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Vessel Analysis Computing System (Ener Sea)

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Fisheries and Oceans   Pêches et Océans

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(ENER SEA)

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ABSTRACT

Pinhorn, P. July 1986. Vessel Analysis Computing System (Ener Sea) Can. Tech. Rep. Fish. Aquat. Sci. 1529: vi + 33p.

Since September, 1984, considerable work has been carried out in order to develop the Ener Sea Program. This work included improving the Vessel Analysis Computing System (VACS), holding energy efficiency/cost reduction seminars, and analyzing vessels by using the VACS software package. Also vessels' fuel consumption and speed were measured during sea trials at varying engine RPM's to determine the impact that engine RPM's has on fuel consumption and speed.

As a result of this work it was demonstrated that the Ener Sea Program has the potential to dramatically reduce the fuel expenditures of the Newfoundland inshore fishing fleet in the near future.

RÉSUMÉ

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Depuis septembre 1984, on a beaucoup travaillé à l'élaboration du Programme Énergie en mer. Ce travail a porté sur l'amélioration du Système d'analyse informatisé des paramètres du bateau, la tenue de séances de travaux pratiques sur l'efficacité du rendement énergétique/la réduction descoûts et l'analyse des paramètres de bateaux à l'aide du système. De plus, la consommation de carburant et la vitesse du navire ont été calculées au cours d'essais en mer à divers nombres de tours par minute du moteur afin de déterminer l'incidence qu'ont ceux-ci sur la consommation de carburant et la vitesse.

Ces travaux ont ainsi démontré que le Programme Énergie en mer a le potentiel de réduire considérablement dans un prochain avenir les dépenses de carburant supportées par la flottille de pêche côtière de Terre-Neuve.

PREFACE

In the early eighties, the Department of Fisheries and Oceans initiated an Energy Efficiency/Cost Reduction Program to improve fishing vessel efficiency. An energy van, complete with computer hardware and software (ENER SEA), was developed to deliver the program to fishermen in outport communities.

A contract was awarded to Seimac Ltd. (DSS-OSC 82-00290) to develop and verify the computer software, and to supply an energy van complete with computer hardware.

A second contract was awarded to Seimac (Nfld.) Ltd. (DSS-OSC 83-00611) to test the vessel analysis computing system (VACS). A final report is available on the results.

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INTRODUCTION

The Department of Fisheries and Oceans, Fisheries Development Branch, undertook a program in 1982 to increase vessel efficiency and predict possible improvements in a vessel's fuel savings. To do this, the Branch developed a vessel efficiency analysis system (Ener Sea) which consists of computer hardware and software housed in a van providing physical access to most fishermen. The software used enables the system to predict fuel savings resulting from changes in propulsion system and certain vessels' maintenance procedures; operational procedures; converts fuel savings into amortized reduction of cost; produces present values for such savings, and prints cost and savings summaries easily understood by fishermen.

From September, 1984, work has included modifications to the Vessel Analysis Computing System (VACS), the creation of the Ener Sea Data Management System (EDAMS); scheduling and holding of energy efficiency/cost reduction seminars; vessel analyses and resultant recommendations on propeller changes, etc.; and testing vessels' fuel consumption characteristics.

The following report outlines the work completed and the subsequent estimation of the program's impact on Newfoundland's fishing industry.

Further details are available through the Fisheries Development Branch upon request.

VESSEL ANALYSIS COMPUTING SYSTEM (VACS)

DESCRIPTION OF VACS

The Vessel Analysis Computing System (VACS) is a versatile software package offering various recommendations for fuel consumption reduction targeted at vessels 35'-65' L.O.A. The VACS package contains three main programs headed: "Propeller Analysis", "Bottom Cleaning", and "Operational Profile". Each program generates the following output:

<u>Propeller Analysis</u>

- Propeller conditions for the current blade; thrust, horsepower, torque, the percentage of cavitation, etc.
- The most efficient propeller for a vessel based on parameters such as horsepower, gear ratio, diameter, pitch, etc.
- Propeller conditions for each new propeller selected.
- Estimated fuel savings for each new propeller.
- Estimate of the payback period and rate of return if the new propeller is retrofitted.

<u>Bottom Cleaning</u>

- The percentage of fuel saved as a result of bottom cleaning, as well as the payback period and the rate of return.

Operational Profile

- By keying in RPM, speed and propeller parameters, the program will give an estimate of reductions in fuel consumption and speed at various RPM levels. It also generates thrust values for each RPM and speed value.

Much of the data from VACS can be presented in either table or graph form.

IMPROVEMENTS TO VACS (PROCHANG. BAS)

While appearing to work quite well, the propeller program (PROCHANG. BAS) in the VACS system contained many program flaws. Some of the data developed was somewhat inaccurate. In several cases it was caused by rounding errors occurring in the optimization calculations. Parameters such as percent cavitation, that were not calculated at all, comprised a significant gap in the information given to fishermen. These problems were soon recognized once operators became familiar with the system. However, PROCHANG. BAS had very little documentation to enable the programmer to locate various segments of the program. Eventually debugging and modifications were made (i.e. format of output and correction of rounding errors) resulting in a far more reliable program (Chalk, 1986). (See Fig. 1)

In addition, it was realized the program had to be documented for future reference and possible modification. PROCHANG. BAS, as revised, should enable any operator to follow the program with relative ease.

Inputed Parameters

Maximum Shaft Horsepower	=	250		
Operating RPM	=	2,500		
Gear Ratio	=	2.5		
Present Diameter	=	24		
Present Pitch	=	24		
Number of Blades	=	3		
Blade Area Ratio (B.A.R.)	=	.52		
Operating Speed (knots)	=	9		
Clearance Above Propeller (in)	=	6		
Clearance Below Propeller (in)	=	6		
Depth of Skeg (in)	=	8		
Draft (ft)	=	4		

Optimization Parameters

Number of Blades (min., max.)	=	3	4	
Blade Area Ratio (min., max., inc.)*	=	.52	.52	.1

Current Propeller Conditions

Diameter	=	24
Pitch	=	24
No. of Blades	=	3
Blade Area Ratio (B.A.R.)	=	.52
RPM	=	2,500
Thrust (lb)	=	2,627
Torque (ft-lb)	=	809
Power (HP)	=	154
Cav. Coef	=	.309
Cav. Number	=	.396
% Cavitation	=	28.7%
Efficiency	=	37.65%

Optimized Steaming Blade

BLADE	DIA	PITCH	BLADES	BAR	RPM	EFF%
1	28	17	4	.52	2,538	44.44%
2	29	16	4	.52	2,546	44.16%
3	29	17	3	.52	2,519	44.5%

THRUST LB	TORQUE LB-FT	POWER HP	CAV COEF	CAV NUM	% CAV	%FUEL DROP
2,628	675	137	.157	.284	8.451%	15.25%
2,629	678	138	.135	.264	6.792%	14.68%
2,629	680	137	.139	.269	7.219%	15.31%

*Inc = Increment

FIG. 1. Sample of Propeller Analysis

ADDITIONS TO VACS (PROCHANG. BAS)

Three features have been added to PROCHANG. BAS. They are:

1. The option of editing input parameters.
2. The transferral of data between VACS and the newly developed Ener Sea Data Management System (EDAMS).
3. A new program, Sheet. BAS, which creates operational profile sheets for fuel consumption, RPM and speed testing.

The first feature was added to enable the operator to change input parameters as required. An example might be when a fisherman inquires about replacing his transmission. Previously the operator would have to enter all parameters for each gear box. By introducing this new feature the operator may enter the parameters needing change. This reduces data entry resulting in vessel analyses being completed faster. This editing option can be utilized before or after the propeller optimization portion of the program.

The second feature can be utilized when a fisherman is interested in having his vessel analyzed but does not have all the pertinent information. By searching EDAMS (Harris 1985) and finding a vessel similar to his, the data can be transferred into VACS quickly and efficently, once again reducing vessel analysis time.

The third feature was added to create operational profile sheets on a vessel's fuel consumption, RPM and speed in the field. These tables are plotted and presented to fishermen in a printed format after testing his vessel. (See Fig. 2 Sample of Operational Guide).

ENER SEA VESSEL OPERATIONAL GUIDE

M.V: SELECTED VESSEL LENGTH: 32ft ENGINE: 62HP PERKINS DATE: JL/86

RPM (engine)	SPEED (knots)	FUEL CONSUMPTION (gal/hr)	DROP IN SPEED FROM MAX (knots)	DROP IN CONSUMPTION FROM MAX (gal/hr)	FUEL SAVED PER TRIP
3000	8.0	2.97	0.0 (0%)	0.00 (0%)	0%
2800	7.6	2.25	0.4 (5%)	0.72 (24%)	20%
2600	7.2	1.68	0.8 (10%)	1.29 (43%)	37%
2400	6.9	1.30	1.2 (14%)	1.67 (56%)	49%
2200	6.4	1.00	1.6 (20%)	1.97 (66%)	58%
1900	5.9	0.76	2.1 (26%)	2.21 (74%)	65%
1700	5.2	0.56	2.8 (35%)	2.41 (81%)	71%

Fig. 2. Sample of Operational Guide

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VERIFICATION OF VACS

Sufficient data from propeller changes, fuel consumption, RPM and speed tests have been acquired to enable comparisons of computer predictions and actual trial results. As seen through Tables 1 - 4 a high degree of reliance can be placed on the computer software for both the propeller optimization program and the operational profile.

COMPARISON OF TRIAL RESULTS VS COMPUTER PREDICTIONS FOR THE PROPELLER OPTIMIZATION PROGRAM

Within the Newfoundland Region the steaming propeller program applies more than the dragging propeller program because 98% of the Newfoundland fleet consists of steaming propellers.

TABLE 1. Predicted vs Actual Fuel Savings for the Propeller Optimization Program

VESSEL #	PREDICTED FUEL SAVINGS %	ACTUAL FUEL SAVINGS %	DIFFERENCE %
1	+ 4.89	+ 5.64	0.75
2	+13.67	+11.0	2.67
3	+ 4.0	+ 2.0	2.0
4	+ 6.0	+23.0*	-
AVG.			1.81

(Seimac (Nfld.) Ltd. 1984)

*For vessel #4 the measured fuel savings for the final run, with respect to the initial run, was taken after the engine was tuned thus causing a large difference between the computer predictions and the measured values.

TABLE 2. % Difference Between Predicted and Measured Changes in Horsepower Due to a Propeller Change

VESSEL #	% CHANGE IN H.P. (PREDICTED)	% CHANGE IN H.P. (TRIAL)	%DIFFERENCE
1	+ 9.1	+11.3	2.2
2	-19.0	-13.3	5.7
3	+26.0	+30.4	4.4
			AVG. 4.1

(Seimac (Nfld.) Ltd. 1984

TABLE 3. Predicted vs Actual Drop in Fuel Consumption as With Selected RPM Reduction

VESSEL #	RPM	SPEED (KNOTS)	% DROP IN SPEED	% DROP IN FUEL (PREDICTED)	(ACTUAL)	% DIFFERENCE
1	2100	9.27	0	0	0	-
	1900	8.70	6	27	24	3
	1700	8.00	14	49	47	2
	1500	7.20	22	66	62	4
2	1900	9.60	0	0	0	-
	1700	8.65	10	29	36	7
	1500	7.75	19	54	59	5
	1300	6.80	29	64	75	11
3	2400	7.9	0	0	0	-
	2200	7.6	4	24	22	2
	2000	7.2	9	44	41	3
	1800	6.6	16	60	56	4
4	2700	8.0	0	0	0	-
	2500	7.6	5	22	28	6
	2300	7.3	11	40	42	2
	2100	6.7	16	55	56	1
5	2100	8.0	0	0	0	-
	1900	7.3	9	26	29	3
	1700	6.45	19	46	54	8
	1500	5.95	26	63	64	1

TABLE 4. % Difference Between Predicted and Measured R.P.M. For The Optimized Propeller

VESSEL #	%DIFFERENCE
1	3.6
2	4.2
3	5.9
4	3.5
5	3.1
6	1.6
AVG.	3.65

Seimac (Nfld.) Ltd. 1984

ENERGY EFFICIENCY/COST REDUCTION SEMINARS AND VESSEL ANALYSES

Since December, 1984 the Fisheries Development Branch has presented 16 energy efficiency/cost reduction seminars throughout the Province. (See Table 5).

During the seminars fishermen were presented with various fuel cost-cutting methods for their vessels. The seminar agenda included fuel consumption data collected by the Branch, three sound-on-slide shows ("Cutting the Cost", "Picking a Prop", and "Engine Efficiency") and a description of the Ener Sea Program (Fig. 3). Fishermen also received press packages complete with fact sheets, summaries of information collected, brochures, etc.

TABLE 5. Summary of Energy Seminars 1984-85-86

Trip No.	Location	Attendance at Seminar	No. of Vessels Analyzed in Van
1	Valleyfield	12	5
2	Bonavista	23	8
3	Fogo Island	17	9
4	Harbour Grace	4	5
5	Roddickton	11	6
6	Southern Harbour	29	8
7	Old Perlican	14	7
8	Durrel	15	15
9	La Scie	9	3
10	Admirals Beach	10	5
11	Labrador	30	8
12	Petty Harbour	40	5
13	Marine Institute	16	5
14	Musgrave Harbour	13	5
15	Port de Grave	15	7
16	St. Lawrence	14	8
TOTAL		272	109

Information collected from fishermen through questionnaires and question and answer periods were useful in assessing each seminar's impact, including its effect on attitudes toward reducing fuel costs.

The Fisheries Development Branch also carried out a study using questionnaires and telephone surveys, on the impact of these seminars on fishermen's attitudes to the program (Carberry, 1985). It was found that before the seminar most fishermen felt strongly about reducing their fuel costs. As a result of the seminar this feeling was reinforced.

1. General Introduction
2. Sound-on-Slide Show "Cutting the Cost".
3. Effects of fuel consumption and speed by reducing RPM on:
   a) 42' vessel; b) 45' vessel; c) 58' vessel; and d) 65' vessel.
4. Sound-on-Slide Show "Picking a Prop".
5. Ener Sea Van Program.
6. Propeller Analysis: a) Input Parameters; b) Present Propeller Conditions and Optimized Blade; c) Cost and Benefits.
7. Bottom Cleaning: a) Input Parameters; b) Cost and Benefits.
8. Operational Profile: a) Input Parameters; b) Output Profile.
9. Sound-on-Slide Show "Engine Efficiency".
10. Appointments for Energy Efficiency Analysis.
11. Completion of Questionnaires.
12. Closing Remarks.

Handouts Included:

1. Pamphlet "Cutting the Cost".
2. Graphs of RPM vs Fuel Consumption and Speed for Four Newfoundland Fishing Vessels.
3. Pamphlet "Picking a Prop".
4. Summary of the Ener Sea Van.
5. Propeller Analysis - Input and Output Parameters.
6. Bottom Cleaning - Input and Output Parameters.
7. Operational Profile - Input and Output Parameters.
8. Pamphlet "Engine Efficiency
9. Pamphlet "Fishing and Fuel Efficiency".
10. Pamphlet "Cutting Fuel Costs".
11. Fisheries Development Branch.
12. "Fisheries Development - 1983".

FIG. 3. Cost Reduction/Energy Efficiency Seminar Agenda

VESSEL ANALYSIS (VACS)

From September 1984 to March 1986, 169 vessels were analyzed using the Ener Sea Vessel Analysis Computing System (VACS). The majority were analyzed immediately after the seminars where individual appointments were made to meet with Ener Sea staff at local Marine Service Centres and haul-ups. The remainder were tested by using information from telephone, mail, marine shows, consulting companies and field work. (See Table 6).

TABLE 6. Summary of Vessels Analysis Activity

METHOD OF CONTACT	NUMBER OF VESSELS
Seminars	109
Telephone and Mail	25
Marine Shows	10
Consulting Companies	8
Other Vessels	16
TOTAL	168

The entry of all 168 vessels' parameters into the Ener Sea Data Management System (EDAMS), (Harris 1985), will enable easy access and utilization of data for further vessel analyses.

In general, most fishermen realized savings by either bottom cleaning, RPM reduction or propeller changes. However, there were some concerns about the accuracy of values pertaining to blade area ratio (B.A.R.), RPM and speed. It was found most skippers didn't know their actual operating speed at specific RPM's, since very few vessels are equipped with speed gauges and many tachometers are inherently inaccurate. Also, blade area ratios often could not be collected because fishermen did not possess all the drawings required for calculation.

It was decided to investigate ways of collecting this data.

VESSEL TESTING FOR FUEL CONSUMPTION, RPM AND SPEED

OBJECTIVES

From June to September, 1985, the Fisheries Development Branch carried out tests on 17 vessels for fuel consumption, speed and RPM (where a slight loss in speed can result in high fuel savings). (See Table 7) (Walsh, 1985). The objectives were as follows:

1. To show fishermen the relationship between RPM, speed and fuel consumption.
2. To crosscheck data gathered during testing with computer predictions for verification of the computer software.
3. To collect RPM and speed values for the propeller optimization program.

When testing vessels on site, Objective 1 was achieved by presenting fishermen with a table of his vessel's results showing various speed and fuel consumption values at different RPM settings (Fig. 2).

Objective 2 was realized by taking data gathered for a particular vessel and entering it into the operational profile program. Comparisons of actual RPM, speed and fuel consumption with computer predictions of these were tabulated.

Objective 3 was achieved by taking actual values of speed at specific RPM's for each vessel and entering the data. The sensitivity of speed and RPM to propeller change was then analyzed. In the majority of cases, analysis based on actual RPM and speed values rather than on fishermen's estimates of these values, led to the recommendation of different propellers. (This is illustrated in Fig. 4). It was therefore concluded that proper analysis of propeller efficiency depends upon accurate RPM and speed values.

VESSEL #1

BASED ON ACTUAL RPM AND SPEED VALUES

OPTIMIZED STEAMING BLADE

BLADE	DIA	PITCH	BLADES	BAR	RPM	EFF%
1	37	24	3	.52	1,852	51.04
2	38	23	3	.52	1,860	50.9
3	36	25	3	.52	1,850	50.74

THRUST LB	TORQUE LB-FT	POWER HP	CAV COEF	CAV NUM	% CAV	% FUEL DROP
2,643	946	117	.144	.458	0%	.54%
2,647	945	117	.128	.431	6%	.15%
2,643	952	117	.162	.484	2.611%	0%

BASED ON FISHERMEN'S ESTIMATES OF RPM AND SPEED VALUES

OPTIMIZED STEAMING BLADE

BLADE	DIA	PITCH	BLADES	BAR	RPM	EFF%
1	38	23	3	.52	1,852	47.76
2	39	22	3	.52	1,861	47.46
3	36	25	3	.52	1,850	47.14

THRUST LB	TORQUE LB-FT	POWER HP	CAV COEF	CAV NUM	% CAV	% FUEL DROP
2,848	996	123	.14	.438	.37	1.25
2,849	997	124	.125	.412	0%	.61
2,847	1,009	124	.176	.488	3.916	0

FIG. 4. Comparison of Propeller Selections Between Fishermen's Estimates on RPM and Speed and the Actual Measured Data

TABLE 7. **Summary of Vessels Tested for Fuel Consumption Speed and RPM**

Vessel No.	Vessel Length (Ft.)	Engine H.P. (Max.)	% Fuel Saved From a Drop of 1 knot from Max. Speed
1	42	210	47
2	45	165	56
3	45	218	35
4	51	107	36
5	38	72	42
6	45	85	40
7	36	41.5	29
8	35	85	41
9	35	125	45
10	38	156	40
11	52	165	38
12	52	220	34
13	42	130	52
14	39	130	42
15	65	520	29
16	42	125	55
17	38	117	30
18*	42	154	40
19*	45	165	49
20*	58	230	34
21*	65	365	40
		Avg. % Drop in Fuel = 41%	

*These vessels were tested by the Branch before the 1984-85 fiscal year.

By analyzing this table it can be concluded that a total fuel consumption decrease of 41% can be realized from reducing 1 knot from the maximum speed.

To calculate numerical values related to hull form, vessel lines plans are needed. Some drawings have been obtained through the Department of Fisheries and more will be forthcoming as the program develops. This will enable a comparison of testing results between vessels of similar hull form.

TEST EQUIPMENT

Radar Gun

The Decatur radar gun was used to determine the speed of a vessel relative to a fixed point on shore. This gun is similar to those used by police forces; but was modified to accurately record low speeds. The unit consists of a hand-held radar emitter/receiver interfaced with a digital data display and powered by a portable 12 volt DC source. (Fig. 5). Readings were given in miles per hour, and later converted to knots.

Tachometer

The tachometer was used to obtain the RPM of the propeller shaft (converted to engine RPM by multiplying by the gear ratio). The Power Instruments Phototach (model 1891-am) is composed of a combined light source and light sensitive cadmium-sulfphide "eye" attached by a cord to a hand-held digital display unit. (Fig. 6). The unit is powered internally by a (1) "D" and four (4) "AA" dry cells. The unit projects a continuous beam of light onto the rotating propeller shaft; pulses of light are reflected back to the unit by a silver patch placed on the shaft; shaft RPM is electronically calculated from the intervals between pulses and shown on the digital display unit. The flashlight is held in position by a chemistry clamp and stand nailed in place in the hold. When the light proved too dim, four more cells were soldered in parallel with the "D" cell.

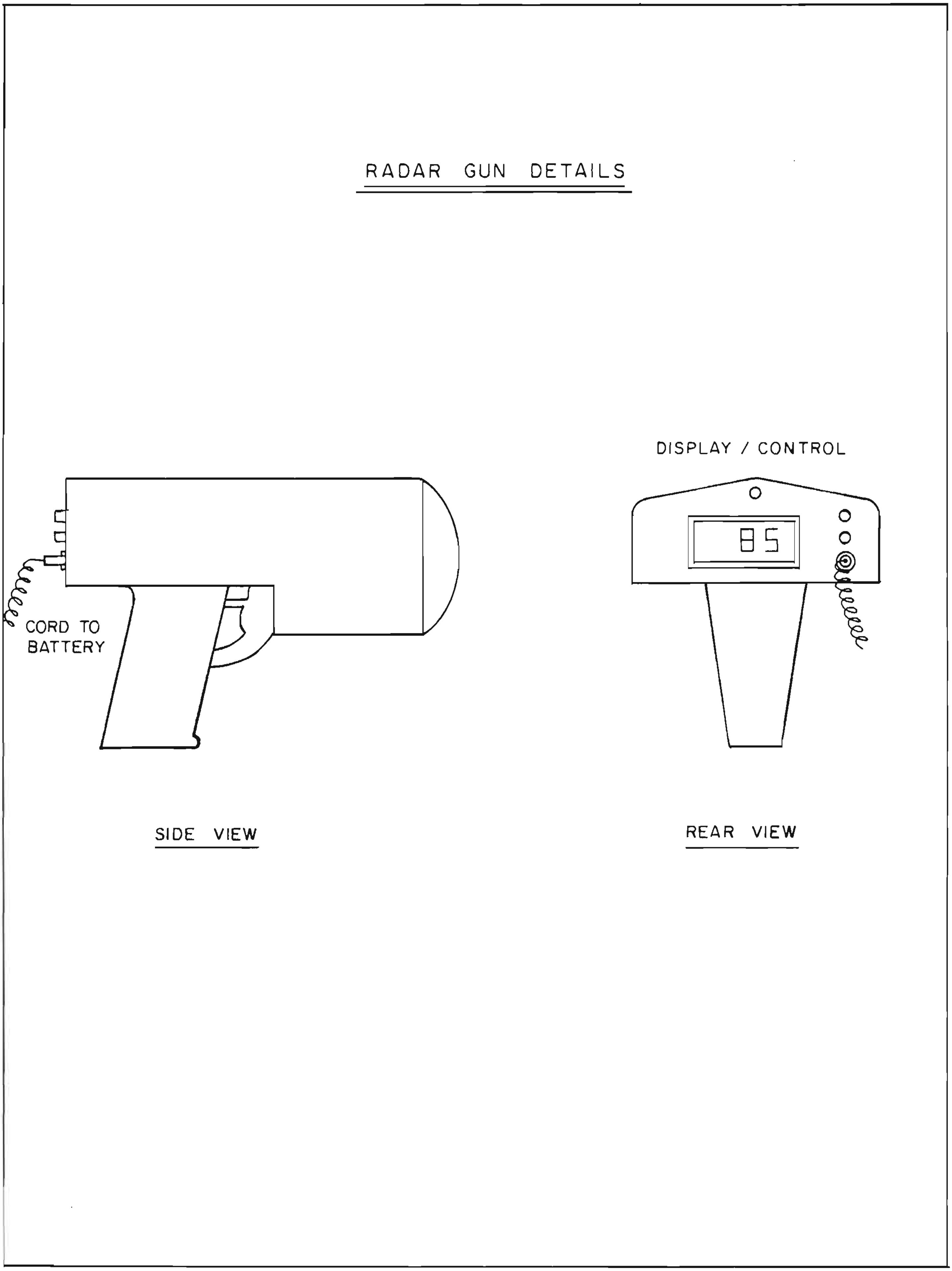

Fig. 5 Radar Gun

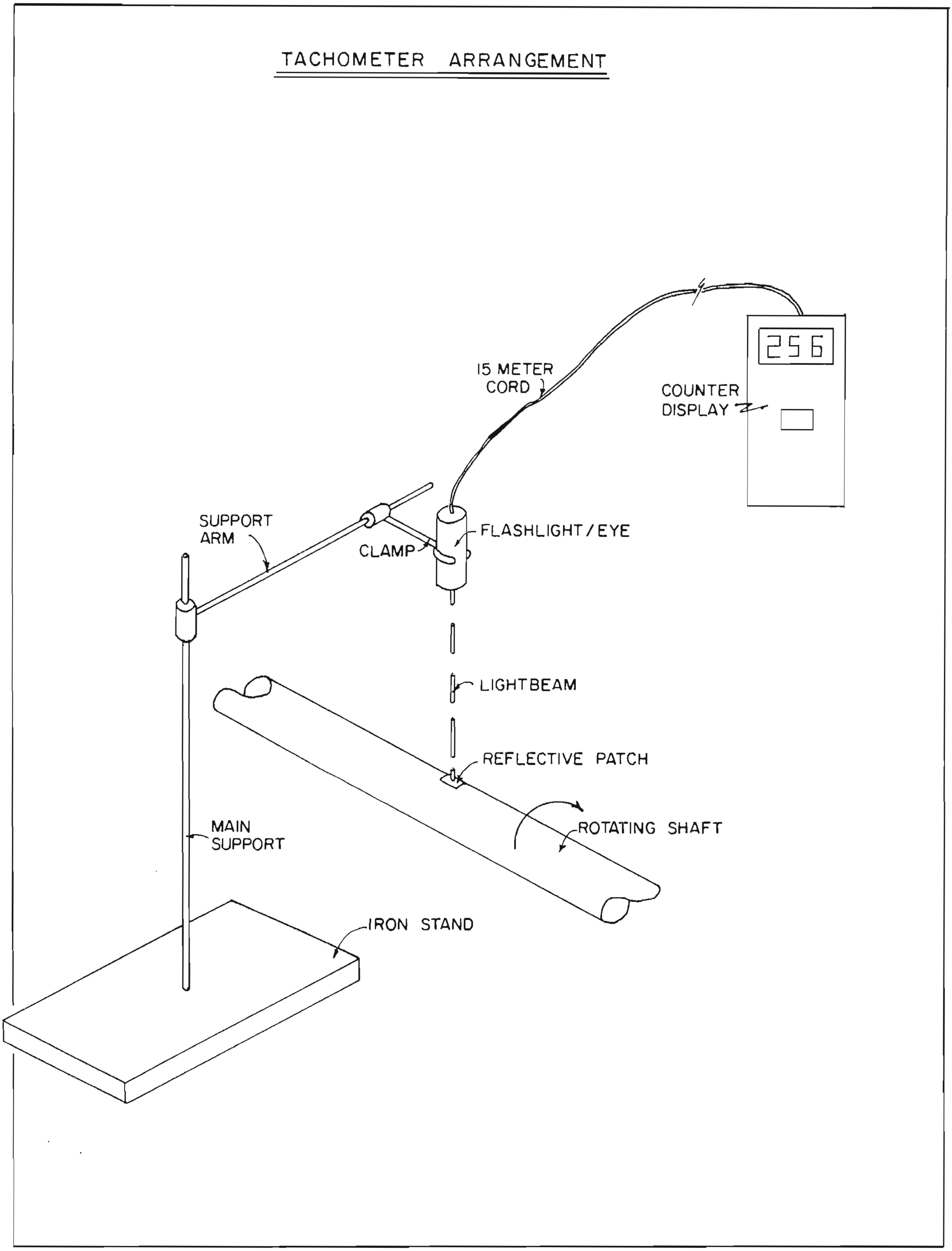

Fig. 6. Tachometer Arrangement

Standpipe

A standpipe composed of two closed containers mounted on a plank and connected with clear 3/8" hose was used to provide an accurate measure of the engine's fuel consumption. Regularly graduated volume levels were measured and marked on the hose. The containers were filled through a two-way valve from the bottom with a 25 litre tank mounted on top of the wheelhouse. A three-way valve allowed fuel to be burned from either the standpipe or the wheelhouse tank. (Fuel was only burned directly from the wheelhouse tank during start up). Almost 200 various brass fittings, sections of hose and clamps allowed the standpipe to be connected to virtually any fuel system. To measure the actual amount of fuel burned, the return line (normally leading back to the main tank) was tied back to the main-line. The standpipe was connected to the engine in such a manner that the main fuel tanks of the boat could be switched back on, and the returned fuel sent back to the main tanks (See Figure 7).

TESTING PROCEDURE

The vessels selected for full-scale trials were chosen from files compiled during the December 1984 - April 1985 period. These files contained pertinent information on vessel characteristics (RPM, Speed, Length, etc.).

Trials were arranged and conducted in such a way to maximize the number of vessels tested and minimize inconvenience to fishermen. Weather conditions also affected scheduling.

A test began with the installation of test equipment. When all equipment was in place, the skipper would steam to a suitable location where the tests could be conducted under minimal wind, tide and current influences.

Five to seven runs were conducted at increasing propeller revolutions in increments of 200 RPM. The number of trials completed was dictated by available time, weather, sea conditions and the skipper's willingness to run his engine at high revs.

To begin the test, the vessel steamed straight away from land at an agreed propeller RPM. A member of the team would operate the standpipe while another monitored vessel speed and shaft RPM, using a radar gun and shaft mounted tachometer. A stopwatch with increments of 1/100 ths. of a second was used to determine the time required to consume a predetermined amount of fuel. Three readings were taken from each instrument while steaming away from land; the vessel was then brought around without changing the RPM and headed back for another three readings. By measuring both ways, most of the variations due to wind, tide, and current were averaged out.

On occasion, data was processed immediately and given to the fishermen at the dock, but most often analysis was completed and delivered at a later date.

ENER SEA DATA MANAGEMENT SYSTEM (EDAMS)

The EDAMS is an organizational tool developed for the Ener Sea Program (Harris, 1985). Its primary function is quick and easy access to Ener Sea data.

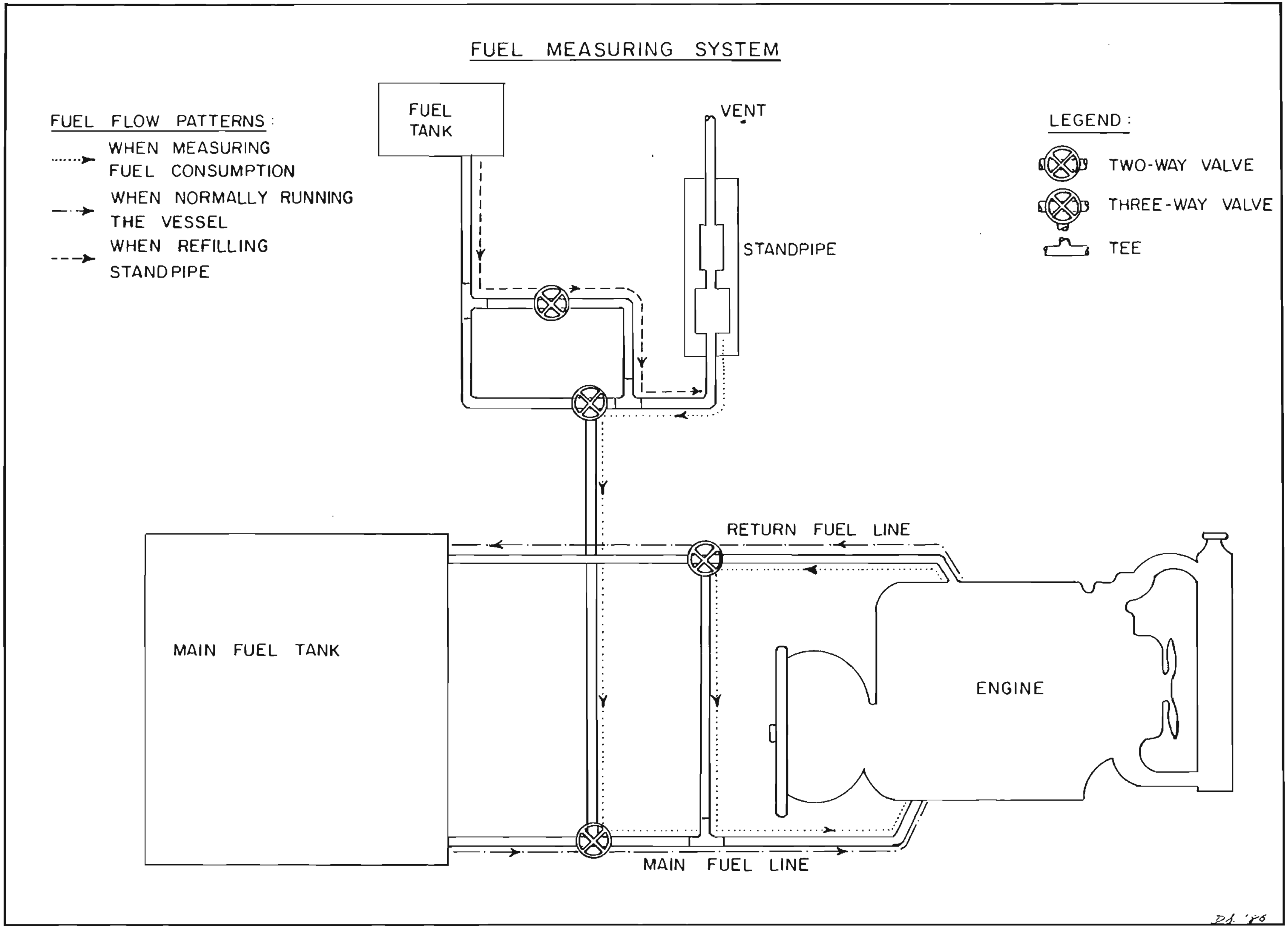

FIG. 7. Fuel Measuring System

Although the system has been in place a short period of time, it is fair to say the goal of setting up a data base for the Ener Sea program has met with unqualified success. It has been modified and expanded to carry out more of the project's work (Chalk 1986). EDAMS is user friendly, and step-by-step instructions allow someone with no knowledge of dBase III* to operate the EDAMS system quite effectively.

The system contains four direct programs, which are:

1. Ener Sea Office Organizer - Provides a list of Government and Industry contacts.
2. Ener Sea Program Information - Information on contacts made with fishermen.
3. Ener Sea Fleet Data Management - Stores vessel parameters and information obtained from the VACS program.
4. Ener Sea Files On Inshore Fleet - Contains information on the inshore fishing fleet.

The benefits of having a data base system in place are readily apparent when information is required on a particular vessel or fisherman and can search through stacks of files in quick order. The EDAMS system saves the Ener Sea personnel a substantial amount of time now spent doing more productive tasks. With its highly modular and expandable nature, EDAMS lends itself readily to changes and expansion. The EDAMS has a good potential for improvement through expansion of the present structure and the linking with other Ener Sea relevant programs.

*dBase III Trademark of Ashton-Tate

THE IMPACT OF THE ENER SEA PROGRAM ON THE NEWFOUNDLAND FISHING INDUSTRY

Sufficient work was carried out by the Branch during the 1984/85 fiscal year to assess the Ener Sea program's impact on the inshore Newfoundland fishing industry (Carberry, 1986).

IMPACTS DUE TO CONTACT WITH ENER SEA

Information collected at cost reduction/energy efficiency seminars suggest that fishermen in attendance would reduce their operating RPM by 118 on average during the 1985 fishing season. When this average was applied to collected data, potential fleet wide, a 15% fuel savings was possible. With the fuel bills accounting for 65% of operating costs in some instances and fishermen's experiences with low incomes, it was clear these savings would be very significant.

In an attempt to correlate the actual impact Ener Sea has on fishermen (i.e. actual behaviour) rather than the fishermen's prediction at the time of the seminar, a follow-up survey was conducted. As time and resources were restrictive, the statistical validity of the survey was somewhat compromised. (See Tables 8 to 11).

The Tables classify the fishermen into groupings based on the level of contact they had with Ener Sea.

TABLE 8. **Summary of Seminar Results**

Went to Seminar But Did Not Visit Ener Sea Van				
Respondent	Previous RPM	Current RPM	RPM Reduction	Recommendations/Comments
1	2550	2100	450	Engine tune-up
2	2350	1975	375	Blade Repaired
3	2600	2350	250	
4	2250	2100	150	
5	2000	1850	150	
6	-	-	-	Already Cut Back
7	-	-	-	Already Cut Back
Average	N.A.	N.A.	196	N.A.

TABLE 9. **Summary of Seminar Results**

Went to Seminar And Visited Ener Sea Van*				
Respondent	Previous RPM	Current RPM	RPM Reduction	Recommendations/Comments
1	3000	2000	1000	
2	2600	2350	250	
3	1750	1550	200	
4	2600	2450	150	
5	2150	2000	150	Will change propeller
6	2000	1850	150	Stern post & propeller
7	—	-	-	Already cut back
8	-	-	-	Already cut back
9	-	-	-	Already cut back
Average	N.A.	N.A.	211	N.A.

*Had their vessel analyzed by VACS.

TABLE 10. **Summary of Fuel Consumption Results**

Subject to Fuel Consumption Analysis										
Respondent	Previous RPM	Consumption Gal./hr.	Current RPM	Consumption Gal./hr.	**RPM* Reduction**	% Decrease Consumption	**% Fuel** Saved**	A	B	C
1	2300	5.50	2000	3.37	**300**	38.7	**34.9**	Yes	X	
2	2500	3.10	2000	1.70	**500**	45.2	**31.0**	Yes	X	
3	2000	5.80	1875	4.80	**125**	17.2	**15.4**	Yes	X	
4	2800	5.78	2600	4.78	**200**	17.3	**13.5**	Yes	X	
5	1850	6.95	1750	6.01	**100**	13.5	**10.5**	Yes	X	
6	-	-	-	-	**0**	0.0	**0.0**	Yes	-	-
7	-	-	-	-	**0**	0.0	**0.0**	Yes	-	-
8	2000	6.55	1800	4.56	**200**	30.4	**26.9**	Yes		X
9	2100	5.80	1850	4.00	**250**	31.0	**26.5**	Yes		X
10	2050	5.98	1950	4.90	**100**	18.1	**17.1**	Yes		X
11 ***	2200	5.71	2000	4.40	**200**	24.3	**20.1**	Yes	X	
12	2250	5.91	2200	5.55	**50**	6.9	**5.0**	No	-	X
13	-	-	-	-	**0**	0.0	**0.0**	No	-	-
Average	N.A.	4.39	N.A.	3.39	156	18.7	15.4			

A - Attended a Seminar (Yes/No)

B - Reduced RPM as a result of seminar

C - Reduced RPM as a result of Fuel Consumption Analysis

* Note: Each respondent with 0 RPM Reduction stated "Already cut back"

** Note: <u>This column is adjusted for the extra time the vessel spends steaming at lower speed.</u>

*** Note: Tachometer was not working - Average of other boats which have reduced R.P.M. has been applied (rounded)

TABLE 11. **Savings per Contact Grouping**

Group	Number	Average RPM Reduction	Fuel Saved (Adjusted)
General Contact	N.A.	N.A.	N.A.
Attended Seminar (Not Van)	73	196	19.3% (Est.)
Attended Seminar (And Van)	60	211	20.8% (Est.)
Fuel Consumption Analysis	18	156	15.4% (Actual)
	TOTAL 151	AVG. 198	AVG. 19.5%

The estimated <u>direct</u> impact of the Ener Sea Program as of September, 1986, with 151 vessels cutting back an average of 198 RPM (weighted) is an average fuel consumption reduction of 19.5% (straight line estimate).

FLEET SAVINGS

RPM Reduction

Maximum potential savings from RPM reduction can be calculated as: 41% savings* multiplied by the total amount of fuel burned by the Newfoundland Nearshore Vessel Fleet. Although, on examination, this estimate appeared reasonable, several refinements are necessary because: a) not all vessels registered were actively fishing, b) the average operator did not run at maximum RPM and, c) many operators believed they'd cut back to a point where additional cuts had a marginal effect on speed (28% of those surveyed above).

*Note: 41% savings estimate came from the speed/fuel consumption testing ie. a one knot reduction from maximum speed.

The number of active vessels (defined by the Economics Branch, Newfoundland Region, as those vessels with landings valued above $43,000, and licensed as a full-time fisherman) were estimated to be 861. (Anon.1985c).

This figure is adjusted for 63 vessels in Labrador (Anon.1985b), not included in this economic survey but included in the Newfoundland Region. Estimating that 11% of the Labrador vessels are inactive (Anon.1985c), the total number of 'active' vessels based in Newfoundland is 917.

When the survey results are applied to the fleet, 917 vessels would cut-back by an average of 198 RPM, (Carberry, 1985), with an average fuel savings of 19.5%. By using fuel cost data from 1984, it was concluded the average fisherman burned $4,260 of fuel in 1984 (Anon.1985a). This meant the fleet savings could be $761,751.90 or 1.93 million litres (approx.) at 39.45¢ per litre.

Propeller Change

Fishermen could avail themselves of several benefits through the Ener Sea program's propeller selection program. The proper selection process led to: a) greater fuel efficiency and; b) lower propeller repair and replacement costs due to cavitation.

Unfortunately, vessel design often dictates the propeller used, not allowing for the optimal prop/vessel match. This led to a third benefit from Ener Sea; the improvement in vessel design as a result of increased awareness by fishermen.

Of the 21 vessels tested for fuel consumption, RPM and speed, there were no underwater measurements available for six of these vessels. Eight vessels had clearances too small to allow installation of larger, more efficient blades. Propeller changes were able to be made on the remaining seven vessels.

The results of the testing on all 21 vessels (Table 7) plus the analysis for fuel savings related to propeller change on seven of the vessels (Table 12) were used to estimate the total fleet savings from both RPM reduction and propeller change.

TABLE 12. Summary of Saving Due to a Propeller Change

Vessel Number	RPM	Gal./ hr.	Old Propeller	New Propeller	% Fuel Saved
1	2,550	2.37	B3, D22, P19	B4, D23, P17	6.97
2	2,178	4.15	B4, D28, P24	B4, D30, P22	5.22
3	1,800	4.56	B3, D24, P16	B3, D25, P15	2.94
4	2,350	2.90	B3, D18, P13	B4, D19, P12	3.41
5	2,250	2.75	B3, D20, P18	B3, D21, P17	4.85
6	1,700	15.60	B3, D54, P30		0
7	1,850	7.00	B3, D36, P25		0
				TOTAL	3.34

The number of vessels in the fleet available for propeller change is 7/15, the six for which no clearance measurements were available being subtracted from the 21 or 47% of the total fleet of 917; thus 917 x .47 = 431.

The fleet savings from a propeller change then becomes = 431 x $4,260 (avg. cost of fuel burned per vessel) x 0.334 (avg. fuel saving per vessel) = $61,324.40 per year.

The total fleet savings over a 10 year period from propeller change and RPM reduction is then = [($761,751.90 (total annual savings from RPM reduction)) + ($61,324.40 (Savings from propeller change))] x 10 = $8,231,000 (non adjusted).

TELEPHONE SURVEY

Another survey was undertaken by telephoning a target group of 83 fishermen. Each one was asked 16 questions related to cost reduction. After answering these questions they were asked if the efforts and methods mentioned in the previous questions resulted in lower operating costs. The results were as follows:

Over 75 percent of the respondents said "yes" (Whiteway, 1986) by employing such cost saving methods they were actually able to reduce their operating costs. They were especially positive about the fuel savings gained by "throttling back".

Twelve people said they saved "a great deal"; while nine said "a little"; two said $200 - $400 a year. Three people reported a fuel cost reduction of 1/2, one a reduction of 1/3 and three a reduction of 1/4. One person said he never noticed a difference and another said it was "hard to tell".

CONCLUSIONS

The Ener Sea Program has developed substantially since its 1982 inception. These developments resulted from extensive data collection enabling the Vessel Analysis Computing System (VACS) to be improved and the

Ener Sea Data Management System (EDAMS) created. These improvements and additions have made the Ener Sea Program more accurate, reliable and organized for the future.

It may also be concluded that the Ener Sea Program has begun to make fishermen more aware of the need to save fuel in order to make their enterprise more viable. This realization has been heightened through seminars, individual vessel analysis, vessel testing and other activities offered through the program.

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