SEA FISH INDUSTRY AUTHORITY

Seafish Technology

INVESTIGATION ON "MARANATHA II" (UL33)

JANUARY 1992

Consultancy Report No.50

H. R. English

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1. INTRODUCTION

The vessel was delivered in 1989 and, since that time, has suffered a number of partial failures of the propulsion engine, a Caterpillar 3508, rated at 765 hp at 1440 revs/min. The failures have taken the form of premature failure of inlet and exhaust values. At or about the time of failure excessive lub oil consumption has been noted.

A number of modifications have been tested in service including use of different valve types and also of valves with different seat face angles but no satisfactory solution has been found. A recent further modification involving the use of oil seals on the valve stems was applied in November 1991 but has not yet proved itself in practise given that the hours run since that time amount to about 4000 hours. Representatives of the engine suppliers have attended the vessel on a number of occasions. Given that the period of engine guarantee will soon expire the owners and insurers wished to assure themselves that all possible steps were being taken to resolve the problem. Mr. Grant Scott and staff of the Sea Fish Industry Authority were engaged by the insurers to carry out independent investigations, including review of such information as already existed on previous failure. An initial visit was made to the vessel on December 15th, 1991 during which the vessel layout was inspected and discussions were held with both of the vessel's usual skippers. A printout from a data logger exercise previously carried out by the engine supplier (Finnings) was also inspected.

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Following these initial enquiries it was concluded that there was no evidence of any excessive loading either from the data printout or the skippers' own records. The data printout offered good information on steady state parameters (e.g. towing or steaming over continuous periods) but could not provide information during transient situations such as during shooting or hauling. While it would be unwise to prejudge any of the options of causes of the failures it was considered that it would be useful to investigate the loadings associated with gear handling (hauling and shooting) operations. It could be foreseen that such loadings would include periods of running at zero power output (gearbox input shaft and built in engine pumps apart) since the skippers had already commented that it was common practice to declutch the propeller shaft when handling the catch on board and it was noted that no external power takeoffs where fitted to the engine. Arrangements were therefore made to carry out an instrumented trial during a vessel turn round period. In the event the instrumented package was fitted to the vessel at Peterhead on January 27th and 28th 1992 and sea trials took place on January 30th 1992.

2.TRIALS INSTRUMENTATION

The vessel was fitted with the instrumentation package as listed below:-

Shaft torque bridge with transmitter

Shaft Speed Meter

Engine Speed Meter

Boost Pressure Transducer

Exhaust Pyrometer (mounted in the port turbocharger discharge trunk)

Fuel Flow Meter

Cooling Water Outlet and Inlet temperature gauges (mounted on the fresh water pipes to and from the SW cooler)

Warp Tension Meters (for use during towing trials)

All parameters were recorded using an Orion type Data Logger which could be programmed to provide analysis of the data collected and to produce mean and standard deviation values over selected periods. In the event periods of 10 seconds and 1 minute were chosen as being most appropriate in different circumstances.

A water manometer device was provided to measure back pressures at the lower end of the crankcase breather pipe (i.e. at the elbow position adjacent to the cylinder head cover). Periodic records were taken from it during the trials. Vessel heading and speed records were taken from the vessel's own instruments.

Messrs. Hairsine, Horton and Greenwood carried out the trials installation and attended the trials.

Mr. Scott Allan attended the trials on an independent basis and took a series of vibration frequency and amplitude recordings during the trials sequence.

A representative from the winch suppliers was also in attendance to carry out modifications to the vessel's winches control system but this did not involve any interference with the trials procedure.

3.TRIALS PROCEDURE AND RESULTS

The vessel left Peterhead at 10.30 hours on Thursday 30th January 1992. A number of steaming trials records were taken during the outward passage to the grounds. The vessels own demersal net was then shot away, towed for about 40 minutes then hauled again. During the tow a variety of engine speed/propeller pitch combinations were selected and all parameters recorded. During shooting and hauling the skipper handled the vessel in his normal manner and continuous records were taken of the whole sequence. The shoot, towing, hauling cycle was repeated and further records collected. After a brief pause to allow of adjustments to the winch auto trawl settings the vessel was steamed to Peterhead, arriving at 17.30 hours.

A selection of the results obtained from the trials are given in Tables 1 to 3 and Figures 1 to 4. Figure 1 shows the range of powers/speeds recorded during the different activities while Figures 2,3 and 4 show changes in parameters recorded during shooting, hauling and steaming respectively.

4.DISCUSSIONS OF RESULTS

It should be noted that Figure 1 is overlaid on Caterpillar Performance Curve TE0017-00 and that this refers to the manufacturers quoted rating of 855 hp at 1800 revs/min. The rating of the engine installed on the "Maranatha II" is quoted at 775 hp at 1440 revs/min. This is about 2% below the performance curve value at full power (i.e. at 1440 revs/min) and may vary by more or less than this value at lower engine speeds. However it can be seen that actual powers recorded were much lower than the performance curve and that the matter is thus of little importance.

All powers recorded during steaming or any of the fishing operations are well within the performance curve of the engine as can be seen in Figure 1. The range of powers used during hauling is particularly low and reflects the skippers handling of winch and vessel during hauling. It is common practice to run the winch at its fastest hauling speed, reducing engine speed and propeller pitch in order to limit forward thrust and thus pull on the winches. This generally gives the minimum hauling time. Vessel speed falls to the range 0 to 1 knot during this sequence. The hauling sequence is shown in Parameter v. Time format in Figure 3. Changes in power shown are consistent with the movements of speed and pitch control and with the demands during a typical hauling sequence. However it should be noted that the water depth in the trials area was only some 40 fathoms; the vessel has fished in waters some 10 times as deep as this and the hauling period would then be extended by about the same ratio. Engine operational parameters (Lub Oil Pressure, Boost Pressure and Exhaust Temp) all appear normal as does the Cooling Water Outlet Temp (not plotted on the graph) which falls by about 2°C during the hauling sequence.

The shooting sequence (Figure 2) is as would be predicted for any stern trawler; a period of low power manoeuvring while the gear is shot away (with checks to ensure that it is not foul) followed by a high power boost to spread the gear, followed in turn by release of the warps and with a final reduction of power when the winch brakes have been applied. The final portion of Figure 2 shows power adjustments by the skipper in selecting the correct towing speed. In all this the engine operating parameters are well within manufacturers stated limits.

The steaming sequence (Figure 4) taken during the run into Peterhead again shows nothing untoward.

In addressing the problem that the engine on this vessel is subject to frequent valve failures while other engines in similar applications are not it is necessary to consider whether some aspects of the application of this particular engine to this duty may be unusual or whether some aspect of the installation may be relevant to the problem. A number of unusual (or "less usual") factors are discussed below. It cannot be considered that they necessarily indicate the source of the problem but are offered as areas for further investigation should the current modification prove ineffective.

(i) Absence of Forward Power Taken Off Loads:

It is quite common for the winch on a modern trawler to be powered from an auxiliary engine, but less common for there to be no takeoff loads at all. Typically such loads as generator sets, sea water cooling pumps or even a winch autotrawl pump would provide a base load ranging from 20 to about 70 hp. This would reduce the effect of changes in shaft power which are common during shooting and hauling. It is suggested that differential cooling by the cylinder head components might lead to increased oil transfer down the valve stems particularly when hauling and that this might be a cause of problems. The skipper has commented that the problem tends to become evident (by obvious blowing through a valve port) to the crew and himself immediately after hauling but this might reflect the combination of lower noise levels, crew on deck, open doors and windows rather than the true onset of valve leakage.

It is not known whether the torsional calculations prepared for the original engine installation assumed one or more power takeoffs for the engine in addition to the propeller shaft. If the calculations have been made on an incorrect assumption it is possible that an incorrect torsional damper has been fitted. It is known that this is being investigated independently by Mr. S. Allen.

(ii) Use of Controllable Pitch Propeller:

This is by no means an uncommon situation but may be of some significance in conjunction with (i) above. For a marine propulsion engine driving a fixed pitch propeller the power demand at different engine speeds would not fall below the propeller demand curve. Figure 1 shows the manufacturers curve for the engine at its higher power/speed rating (P), together with a calculated curve (P_M) to represent the circumstances of the engine at its current power/speed rating with a fixed pitch propeller. The use of a controllable pitch propeller on this vessel allows of power/speed combinations well below the P_M curve, as shown in Figure 1. Only the engine manufacturer could comment on whether this might cause effects such as undercooling in the air inlet passages, due to the possibility of excessive air supplies being provided from the turbocharger. The point is raised since operation of an engine in the low power/middle speed regimes noted on the vessel trials might not be an important part of the manufacturers test procedures on their own engines. There is no evidence of "abnormal" temperature changes to be detected from exhaust temperature readings for example.

(iii) Engine Room Ventilation:

A feature of operation of the vessel is the performance of the engine room ventilation system. Whereas many vessels inspected have problems in maintaining adequate ventilation for this space the engine room on the "Maranatha II" was noticeably cool; typical temperatures in the space above the engine were about 27°C while air temperatures at the engine air intake fell to as low as 19°C (outside temperatures were of the order of 5°C at this time). The relatively low engine room temperatures possibly reflect a mismatch between the shipbuilders' requirement to meet the demands of the engine operating at its full rating and powers which are demanded in actual fishing operations on this vessel. The operating circumstances would, of course, not be unusual in a land-mobile application of this engine.

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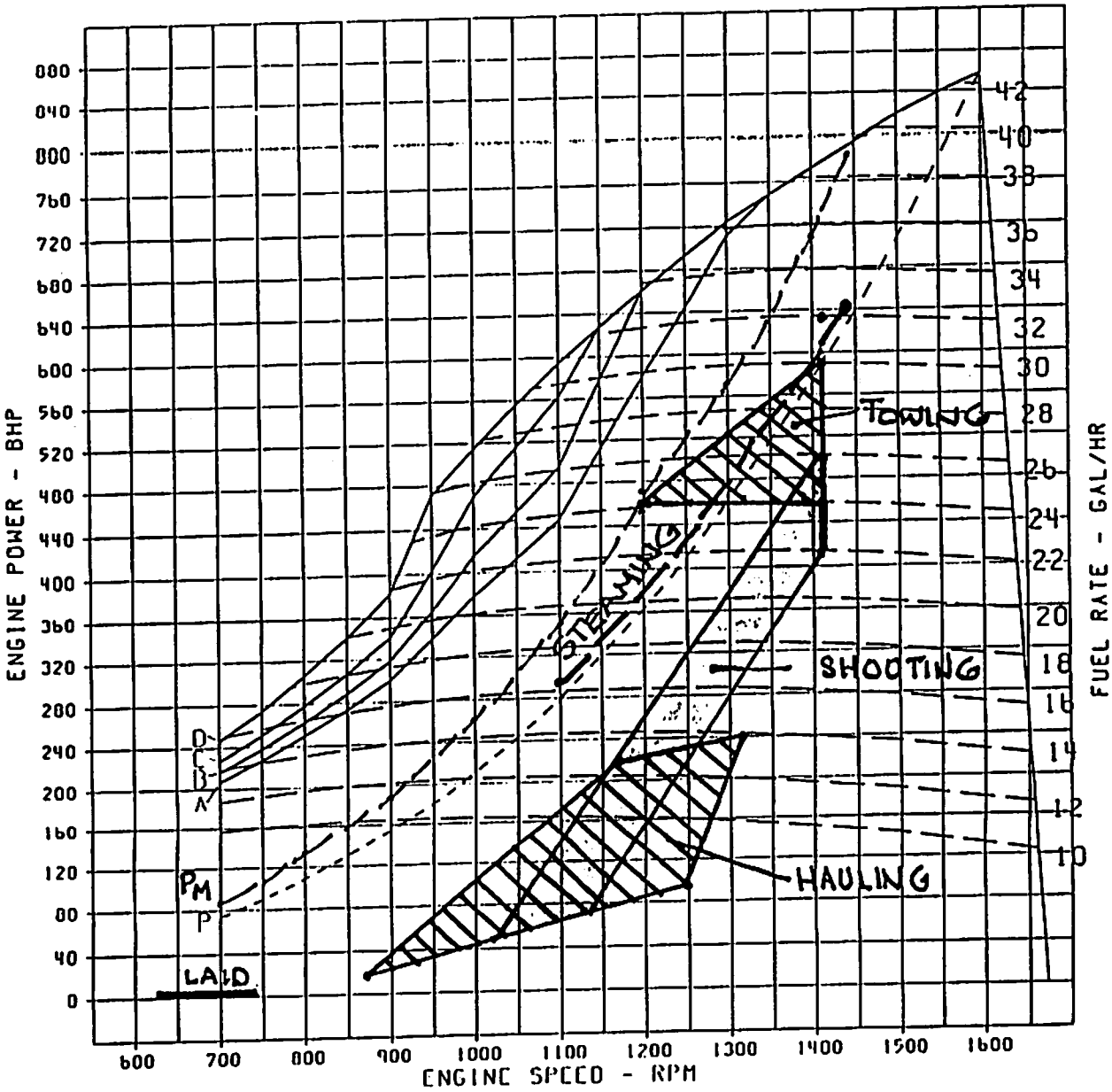
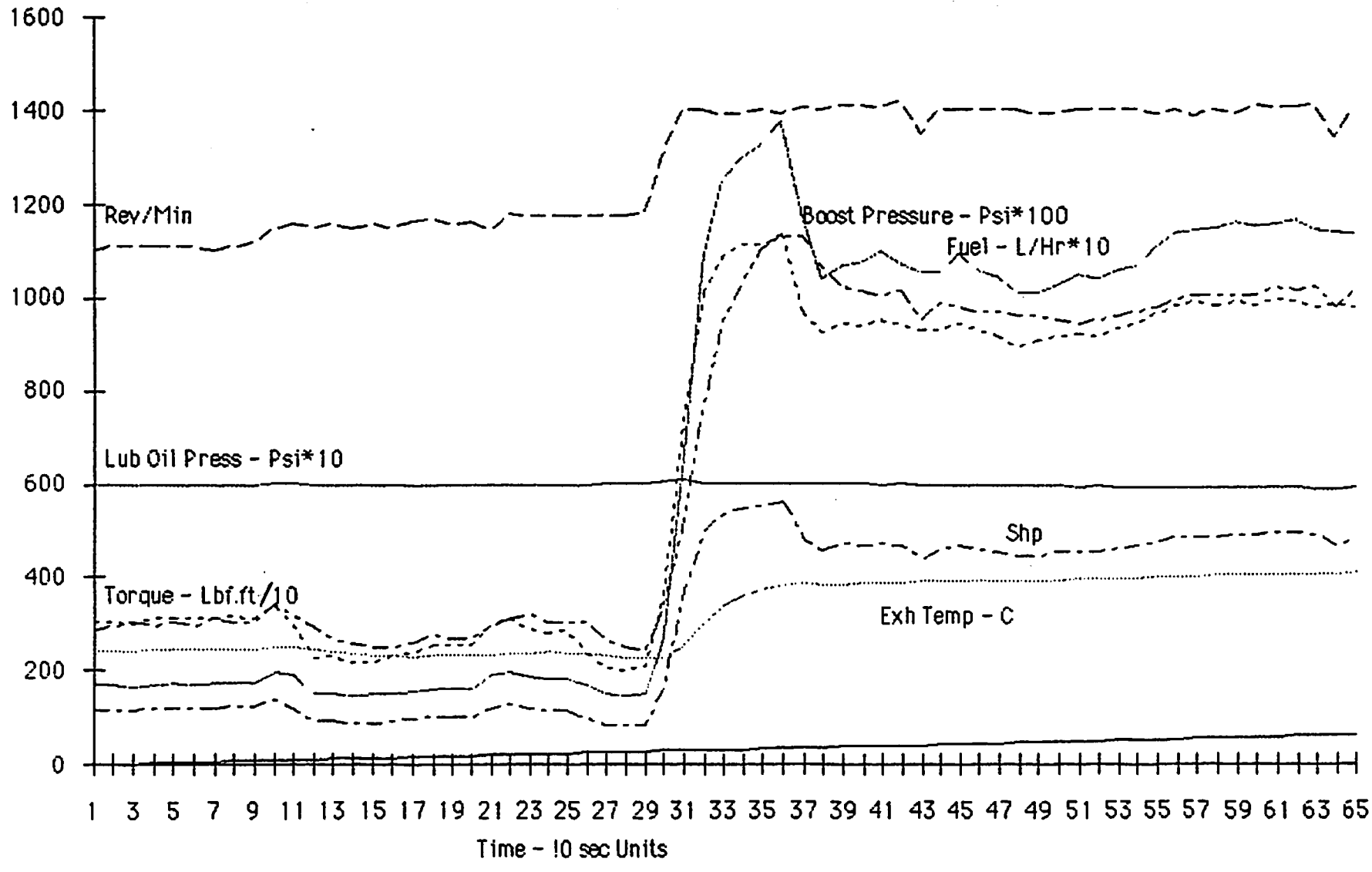


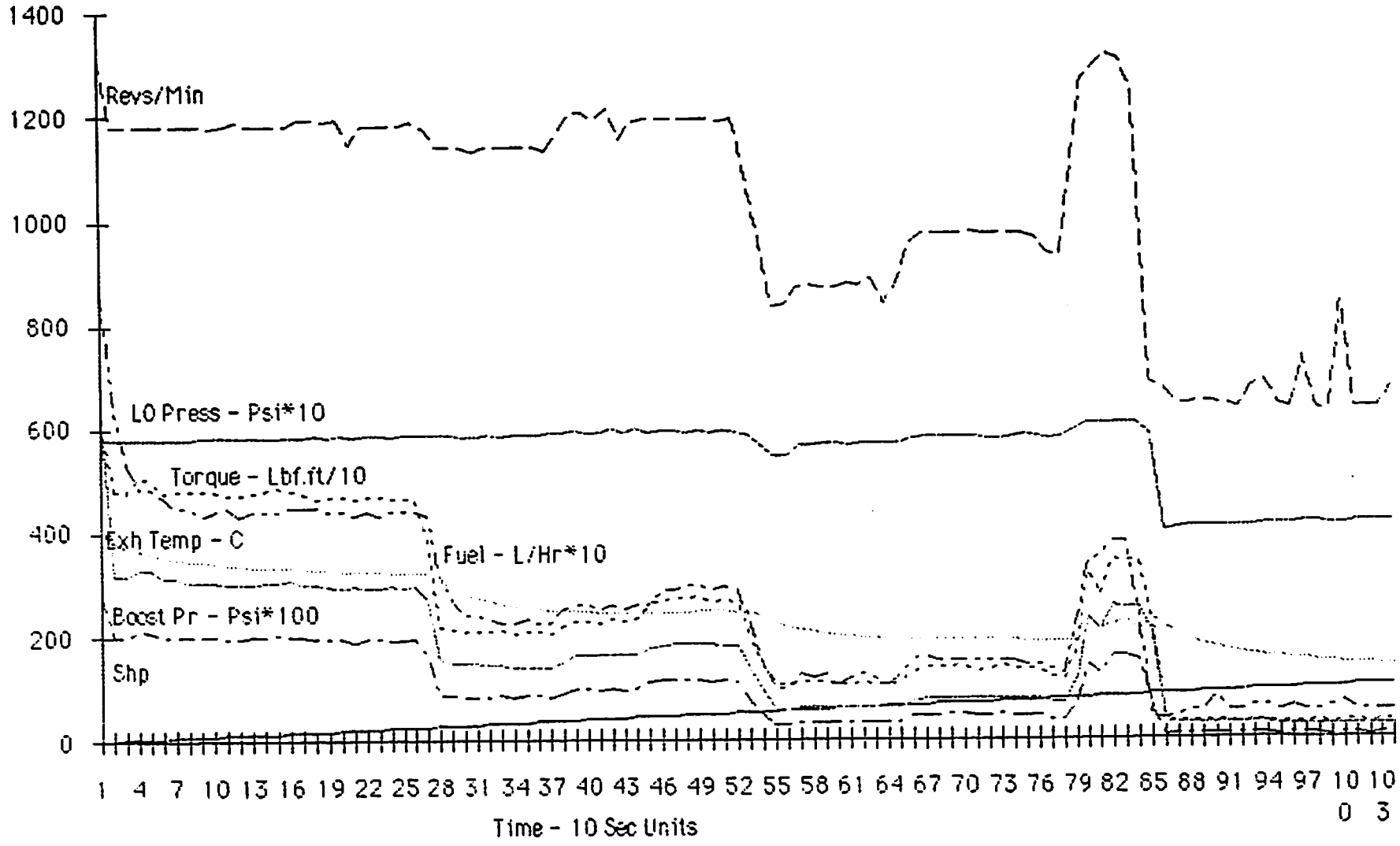
CAT	MARINE ENGINE PERFORMANCE - CONTINUOUS	MODEL 3508	TE0017-00

Maranatha II - Engine Power / Speed Relationships Fig1



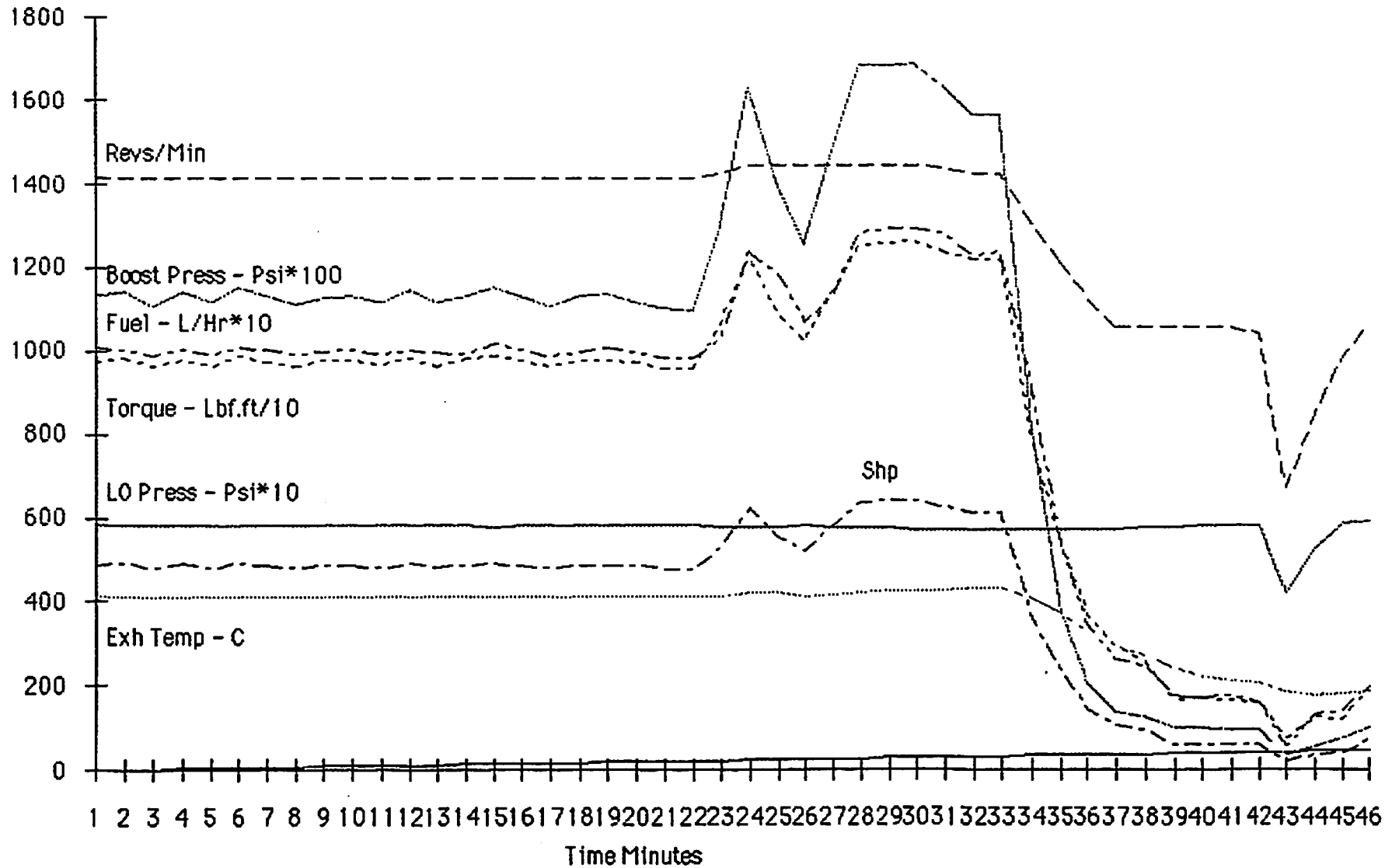
Maranatha II - Engine Parameters While Shooting

Fig 2



Maranatha II - Engine Parameters while Hauling

Fig3



Maranatha II - Engine Parameters while Steaming.

Fig 4

SHOOT3	Rev/Min	Torque	SHP	Fuel L/hr	Boost Psi	LO Psi	Exh DegC
Mult Factor	1	0.1	1	10	100	10	1
Time: 10sec							
1	1104	304	118	288	169	599	243
2	1110	304	119	297	169	597	243
3	1110	301	118	306	168	597	244
4	1110	312	122	297	171	597	244
5	1110	313	123	306	173	598	245
6	1110	313	122	297	171	596	245
7	1104	311	121	315	173	597	246
8	1110	318	125	306	173	596	246
9	1122	313	124	306	176	597	247
10	1152	338	137	342	199	601	249
11	1158	299	122	324	191	601	250
12	1152	229	93	297	155	600	246
13	1158	231	94	270	153	600	240
14	1152	221	90	261	150	597	237
15	1158	221	90	252	151	597	233
16	1152	233	95	252	153	598	231
17	1164	238	98	261	156	599	230
18	1170	255	105	279	162	598	231
19	1158	254	104	270	161	599	231
20	1164	256	105	270	160	599	231
21	1146	302	122	297	192	599	233
22	1182	311	130	315	196	600	237
23	1176	290	120	324	187	599	239
24	1176	282	117	306	183	598	239
25	1176	285	118	306	184	599	239
26	1176	235	98	306	171	600	239
27	1176	205	85	270	151	601	235
28	1176	203	84	252	148	601	230
29	1182	208	87	243	151	601	227
30	1302	362	166	333	270	606	230
31	1404	737	365	522	650	610	256
32	1404	1011	500	774	1091	605	304
33	1398	1089	537	945	1249	604	339
34	1398	1115	549	1035	1301	602	361
35	1404	1117	553	1107	1331	602	374
36	1398	1138	561	1134	1380	601	384
37	1410	973	484	1134	1173	603	387
38	1404	929	460	1071	1045	604	385
39	1416	945	472	1026	1072	602	385
40	1416	944	471	1017	1078	602	387
41	1410	954	474	1008	1101	600	389
42	1422	940	471	1017	1076	603	390
43	1350	931	443	954	1058	600	391
44	1404	933	462	990	1058	599	392
45	1404	947	469	981	1098	599	394
46	1404	932	461	972	1063	599	395
47	1404	921	456	972	1047	599	395
48	1404	898	445	963	1015	600	395
49	1398	908	448	963	1013	598	395