SEA FISH INDUSTRY AUTHORITY

Industrial Development Unit

NOISE LEVELS ON MFV "OCEAN CHALLENGE" BEFORE AND AFTER INSTALLATION OF A HIGHLY SKEWED PROPELLER

Internal Report No. 1265

N. Ward

January 1986

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SUMMARY

The skipper of the newly built MFV "Ocean Challenge" had complained about high noise levels in the crew cabin aboard the vessel, so the builders agreed to change the propeller to one of a highly skewed design.

The SFIA were invited to record noise levels and vessel performance both with the original conventional propeller and the new highly skewed propeller.

Noise levels at the noisiest point in the cabin were found to have dropped by 4 decibels (A-weighted scale), or 25% in perceived noise terms, at full engine r.p.m. with the new propeller.

The vessel performance with the new propeller was not found to have altered significantly.

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1. INTRODUCTION

The investigation described in this report was brought about by an invitation from Macduff Boatbuilding and Engineering Co. to the Industrial Development Unit of the SFIA.

The owner of MFV OCEAN CHALLENGE (BF 85) had stated to the yard that there was excessive noise in the crew cabin caused by the propeller.

Macduff Boatbuilding decided, in consultation with Brunton's Propellers Limited, that a change of propeller to a highly skewed design would reduce the level of propeller induced noise.

The SFIA were invited to appraise the noise levels and vessel performance both with the original propeller of conventional design and the new propeller of skewed design.

The noise of which the skipper had complained can best be described as an irritating "high" frequency chipping hammer type of noise around the sternpost area. The frequency of the noise appeared to be consitent with each propeller blade passing the sternpost.

As the engine was not reaching full rated RPM, it was considered that the original propeller was overpitched and so the new propeller was designed with slightly less pitch.

OCEAN CHALLENGE is a typical modern Scottish seiner and a specification for the vessel is given in Appendix I. A profile of the vessel is given in Fig. 1 showing the general layout and also the positions of noise measurement.

Figs. 2, 3 and 4 show the general difference between the conventional and highly skewed propellers and also the general layout at the stern of the vessel.

2. TRIALS PROCEDURE

In order to get a direct comparison of noise levels and performance between the original and new propellers, trials were conducted with the vessel in as near to the same condition of loading as possible.

The propeller was changed on the slipway at Macduff during the turnround period between consecutive trips.

This was achieved by the vessel landing at Peterhead at 1.00am on a Thursday morning and sailing for Macduff at 3.00am. As the vessel approached Macduff, trials were carried out on reciprocal runs to establish noise levels and vessel speed for varying engine rpm.

The vessel was slipped at approximately 9.00am and work commenced to change the propeller and repaint the hull.

It should be noted that the hull was, in fact, in good clean condition, but was repainted both because the vessel was already on the slip and also the skipper's general policy to repaint very regularly.

The vessel was re-launched on the following Saturday morning and immediately proceeded to sea to conduct trials with the new propeller.

No diesel oil or ice were taken on between the two trials so the displacement of the vessel can be taken to be constant.

The parameters measured and instruments used are given in Appendix II and the trials results in Appendices III and IV.

3. NOISE LEVEL MEASUREMENTS

3.1 Location and Method of Measurement

As the crew cabin was considered to be the problem area for high noise levels, three readings of noise levels were recorded down the centreline of the cabin. In each of the other accommodation spaces and in the engine room only one recording was taken.

Initially sound levels were taken at many points all over the cabin including inside individual bunks. The highest noise level was found to be right against the forward end of the sternpost where it continued up through the cabin to the deckhead.

Each noise level recording was taken with the instrument held at arms length and approximately 1.5 metres above the deck.

The positions of the noise measurement are given in Fig. 1 and were taken at the middle point of the space in question.

The results obtained for noise level measurements are given in Appendix III, and as two readings were taken for each rpm setting with the new propeller, these have been meaned to give a single figure.

On the assumption that a decrease of 10 decibels (A - weighted scale) is equivalent to halving the noise level as perceived by the human ear, a further table was drawn up showing the percentage noise with the new propeller compared to the noise with the original propeller. This comparison is shown at the end of Appendix III.

3.2 Interpretation of Results

When noise measurement levels were read from the instrument, there was generally a fluctuation of ±1dB. On occasions there were pulses of up to +5dB, but these could generally be accounted for by some sudden noise such as the VHF radio or someone talking.

If the noise levels in percentage terms are examined between the new and original propellers (see Appendix III), a definite trend can be seen of a lowering of noise in the cabin, especially at higher engine rpm levels.

Because of the fluctuation in the instrument reading, a noise level must drop by more than the instrument reading accuracy before it can be classified as significantly lower. This means that a noise level must change by more than 1dB (or 7% in percentage terms) before any change can be detected.

Between 1250 and 1300 engine rpm, the noise levels can be seen to have dropped at least 15% in the cabin and up to 25% at the noisiest point in the cabin.

To demonstrate the change in noise levels in the cabin due to the propeller change, Fig. 5 was drawn. This figure shows how the noise levels differ more greatly at higher rpm than lower rpm.

Although noise levels have increased in some of the other spaces, this is not considered to be significant. The trial with the new skewed propeller was conducted during the day with a greater number of people on board. The trial with the original propeller was conducted at night and there was considerably less activity on board.

During both trials, the vibration levels were exceptionally low at all engine rpm values.

4. PERFORMANCE MEASUREMENTS

4.1 Method of Measurement

As the vessel was already fitted with a fuel flow meter, the vessel performance was assessed by measuring the fuel flow rate against ship speed.

In order to check the engine rpm, an optical hand held tachometer was used. Initially the vessel's own tachometer was checked and found to be less than 10 rpm out at any engine setting. During the course of the trial the engine rpm was set by the vessel's tachometer, then shaft rpm recorded with the optical tachometer.

The performance was recorded on reciprocal runs for each propeller to eliminate the effect of weather variations.

4.2 Interpretation of Results

The results of the vessel performance are given in Appendix IV and have been plotted in Fig. 6.

It can be seen in Fig. 6 that the mean curves of performance for the old and new propellers cross at 9.5 knots indicating the same performance at the higher rpm levels. At lower rpm the new highly skewed propeller performance appears to be slightly worse but, in fact, the weather was worse for the new propeller trial and so no significance can be taken from this.

However, taking the weather into account, the new skewed propeller is definitely not worse than the original propeller at high rpm and, therefore, the reduction in noise at high rpm has not been gained at the expense of reduction in performance.

Even though the new skewed propeller was of lower pitch than the original propeller, higher fuel flow values were obtained at maximum attainable engine rpm (1300 rpm for both trials). This can be attributed to the worse trial weather conditions. However, it does indicate that the engine was not, in fact, overloaded or restricted from achieving full rpm during the trial with the original propeller.

The skipper did mention though that there were problems with overloading of the winch during the fast haul when fishing and so a reduction in propeller pitch for the new propeller seems to be the best solution.

5. NOISE LEVEL COMPARISONS

Appendix V gives the noise levels and specifications of three other vessels which may be used as yardsticks against which to measure the results from OCEAN CHALLENGE.

However, it should be stated that vessels 1 and 2 are likely to have lower noise levels by virtue of vessel 1 having an engine which develops full power at only 750 engine rpm, and vessel 2 only having a 230 BHP main engine.

The results for vessel 3 can be compared directly with OCEAN CHALLENGE as this vessel is a modern seine net vessel with the same main engine. The results for this vessel show the same trend of relatively high noise levels in the crew cabin at normal steaming speeds.

As the collection of noise data in such a form is a relatively quick and easy task, it is hoped that more noise level data can be recorded during other trial trips against which to give valid comparisons for the OCEAN CHALLENGE results.

6. CONCLUSIONS

1. The excessive noise in the crew cabin appeared to be generated in part by the propeller blades passing the dead water behind the sternpost during each revolution.

2. By fitting a highly skewed propeller, noise levels at the noisiest point in the crew cabin on OCEAN CHALLENGE have dropped by 4 decibels (A - weighted scale) at full engine rpm. This is equivalent to a drop in noise level of 25% as perceived by the human ear.

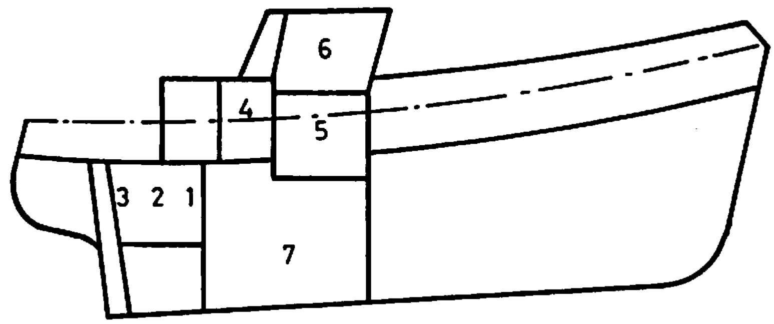
3. Noise levels elsewhere in the crew accommodation are not considered to be significantly different with the new propeller.

4. Vessel performance at full engine rpm is not significantly different with the highly skewed propeller than with the conventional propeller.

5. Noise levels in the crew cabin were comparable to another seine net vessel of a similar age, size and with the same main engine.

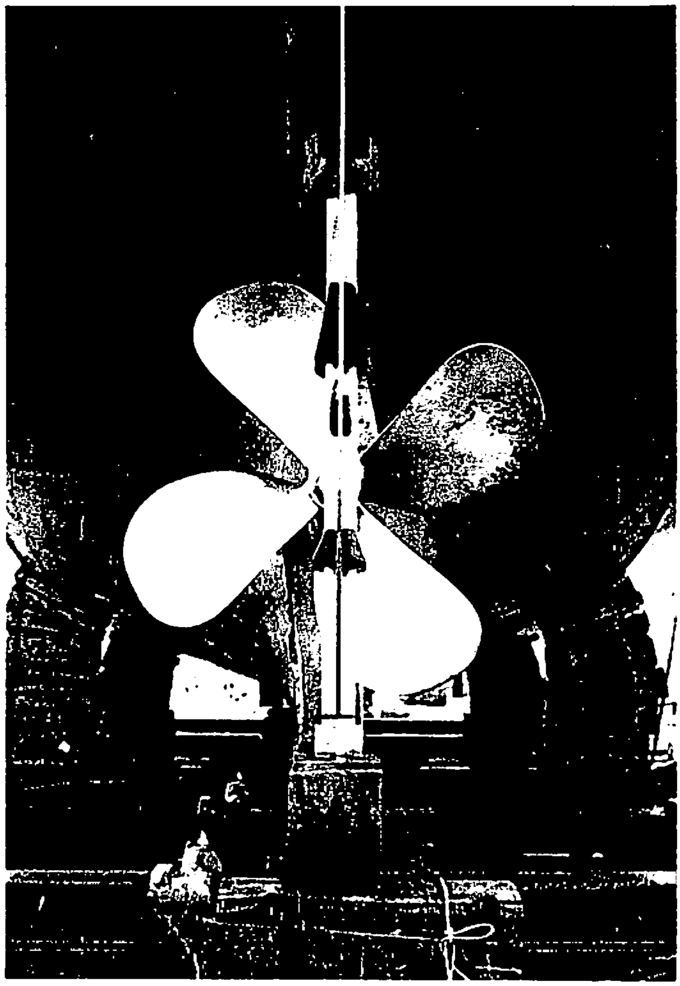
7. RECOMMENDATIONS

1. Further noise level data should be gathered aboard other vessels similar to OCEAN CHALLENGE, to provide valid comparisons. This could be achieved during normal trial trips so that "normal" standards for modern vessels could be recorded.

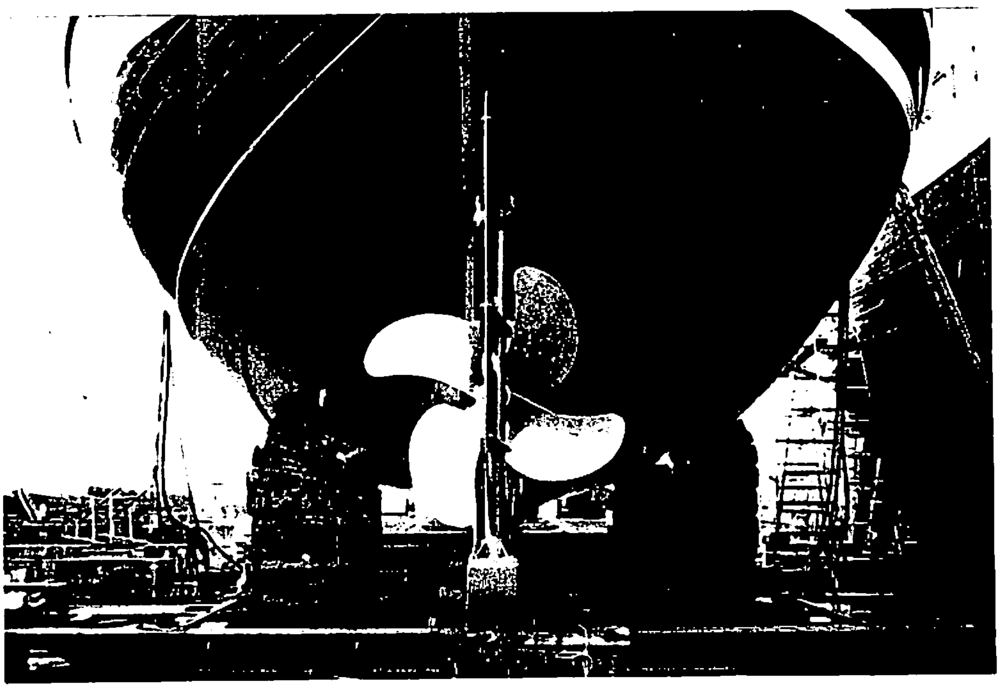


POSITION No.	LOCATION
1	Crew Cabin Forward
2	Crew Cabin Midway Between 1 and 3
3	Crew Cabin Forward Side of Sternpost
4	Galley (Port of Centreline)
5	Mess
6	Wheelhouse
7	Engine Room to Port of Main Engine

MFV Ocean Challenge - Noise Measurement Positions Fig.1



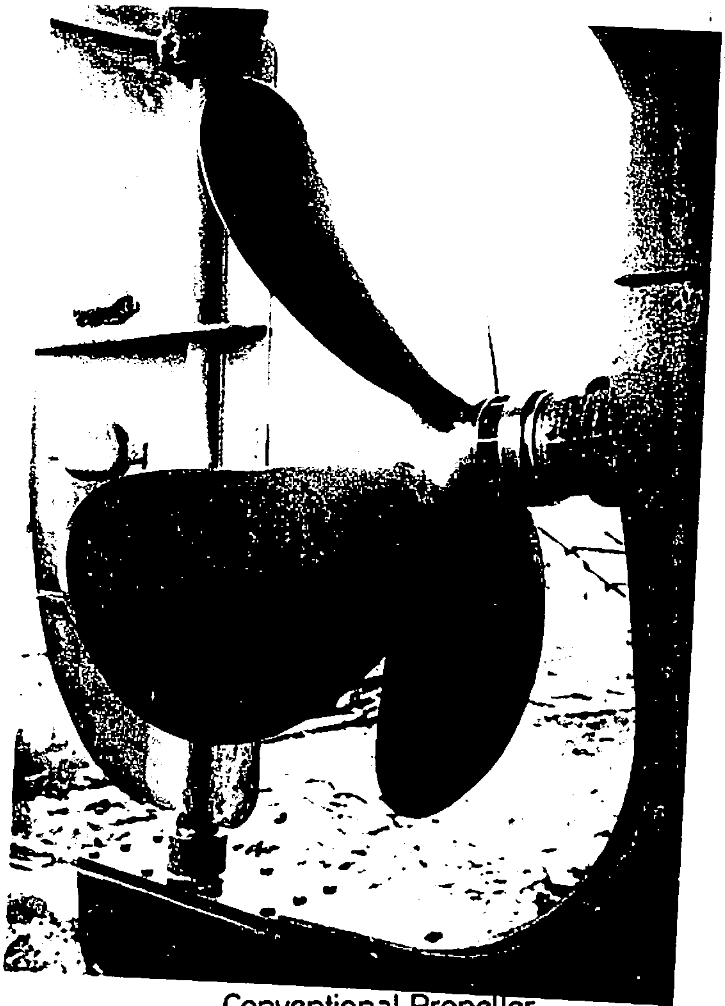
Conventional Propeller



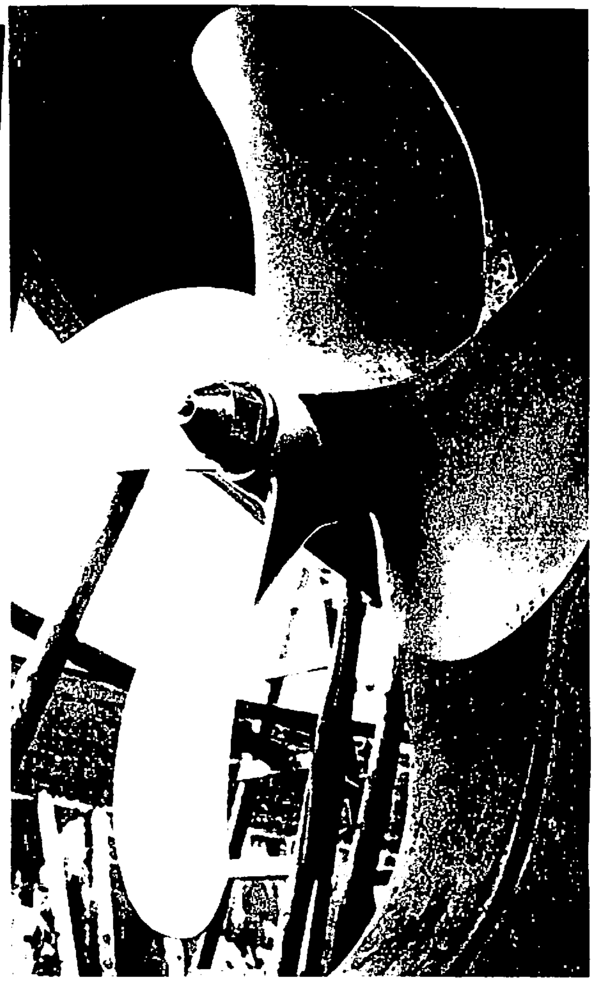
Highly Skewed Propeller

MFV Ocean Challenge - Propeller Comparison

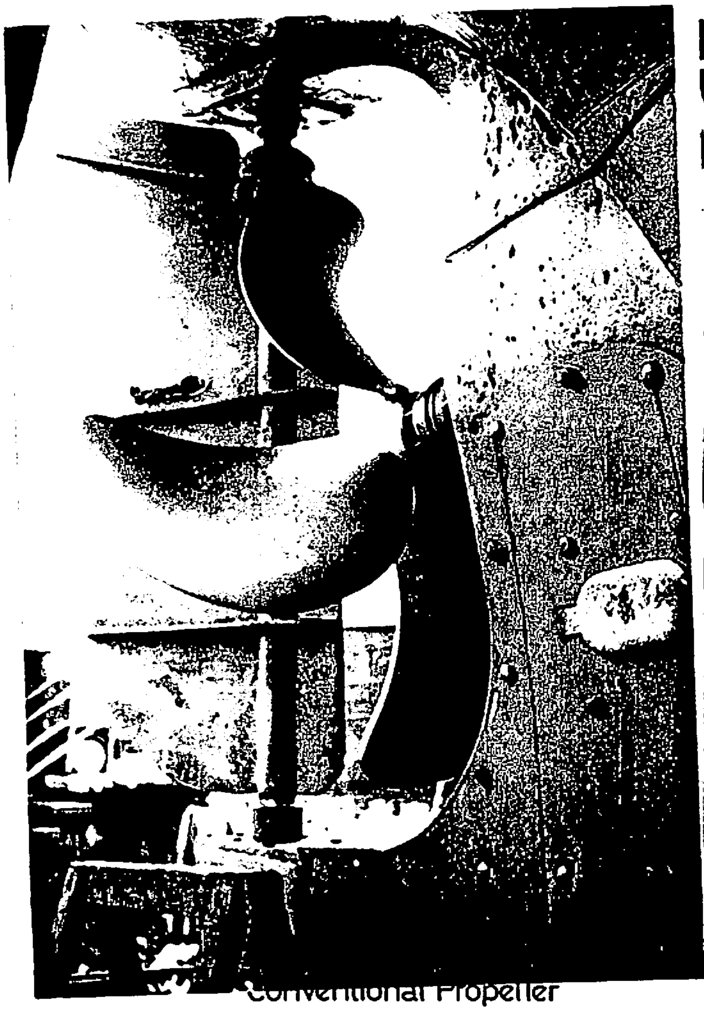
Fig.



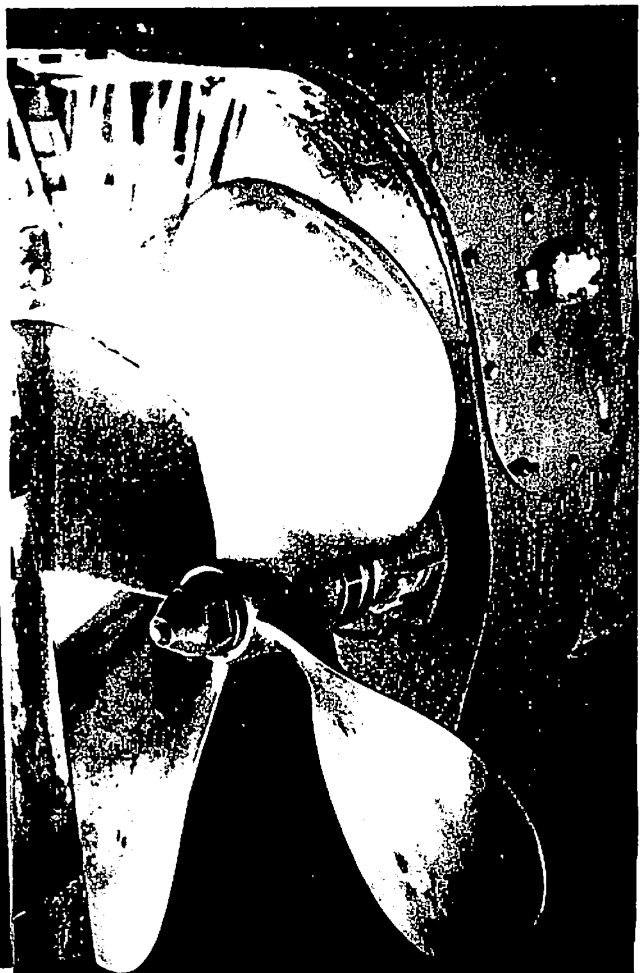
Conventional Propeller



Highly Skewed Propeller



Conventional Propeller



Highly Skewed Propeller

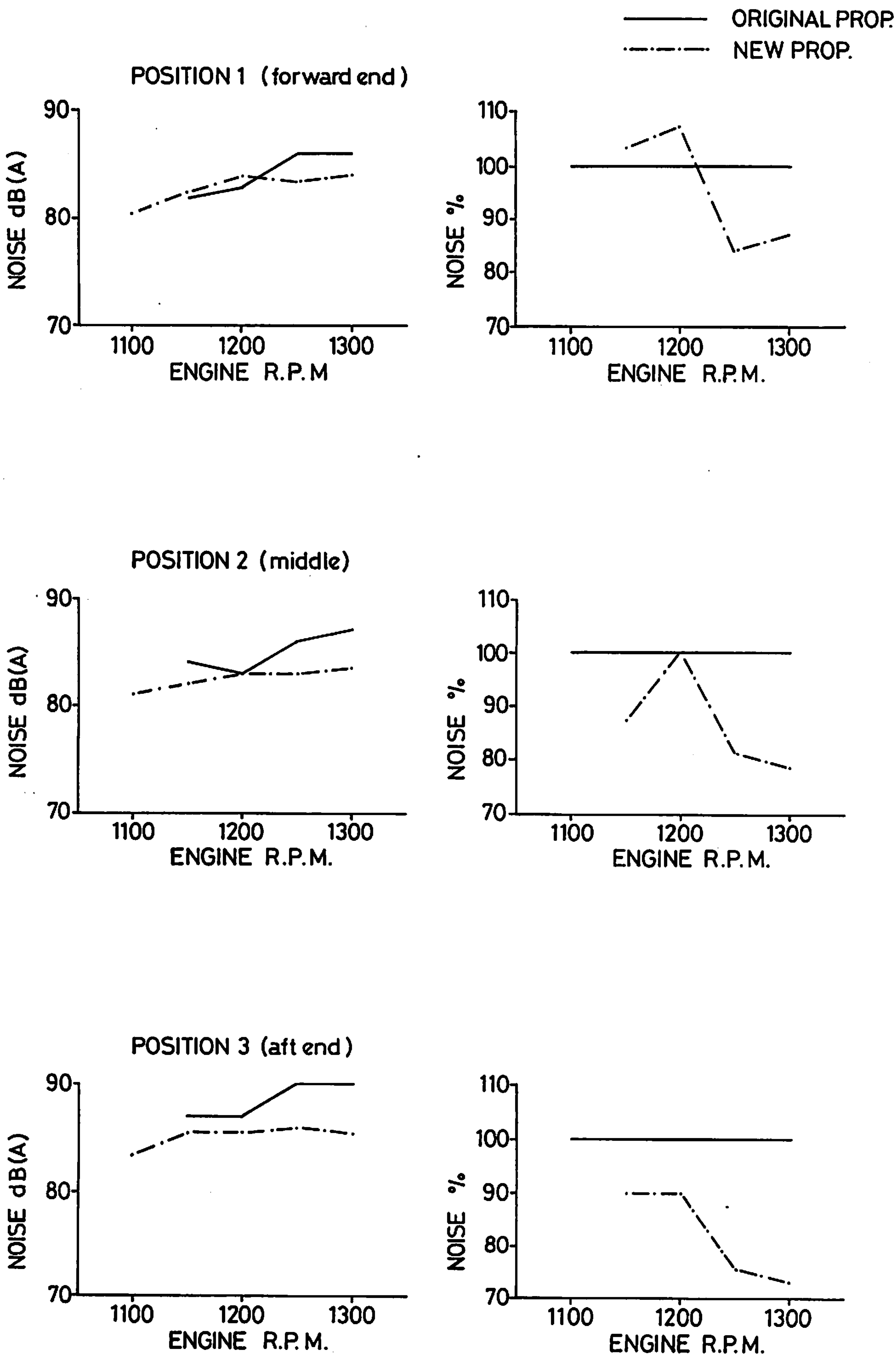
MFV Ocean Challenge - Propeller Comparison

Conventional Propeller

Highly Skewed Propeller

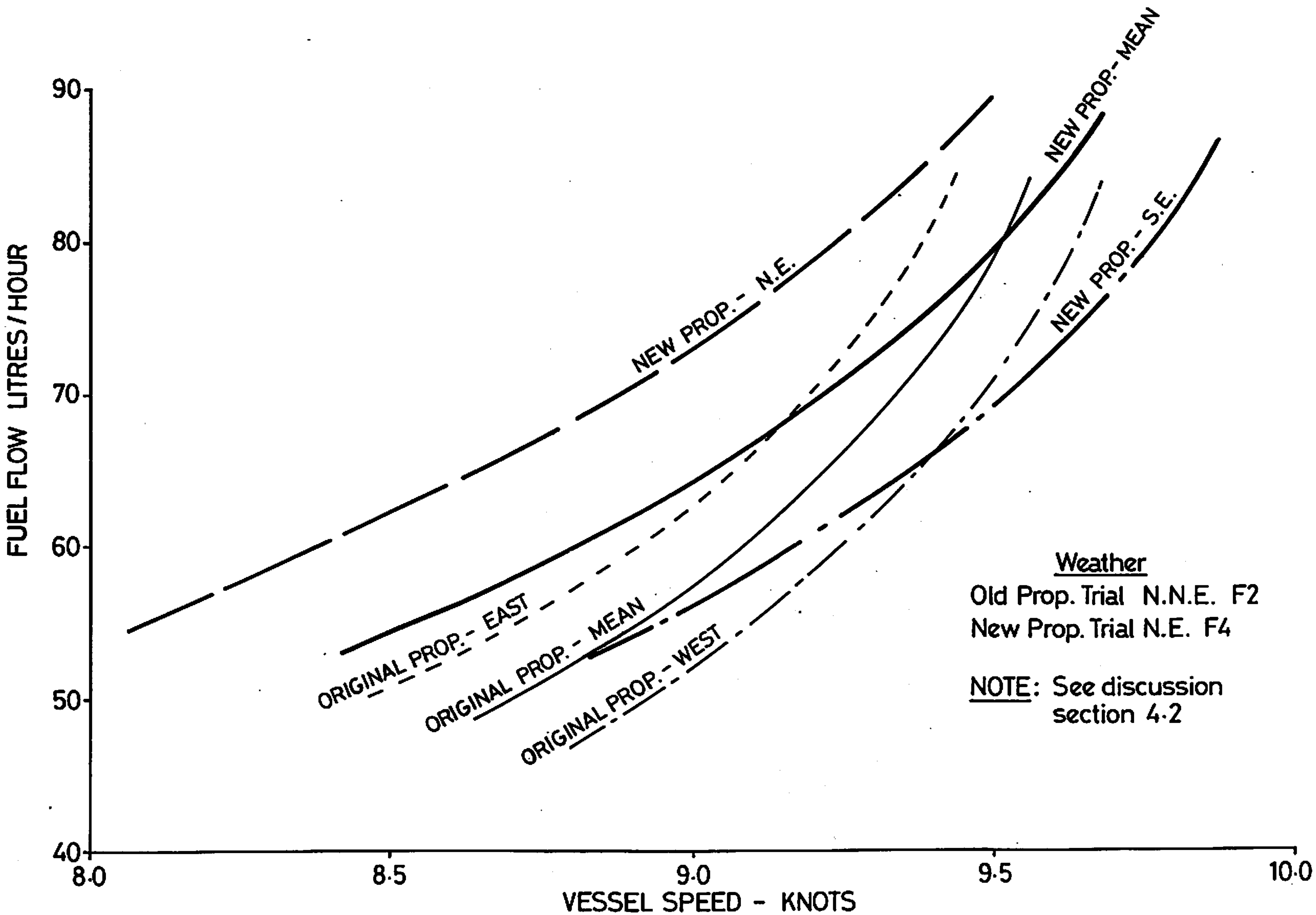
MFV Ocean Challenge - Propeller Comparison

Fig.4



MFV Ocean Challenge - Noise Levels in Crew Cabin

Fig.5



MFV Ocean Challenge - Vessel Performance

Fig. 6

APPENDIX I

VESSEL SPECIFICATION
MFV "OCEAN CHALLENGE" BF85

Wood hulled seiner with cruiser stern and three quarter length shelter deck. Built by Macduff Boatbuilding and Engineering Co. in 1985.

Length Overall	22.00m
Breadth Extreme	7.02m
Depth Moulded	3.65m

Lightship Displacement	165 tonnes	Draft aft 3.40m
Depart Port Displacement	198 tonnes	Draft aft 3.45m
Arrive Port Displacement	212 tonnes	Draft aft 3.31m

Engine - Kelvin TBSC8 465 SHP at 1315 rpm

Gearbox - Reintjes 3.895:1 reduction

Original propeller - Fixed pitch Brunton's Superston
Conventional design with 4 blades
1.676m diameter x 1.130m pitch
Blade area ratio 0.58

New propeller - Fixed pitch Brunton's Superston
Skewed design with 4 blades
1.680m diameter x 1.095m pitch
Blade area ratio 0.58

APPENDIX II

PARAMETERS MEASURED ON TRIALS

PARAMETER	INSTRUMENT
Engine rpm	Standard engine tachometer
Shaft rpm	Hand held optical tachometer with digital readout
Fuel Flow	Envirosystems fuel flow meter
Vessel Speed	Braystoke towed log
Wind Speed and Direction	Visual estimation
Noise Levels	Onsoku hand held sound meter 50 - 110dB (dB(A) scale used)

APPENDIX III

"OCEAN CHALLENGE" TRIALS RESULTS - NOISE LEVELS

Original Propeller

Run No.	Engine rpm	Noise level in dB(A) at position						
		1 Cabin for'd	2 Cabin mid	3 Cabin aft	4 Galley	5 Mess	6 Wheel house	7 Engine room
1	1300	86	87	90	85*	87*	80	103
2	1200	83	83	87	75	77	75	101
3	1100	-	-	-	74	76	77	100
4	1100							
5	1200							
6	1300	-	-	-	-	79	-	-
7	1150	82	84	87	75	76	77	101
8	1250	86	86	90	77	78	78	103

New Propeller

Run No.	Engine rpm	Noise level in dB(A) at position						
		1 Cabin for'd	2 Cabin mid	3 Cabin aft	4 Galley	5 Mess	6 Wheel house	7 Engine room
1	1300	84	83	85	77	77	79	103
2	1250	83	83	86	80	78	79	103
3	1200	84	83	85	75	78	79	103
4	1150	83	82	86	78	76	78	102
5	1100	80	81	84	78	75	75	100
6	1100	81	81	83	78	76	76	101
7	1150	82	82	85	78	75	78	102
8	1200	84	83	86	77	77	80	103
9	1250	84	83	86	78	77	80	103
10	1300	84	84	86	79	79	81	104

VESSEL NOISE LEVELS

Original Propeller Noise in dB(A)

Engine rpm	1 Cabin for'd	2 Cabin mid	3 Cabin aft	4 Galley	5 Mess	6 Wheel house	7 Engine room
1100	-	-	-	74	76	77	100
1150	82	84	87	75	76	77	101
1200	83	83	87	75	77	75	101
1250	86	86	90	77	78	78	103
1300	86	87	90	-	79	80	103

New Propeller Noise in dB(A)
Mean of Two Runs

Engine rpm	1 Cabin for'd	2 Cabin mid	3 Cabin aft	4 Galley	5 Mess	6 Wheel house	7 Engine room
1100	80.5	81	83.5	78	75.5	75.5	100.5
1150	82.5	82	85.5	78	75.5	78	102
1200	84	83	85.5	76	77.5	77	103
1250	83.5	83	86	79	77.5	79.5	103
1300	84	83.5	85.5	78	78	80	103.5

New Propeller Noise/Original Propeller Noise in % *

Engine rpm	1 Cabin for'd	2 Cabin mid	3 Cabin aft	4 Galley	5 Mess	6 Wheel house	7 Engine room
1100	-	-	-	132.0	96.6	90.1	103.5
1150	103.5	87.1	90.1	123.1	96.6	107.2	107.2
1200	107.2	100.0	90.0	107.2	103.5	114.9	114.9
1250	84.0	81.2	75.8	114.9	96.6	111.0	100.0
1300	87.0	78.5	73.2	-	93.3	100.0	103.5

* Based on a 10dB drop in sound level being required to make the noise sound half as loud to the human ear

APPENDIX IV

TRIALS RESULTS - VESSEL PERFORMANCE

Performance with Original Propeller

Run No.	Course	Wind Force	Wind Direction	Engine R.P.M. Bridge Tacho	Shaft R.P.M. Hand Tacho	Fuel Flow L/Hr	Speed Knots
1	W	2	NNE	1300	333	83.5	9.68
2	W	2	NNE	1200	308	64.5	9.37
3	W	2	NNE	1100	280	47.5	8.82
4	E	2	NNE	1100	280	50.0	8.46
5	E	2	NNE	1200	308	65.5	9.09
6	E	2	NNE	1300	333	84.3	9.44
7	W	2	NNE	1150	297	56.2	9.19
8	W	2	NNE	1250	323	74.3	9.70

Peformance with New Propeller

Run No.	Course	Wind Force	Wind Direction	Engine R.P.M. Bridge Tacho	Shaft R.P.M. Hand Tacho	Fuel Flow L/Hr	Speed Knots
1	NE	4	NE	1300	332	90.1	9.50
2	NE	4	NE	1250	324	82.3	9.33
3	NE	4	NE	1200	312	76.2	9.06
4	NE	4	NE	1150	299	64.0	8.66
5	NE	4	NE	1100	280	54.5	8.07
6	SW	4	NE	1100	281	51.5	8.77
7	SW	4	NE	1150	301	63.7	9.30
8	SW	4	NE	1200	311	71.0	9.57
9	SW	4	NE	1250	323	79.2	9.76
10	SW	4	NE	1300	332	86.6	9.87

Vessel Performance

Mean of Two Runs

Engine R.P.M.	Original Prop		New Prop	
	Mean Speed Knots	Fuel Flow L/Hr	Mean Speed Knots	Fuel Flow L/Hr
1300	9.56	83.9	9.68	88.3
1250	-	-	9.54	80.7
1200	9.23	65.0	9.31	73.6
1150	-	-	8.98	63.8
1100	8.64	48.7	8.42	53.0

APPENDIX V

NOISE LEVEL COMPARISONS OF THREE OTHER VESSELS

Vessel 1

Wheelhouse and accommodation aft.

Year built	1974
Length overall	24.38M
Engine H.P.	637 at 750 r.p.m.

Noise levels in dB(A) when steaming

Location	dB(A)
Crew Cabin	75
Galley	74
Mess	74
Wheelhouse	68
Engine Room	106

Vessel 2

Wheelhouse and accommodation aft. with shelterdeck

Year built	1976
Length overall	19.81M
Engine H.P.	230 at 1150 r.p.m.

Noise levels in dB(A) when steaming

Location	dB(A)
Crew Cabin	81
Mess	77
Wheelhouse	71
Engine Room	103

Vessel 3

Wheelhouse and accommodation aft. with shelterdeck

Year built	1985
Length overall	23.13M
Engine H.P.	495 at 1315 r.p.m.

Noise levels in dB(A) when steaming at 1250 r.p.m.

Location	**dB(A)**
Crew Cabin	87
Mess	87
Wheelhouse	78
Engine Room	104