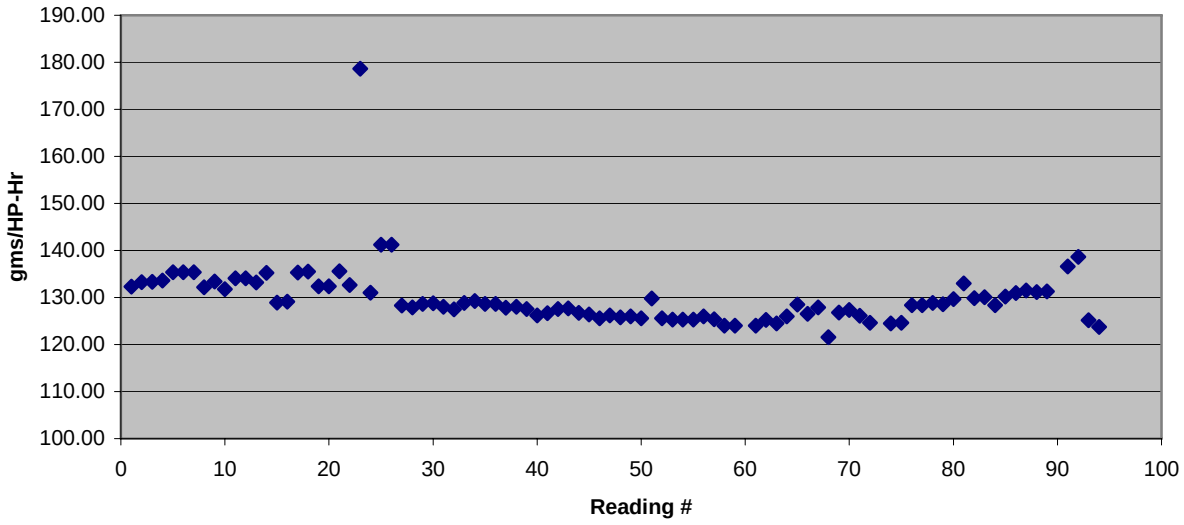
RJS/wb
Attach.

M.T.NIVOSA
OPERATIONAL DATA COMMENCING APR 21, 1986 **TABLE 1**

D.O.Y.	DENSITY	S.F.C.	RPM	HP	REMARKS
111	934	132.31	78.70	13573.6	Outbound #1
112		133.24	78.60	13744.7	
112		133.31	78.50	13645.3	
112		133.60	79.00	13661.6	
113		135.39	77.90	13670.7	
113		135.39	78.10	13670.7	
113		135.39	78.40	13670.7	
114		132.17	78.60	13728.8	
114		133.38	78.50	13505.6	
115		131.78	78.39	13720.9	
116	938	134.09	78.02	13478.1	
116		134.09	77.70	13478.1	
117		133.22	78.70	13763.4	
117		135.22	78.10	13577.0	
118		128.91	79.20	13904.5	
118		129.09	79.20	13907.2	
119		135.34	77.50	13281.5	
119		135.53	77.70	13159.9	
120		132.38	78.20	13301.0	
120		132.38	77.90	13301.0	
121		135.59	77.80	13091.7	
121		132.65	78.10	13150.4	
122		178.66	67.10	8800.3	
122		131.04	67.00	8884.9	
123		141.21	66.70	8353.4	
123		141.21	66.40	8353.4	
140		128.33	76.30	13481.2	Inbound #1
140		127.90	76.40	13647.0	
141		128.61	76.00	13830.8	
141		128.80	76.00	13866.4	
142		128.04	76.10	13595.4	
142		127.46	76.10	13591.3	
143		128.86	75.10	13607.4	
143		129.25	75.00	13439.4	
144		128.67	75.80	13888.2	
144		128.65	75.90	13790.3	
145	918	127.81	74.40	13857.0	
145		128.06	74.40	13769.1	
146		127.56	74.40	13923.0	
146		126.22	74.60	13530.7	
147		126.65	72.40	13719.6	
147		127.57	72.80	13760.2	
148		127.71	73.00	13269.5	
148		126.75	73.70	13076.0	

149		126.42	75.70	13493.7	
149		125.60	75.50	13932.6	
150		126.18	75.80	13749.8	
150		125.80	76.50	13565.7	
151	918	126.00	76.30	13350.6	
151	918	125.55	76.00	13903.8	
152		129.81	75.40	13432.3	
152		125.58	75.40	13725.0	
154		125.33	76.00	13723.7	
154		125.33	76.00	13723.7	
154		125.33	76.00	13723.7	
155		126.01	76.10	13222.4	
155		125.36	75.70	14231.7	
157		124.04	75.10	13375.3	
157	918	124.04	75.20	13375.3	6/6/86
174	918	124.04	76.50	13556.3	24/6/86
175		125.26	76.17	13607.7	Outbound #2
176		124.49	78.16	13543.8	
177		125.99	77.30	13585.5	
180		128.49	77.65	13754.7	
181		126.54	77.74	13686.1	
183		127.87	77.50	13477.8	
184		121.59	78.11	13829.6	
185		126.80	77.27	13392.6	
188		127.33	74.70	13422.2	
189		126.09	74.66	13619.8	Inbound #2
208	918	124.60	75.90	13642.6	28/7/86
250	923	124.51	76.36	13621.2	8/9/86
251		124.64	76.14	13830.7	Outbound #3
252	944	128.38	75.97	13863.6	
253		128.35	76.46	14165.8	
254		128.82	75.65	13217.0	
255		128.60	75.84	13393.9	
256		129.66	76.92	13785.2	
257	945	132.98	75.24	13358.9	
258		129.87	75.30	13484.4	
259		130.07	75.53	13318.3	
260		128.39	75.78	13406.4	
261		130.22	76.32	13569.5	
262		130.92	76.20	13399.4	
263		131.49	75.99	13295.0	New injectors fitted
280		131.13	76.70	13464.5	
283		131.30	77.06	13402.4	End of trial
287		136.62	76.06	13496.8	Dalian Fuel Mix
291		138.67	76.06	13085.9	
295	857	125.16	76.30	13038.8	Dalian Fuel
299	857	123.72	76.91	13469.9	27/10/86

Fig. 1
M.V. Nivosa Fuel Consumption Trial
Data from engine performance monitor



M.T.NIVOSA
(EDITED) OPERATIONAL DATA **TABLE 2**

D.O.Y.	DENSITY	S.F.C.	RPM	HP	Average
111	934	129.49	78.70	13573.6	
112		130.40	78.60	13744.7	
112		130.47	78.50	13645.3	
112		130.75	79.00	13661.6	
113		132.50	77.90	13670.7	
113		132.50	78.10	13670.7	
113		132.50	78.40	13670.7	
114		129.35	78.60	13728.8	
114		130.53	78.50	13505.6	
115		128.97	78.39	13720.9	
116	938	131.23	78.02	13478.1	
116		131.23	77.70	13478.1	
117		130.38	78.70	13763.4	
117		132.34	78.10	13577.0	
118		126.16	79.20	13904.5	
118		126.34	79.20	13907.2	
119		132.45	77.50	13281.5	
119		132.64	77.70	13159.9	
120		129.56	78.20	13301.0	
120		129.56	77.90	13301.0	
121		132.70	77.80	13091.7	
121		129.82	78.10	13150.4	
140		128.33	76.30	13481.2	
140		127.90	76.40	13647.0	
141		128.61	76.00	13830.8	
141		128.80	76.00	13866.4	
142		128.04	76.10	13595.4	
142		127.46	76.10	13591.3	
143		128.86	75.10	13607.4	
143		129.25	75.00	13439.4	
144		128.67	75.80	13888.2	
144		128.65	75.90	13790.3	
145	918	127.81	74.40	13857.0	
145		128.06	74.40	13769.1	
146		127.56	74.40	13923.0	
146		126.22	74.60	13530.7	
147		126.65	72.40	13719.6	
147		127.57	72.80	13760.2	
148		127.71	73.00	13269.5	
148		126.75	73.70	13076.0	
149		126.42	75.70	13493.7	
149		125.60	75.50	13932.6	
150		126.18	75.80	13749.8	
150		125.80	76.50	13565.7	

151		126.00	76.30	13350.6	
151		125.55	76.00	13903.8	
152		129.81	75.40	13432.3	
152		125.58	75.40	13725.0	
154		125.33	76.00	13723.7	
154	918	125.33	76.00	13723.7	
154	918	125.33	76.00	13723.7	
155		126.01	76.10	13222.4	
155		125.36	75.70	14231.7	
157		124.04	75.10	13375.3	
157	918	124.04	75.20	13375.3	128.38

174	918	124.04	76.50	13556.3	
175		125.60	76.17	13607.7	
176		125.80	78.16	13543.8	
177		126.70	77.30	13585.5	
180		128.49	77.65	13754.7	
181		126.54	77.74	13686.1	
183		127.87	77.50	13477.8	
184		121.59	78.11	13829.6	
185		126.80	77.27	13392.6	
188		127.33	74.70	13422.2	
189		126.09	74.66	13619.8	
208		124.60	75.90	13642.6	
208	918	125.01	75.97	13757.7	125.88

250	923	124.51	76.36	13621.2	
251		124.64	76.14	13830.7	
252	944	128.38	75.97	13863.6	
253		128.35	76.46	14165.8	
254		128.82	75.65	13217.0	
255		128.60	75.84	13393.9	
256		129.66	76.92	13785.2	
257	945	132.98	75.24	13358.9	
258		129.87	75.30	13484.4	
259		130.07	75.53	13318.3	
260		128.39	75.78	13406.4	
261		130.22	76.32	13569.5	
262		130.92	76.20	13399.4	
263		131.49	75.99	13295.0	
280		131.13	76.70	13464.5	
283		131.30	77.06	13402.4	129.33

Fig. 2
M.V. Nivosa Fuel Consumption Trial
Data from Table 2

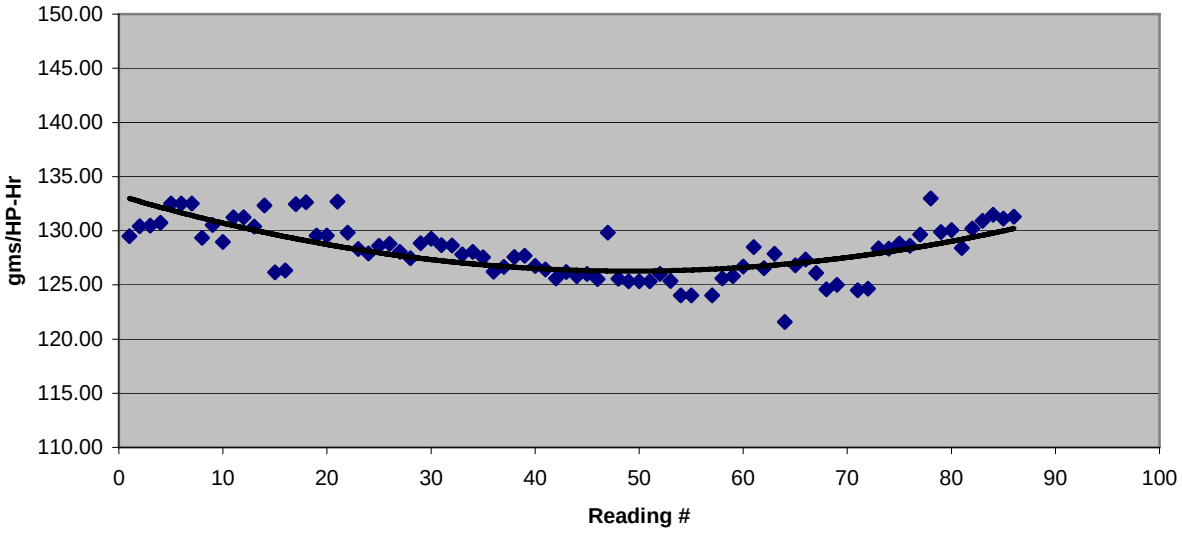


Fig. 2a

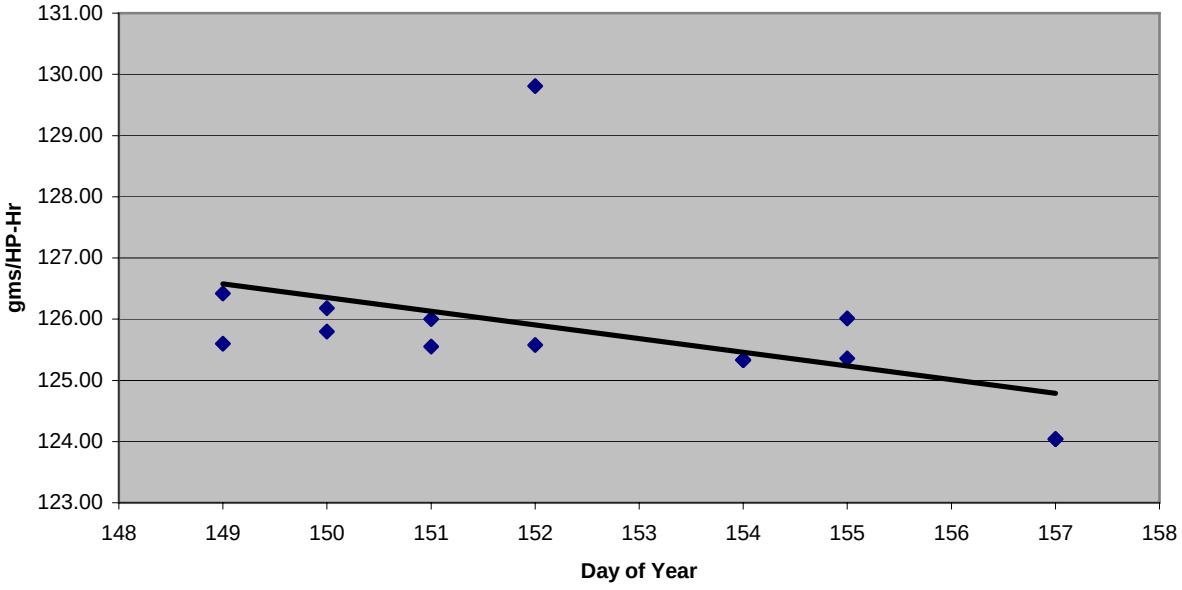
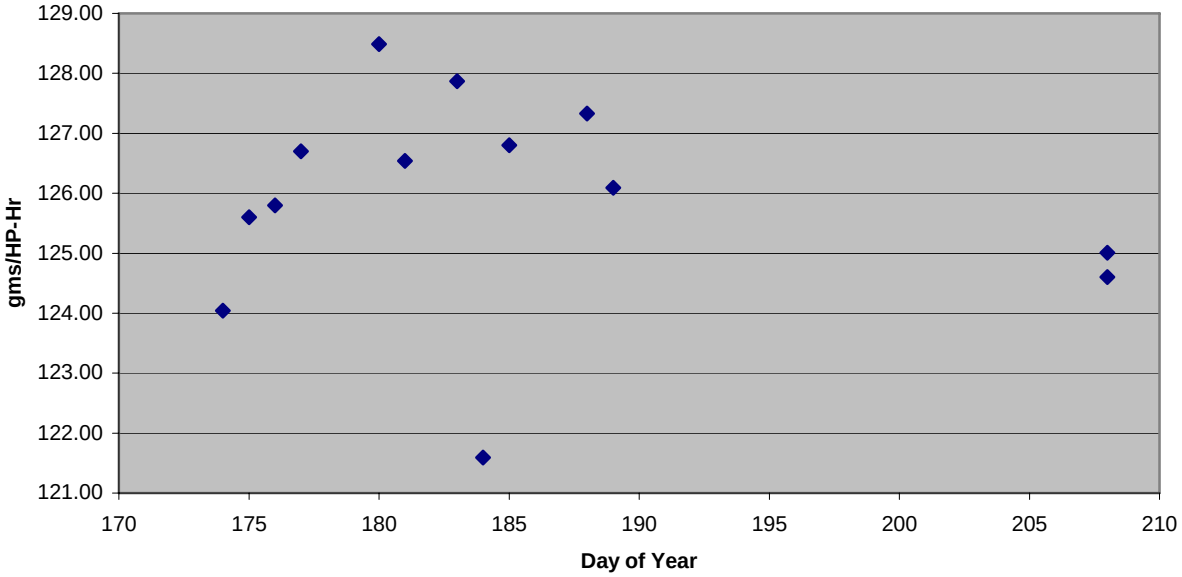


Fig. 2b


129.00
128.00
127.00
126.00
125.00
124.00
123.00
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121.00
gms/HP-Hr
170
175
180
185
190
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200
205
210
Day of Year