Some Comments on Merchant Ship Trials

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A short review and a comparison of ships' trials are given, with references to general practice and also standardized trial codes. As a consequence of deliveries from several shipbuilding countries, it was decided to produce a Norwegian Trials Code. The contents of this Code are presented with examples of some main items. The Code is prepared not only for checking of satisfactory operation, but also for control of specified capacities of main and auxiliary equipment. Examples of presentation are given.

INTRODUCTION

The efficient performance of a ship is of great importance to the owner. Although every effort is made to retain speed, output and low consumption, there must always be a decrease in efficiency during the lifetime of any vessel. Heat exchangers will lose their efficiency and moving parts will be exposed to wear.

It often happens that it is impossible to obtain performance figures for the new plant, and this makes it difficult to check performance in service. Delivery trials take place all too often without records being kept. Even if records are kept, their form does not give the information necessary for the eventual evaluation of service results.

TRIALS PROGRAMMES

If contract documents from the major shipbuilding nations are compared, they will be found to be surprisingly divergent. Nevertheless, it is hard to justify the common lack of detailed description with regard to delivery trials. When the value of modern ships is taken into consideration, it is inexplicable.

TABLE I.—COMPARISON OF DURATION OF DELIVERY TESTS

Item	Approximate value, £	Duration of delivery tests
Hydro-electric turbine plant	1,000,000	About two weeks
Paper mill	500,000	About three weeks or more
Steam boiler	200,000	About one week
Locomotive	100,000	About one week or more
Ship	2,500,000	About one to three days

The contracts usually specify: Deadweight, horsepower and speed fully loaded.

With few exceptions the trial trip is only mentioned in connexion with the speed trials and the tests to be carried out in order to satisfy the classification society.

The owners often leave the trials and testing of a newly-built merchant ship to the builders' customary trial programme.

Such a conventional trial trip programme is only too simple:

i) Speed tests over a measured mile, with measurement of horsepower.
ii) Test of steering gear.
iii) Starting tests of main engine (M/S).
iv) Anchor test.

Some consideration should be given to the great part played by the classification societies during the trial trip. Their requirements ensure that some reasonable tests at least are carried out in a uniform way, wherever the ship is built. In the following paragraphs, however, references to the class requirements will not be made. On the other hand, the checking of some charterer's and owners' typical requirements will be dealt with.

What should be tested

The following lists give an idea of which requirements should be checked.

Requirements of charterers:

a) Speed (knots).
b) Fuel consumption.
c) Deadweight.
d) Loading/discharging capacity.

Requirements of shipping company (in addition to the foregoing):

1) Output/capactiy of main and auxiliary engines.
2) Output/capacity of engine equipment.
3) Output/capacity of deck machinery and outfit.
4) Output/capacity of ventilation in cargo spaces.
5) Navigating instruments.
6) Manœuvring.

In order to fulfil these requirements, certain trials programmes have been worked out.

S.N.A.M.E. Trials Codes

The Society of Naval Architects and Marine Engineers, N.Y. (S.N.A.M.E.) introduced the following codes:

i) Standardization Trials Code 1949.
ii) Code on Manœuvring and Special Trials and Test 1950.
iii) Economy and Endurance Trials Code 1952.

These codes have been—and still are—of great value. The trials and tests mentioned in the S.N.A.M.E. codes have, to a great extent, become standard, not only in the U.S.A., but also in other shipbuilding countries.

The S.N.A.M.E. codes describe, in an excellent way, which trials and tests should be carried out. The codes do not, however, indicate in which way the results are to be presented. It is also desirable that a closer check be made on the specified capacities of various pieces of equipment on board.

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Scandinavian Approach

Already in 1959 a proposed programme for manœuvring tests had been published in a report by the Swedish State Shipbuilding Experimental Tank[1]. The report is to be considered as a contribution to a future Swedish Trial Code.

The Danish Ship Research Institute published their "Ship Trial Trip Code 1964"[2] recently. This code is so worded that it could be used "as part of a specification". It seems practical and includes a number of observations to be recorded during the different tests. Main stress is laid upon trials covering speed, manœuvres and propulsion machinery.

NORWEGIAN TRIALS CODE

At the Scandinavian Ship Technical Conference 1962 the trials of new merchant shipbuildings were discussed[3]. Efforts to work out a common Scandinavian Trials Code did not lead to any conclusions. Later on in the same year, however, it was decided to set up a separate Norwegian Committee to work out a Trials Code. The Committee included representatives of yards, model test basin, research and owners. The work was finished in Summer 1964, and the Code will be published in the near future.

Norway obtained, in 1963, some 1,700,000 gross tons of new ships. Only 370,000 gross tons were built in Norwegian yards (only about 15,000 labourers), the rest being delivered from eight different shipbuilding countries.

It is obvious that deliveries from many sources lead to a lack of uniform testing. This again results in widely differing selections of test data, which are believed to be rather inconvenient when analysing the vessels' later service results and readings.

The Code contains the following paragraphs:

1) Speed trial (see Example 1).
2) Manœuvring and steering gear (see Example 2).
3) Anchor—windlass.
4) Winches.
5) Inclination test.
6 a) Cubic;
  b) Deadweight.
7 a) Propulsion machinery—output (see Example 3);
  b) Propulsion machinery—consumption;
  c) Propulsion machinery—manœuvring;
  d) Propulsion machinery—torsional vibration;
  e) Propulsion machinery—potential voltage;
  f) Propulsion machinery—turning gear.
8 a) Electric generators—output;
  b) Electric generators—consumption;
  c) Electric generators—synchronizing.
9) Boilers—capacity test (see Example 4).
10) Evaporators—capacity test.
11) Sea water main cooling water pumps—capacity test (see Example 5).
12) Sea water auxiliary cooling water pumps—capacity test.
13) Fresh water main cooling water pumps—capacity test.
14) Fresh water auxiliary cooling water pumps—capacity test.
15) Bilge pumps—capacity test.
16) Cargo pumps—capacity test.
17) Ballast water pumps—capacity test.
18) Fire pumps—capacity test.
19) Air compressors—capacity test.
20) Refrigerating compressors—capacity test.
21) Ventilation, reefer compartment—capacity test.
22) Ventilation, cargo holds—capacity test.
23) Ventilation, engine room—capacity test.
24) Fresh water coolers—capacity test.
25) Lubricating oil coolers—capacity test.
26) Steam condensers—capacity test.
27 a) Purifier;
  b) Purifier heater.
28) Vibrations (hull) measurements.
29) Noise level measurement.
30) Compass adjusting.
31) Radio direction finder adjusting.
32) Radio, certifying of.
33) Log, checking of.

Presentation of Trial Results

The main idea behind the Code is that the results should be presented in a way which enables easy and practical use. Contrary to previous practice, the code thus gives examples of recommended report forms. Further, the Code prescribes the information which must be available on board when the trials start.

There is little justification for dealing with each item of the programme. Only a short review, with examples of application, will be given.

As general conditions the Committee sets forth as requirements:

a) Depth of water $> 10 \times d \times V_S / \sqrt{L}$ (Taylor's formulae*).
b) Wind not to exceed Beaufort 5 for ship $L > 450$ft. and wind not to exceed Beaufort 4 for ship $L < 450$ft.
c) It is recommended that speed and manœuvring trials be recorded by means of Decca. Other methods of observation are permitted although it is felt that "Decca trials" will be increasingly applied in the future. The accuracy of the Decca readings is convincing[3, 4].
d) It is recommended that main engine output be measured by means of torsionmeter. For reciprocating engines, indicator cards may be used. It is, however, taken that the accuracy of pv-indicators (±5 per cent) is inferior to that of torsionmeters (±2 per cent).

It is worth stressing that the Norwegian Trials Trip Code is worked out with a view to fitting into most of the known trials procedures. It does not, therefore, encompass either complicated tests or evaluations. In fact, some members of the Committee would have preferred to include more details regarding procedure, for instance, accuracy of readings and types of approved instruments. It is, however, considered to be of major importance to introduce a fairly simple code which will be acceptable to all parties concerned.

Example 1—Speed Results

As will be seen from Fig. 1, the vessel's speed is plotted

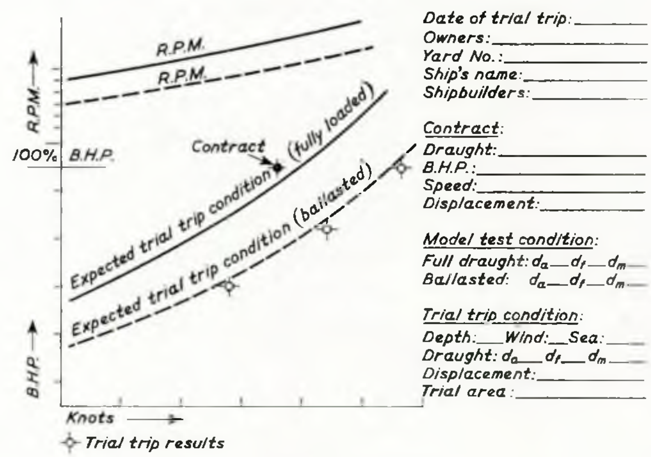

FIG. 1—*Speed trials*

against the brake horsepower. The predictions from the model test basin are drawn in, as is also the result of the speed trials, making comparison easy.

It should be noted that model tests are also carried out

*With reference to loss of speed due to shallow water, see B.S.R.A. report No. 377.

in ballast condition which conforms with trial trip draught for most dry cargo vessels.

The speed trials are to prove that the contract requirements are met. The speed results do, however, also play an important part in relation to the actual *service speed* reached in operation.

The prediction of the expected service speed has always caused some headache to the owners or in casu the owners' technical staff. The whole question has been given greater significance by the introduction of, for instance, "Shelltime III".

This charter party states under clause 24:

> ". . . Owners guarantee that the average speed of the vessel will be not less than . . . knots with a maximum bunker consumption of . . . tons Diesel oil/. . . tons fuel oil per day for all purposes excluding cargo heating and tank cleaning."

It will be noted that the *average speed* through the whole charter party period is stated, which means that not only weather conditions, but also increased skin friction (fouling) will have to be taken into account.

Research has recently led to the publication of quite revealing figures for the increased skin friction, observed over a longer period. After the first year or two—depending on condition—a resistance increase of about 30 per cent seems likely[5]. Actual measurements show that a 32,000-d.w.t. tanker, five years old, had to increase the engine output by 27 per cent in order to achieve the same speed as on the trials[5]. Approximately the same figure, 33 per cent, was found by carrying out speed measurements with a seven-year old 34,000-d.w.t. tanker prior to and after drydocking. During the drydocking the underwater surface was sandblasted and given three coats of paint[6].

Because of the increased fraction for friction resistance, there are reasons to believe that the fouling of the bottom will prove to play an even more important part for the bigger vessels such as mammoth tankers and bulk carriers.

What Will the Service Speed Be?

In Fig. 2, b.h.p./speed curves are plotted, including 30 per cent increased resistance for full draught as well as ballast conditions. Based on half and half loaded/ballasted the figure indicates expected service speed.

For this type of vessel an addition of about 20 per cent to the full draught resistance curve should give reasonable results.

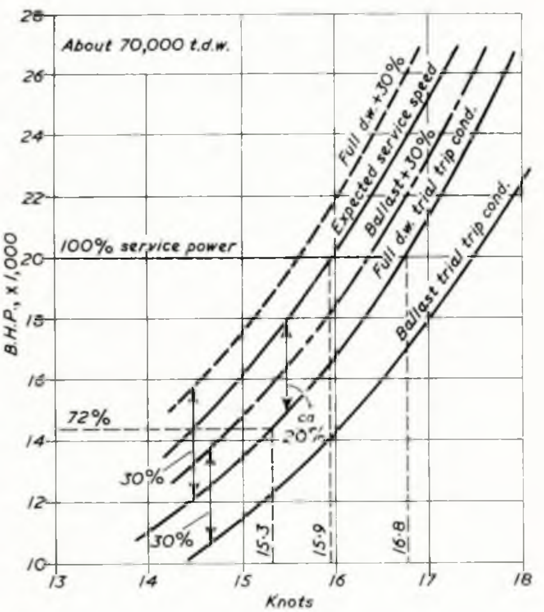

FIG. 2—*Estimation of service speed based on tank test*

Type of engine (Diesel or steam) and trade routes will have to be taken into account for final assessment of service speed. It is of interest to note what is stated in "specification of Shell new-buildings 1961":

> "Average service speed is considered as the speed of the vessel over a period of years, and for say the first eight years it is suggested that this will approximate to the speed obtained on fully laden trials at 72 per cent of service power."

The corresponding speed is also shown on the graph. This is almost identical with the estimation as just described, provided an output of 90 per cent for the propulsion machinery is achieved.

Example 2—Manœuvring Tests

The tests include:

i) Turning circle test—port and starboard.
ii) Z-manœuvre (optional).
iii) Course stability (optional).
iv) Crash stop ahead.
v) Crash stop astern (optional).
vi) Coasting test (optional).
vii) Dead slow.

Testing of the steering gear (both units) during ahead and astern manœuvring is included. Details are, however, not specially mentioned inasmuch as the steering gear test is a classification society requirement.

Plotting of all manœuvring tests is based on Decca readings. The recommended way of presentation is shown in Figs. 3, 4, 5 and 6.

Boutakoff's double turn is shown in Fig. 7. This manœuvre is not included in the Trials Code. Nevertheless, it is worth while mentioning, mainly because it is taught at nautical colleges as the manœuvre to perform in connexion with "Man overboard" (note the distance between the original track and the return track).

Although the observations themselves are of interest, it is obvious that comparative "standard" figures are desirable. Relatively few results of turning circle and stop tests have been published. Test results from several sources were, therefore, collected and are given in Tables II and III.

In Fig. 8, turning circle test results for 60 vessels are shown, and in Fig. 9 crash stop results for 70 vessels are

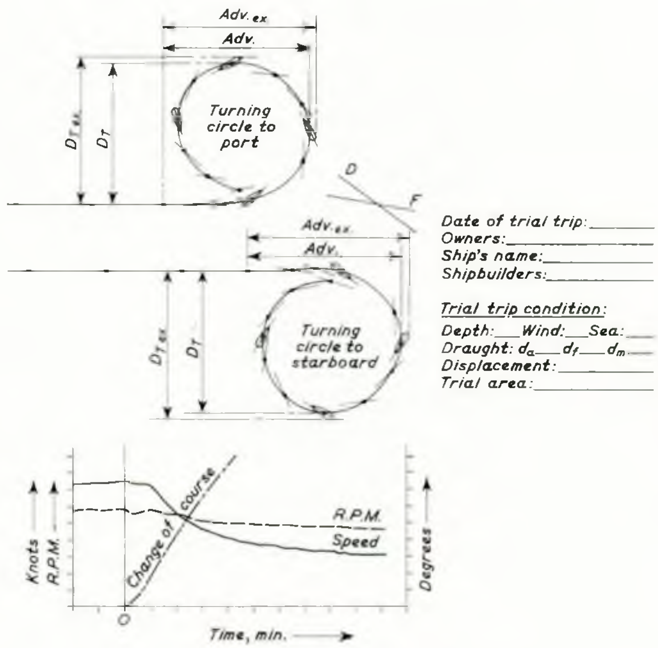

FIG. 3—*Turning test*

Table II.—Circle test: Single-screw ships/tactical diameter/advance—Decca observations.

M.S. T.S.	Lpp		A_R	C_B	da	df	dm	Port turn			Starb. turn			Wind/ sea	Remarks
								$D_{tact.}$	Adv.	360°	$D_{tact.}$	Adv.	360°		
	m.	ft.	sq. m.	—	ft. in.	ft. in.	ft. in.	m.	m.	time min. sec.	m.	m.	time min. sec.		
T	262	860	53·6	0·794			47 6	970	900		820	910			
T	250	820	61·0	0·805	46 11	46 9	46 10	675	800	7 50	780	700	8 30	5/3	ex.
T	250	820	61·0	0·793	48 6	46 6	47 6	880	725	9 20	735	770	9 0	6/2	ex.
T	238	782	45·0	0·796	43 2	43 2	43 2	840	790	9 30	1,080	880	10 0	4/–	ex.
T	238	782	45·0	0·796	43 0	43 0	43 0	730	750	8 15	840	675	8 30	2/0	ex.
T	238	782	45·0	0·796	43 0	43 0	43 0	790	670	8 0	835	680	8 30	4/–	ex.
T	238	782	45·0	0·796	43 7	43 7	43 7	990	835	8 15	900	700	9 0	2/1	ex.
M	227	745	42·9	0·801	38 0	38 0	38 0	1,020	685	10 0	1,080	845	9 50	6/3	
T	227	746	43·2	0·803	40 4	38 8	39 6	825	905	8 50	855	920	9 30	4/1–2	ex.
T	227	746	42·5	0·803	39 7	39 7	39 7	650	900	8 30	980	760	9 0	2/2	ex.
T	227	746	42·5				(28 0)	815	790	7 40	960	855	8 20	1/1	ex.
M	227	746	42·1	0·803	39 6	39 6	39 6	800	650	8 0	790	680	9 10	5/3	ex.
M	225	741	37·8	0·796	38 6	38 6	38 6	780	800	9 0	900	830	9 10	2/1	ex.
M	225	740	39·2	0·800	38 5	37 7	38 0	900	1,020	—	880	1,050	—	1/3	
T	219	715	36·2	0·780	38 0	38 0	38 0	730	710	7 30	800	760	7 40	2/–	
M	215	703	38·1	0·808	40 1	38 9	39 5	550		7 18	650		7 32		
T	215	703	35·2	0·795	38 6	38 6	38 6	750	640	—	690	750	—		
T	215	703	35·2	0·795	38 6	38 6	38 6	625	565	—	545	735	—	8/–	
T	215	703	35·2	0·795	38 6	38 6	38 6	650	530	—	740	695	—		
M	210	689	34·7	0·787	37 10	36 6	37 2	850	595	8 30	920	715	8 40	—	ex.
T	209	685	35·5	0·775	36 7	36 8	36 9	810	815	7 20	675	655	7 0	2/1	ex.
T	209	685	35·5	0·775	36 6	36 6	36 6	930	765	7 0	680	740	7 20	2/–	ex.
T	204	670	34·2	0·787	35 6	35 0	35 3	660	645	7 10	880	760	7 30	5/3	ex.
M	204	670	34·2	0·785	35 3	35 0	35 1				825	720	9 0	2/1	ex.
M	203	665	34·4	0·774	37 0	36 11	36 11½	890	805	9 40	885	840	9 30	0/3	ex.
M	198	650	33·3	0·776	35 3	35 3	35 3	670	620	7 30	600	600	7 40	3/–	ex.
M	196	645	33·1	0·792	36 9	35 11	36 4	800	635	—	750	765	—	5/3	
M	195	640	34·9	0·778	37 1	35 1	36 1	720	500	8 0	615	440	7 40	—	ex.
M	192	630	19·6	0·812	21 2	14 10	18 0	830	620	7 50	790	735	8 0	7/3–4	ex.
M	190	625	38·8	0·796	35 0	33 2	34 1	555	520	—	650	770	—	2/1	
M	184	602	28·7	0·792	23 2	16 3	19 8	675	820	7 30	690	665	7 30	4/–	
M	184	605	29·4	0·760	24 6	13 6	19 0	720	—	8 20	710	—	8 0	3/–	
M	177	580	26·7	0·763	33 4	32 10	33 1	650	665	—	720	580	—	4/1	
M	177	580	26·7	0·763	33 5	32 7	33 0	690	590	—	640	610	—	2/1	
M	177	580	26·7	0·718	24 0	14 0	19 0	790	650	—	740	570	—	1/1	
M	175	577	27·3	0·789	36 8	21 0	24 2	620	600	8 0	570	600	7 40	5/3–4	ex.
M	175	575	25·6	0·780	32 7	32 10	32 9	680	(690)	—	630	(650)	—	1/0	
M	171	560	26·3	0·740	24 0	19 2	21 7	680	780	—	650	700	—	3/1	
M	169	551	25·5	0·793	23 1	18 11	21 0	656	656	6 20	660	660	6 40	3/1	ex.
M	168	550	22·2	0·760	30 1	29 9	30 0	700	760	—	710	690	—	5/2	
M	167	548	21·8	0·760	—	—	20 1	610	500	7 30	620	510	8 0	1/0	
M	164	538	20·2	0·775	29 2	29 2	29 2	700	610	7 0	760	670	7 30	–/2–3	ex.
M	163	535	23·4	0·781	31 0	30 4	30 8	600	670	6 40	730	750	6 40	5/1	ex.
M	162	530	22·1	0·785	30 6	30 6	30 6	630	—	7 0	640	—	8 50	3/0	
M	161	526	20·7	0·753	30 5	30 5	30 5	725	585	—	710	590	—	—	
M	158	520	20·2	0·765	21 7	13 0	17 4	630	750	6 20	705	680	6 40	3/0	
M	155	509	20·0	0·717	19 4	16 1	17 8½	770	660	6 40	670	650	6 20	2/2	ex.
M	150	492	20·2	0·688	19 5	12 0	15 8	1,010	635	7 30	690	600	5 50	5/3	
M	150	492	20·2	0·688	19 1	11 8	15 4	1,020	790	7 20	500	430	6 0	6/3	
M	150	492	20·2	0·688	19 0	11 7	15 3	1,030	700	7 40	620	650	5 40	7/3	
M	149	490	16·0	0·547	20 9	13 9	17 3	745	580	—	770	650	—	3/2	

M	149	488	19·9	0·670	17 10	9 0	13 5	890	750	6 0	700	545	5 40	2/1	
M	148	481	19·6	0·757	21 2	10 2	15 7	680	520	6 0	690	490	6 0	7/4	ex.
M	145	475	20·0	0·730	19 5	19 7	19 6	600	510	7 20	570	650	6 30	2/–	
M	144	474	18·8	0·650	19 10	10 10	15 4	640	575	5 20	610	545	5 0	1/0	
M	137	450	18·5	0·545	20 5	13 7	17 0	860	435	—	860	595	—	6/2	
M	137	450	20·7	0·760	29 0	29 0	29 0	635	470	—	620	530	—	5/–	
M	134	440	17·6	0·684	18 0	12 0	15 0	670	630	—	540	510	—	4/2	
M	132	430	16·2	0·650	19 10	5 4	12 7	585	630	—	700	510	—	1/0	
M	130	425	16·2	0·644	19 5	10 5	15 0	660	550	5 50	630	515	5 40	0/0	
M	125	410	15·3	0·553	20 0	13 6	16 9	720	585	—	725	625	—	5/2	
M	120	391	13·3	0·612	20 2½	14 3	17 3	—	—	—	625	530	5 0	2/1	ex.
M	120	391	13·2	0·613	21 2	14 10	18 0	690	520	5 20	575	485	4 40	2/1	
M	120	395	15·8	0·595	19 4	6 4	12 10	570	(480)	5 10	470	(400)	5 0	2/0	
M	114	375	14·3	0·600	19 0	9 8	14 4	640	—	—	640	—	—	0/0	
M	107	351	12·0	0·600	16 5	8 5	12 5	490	510	5 10	535	515	5 05	4/0	

A_R = Rudder area
C_B = Block coefficient
d = draught (aft, forward and midship)
D_{tact} = Tactical diameter
Adv. = Advance
Remarks ex. = extreme reach (see text)

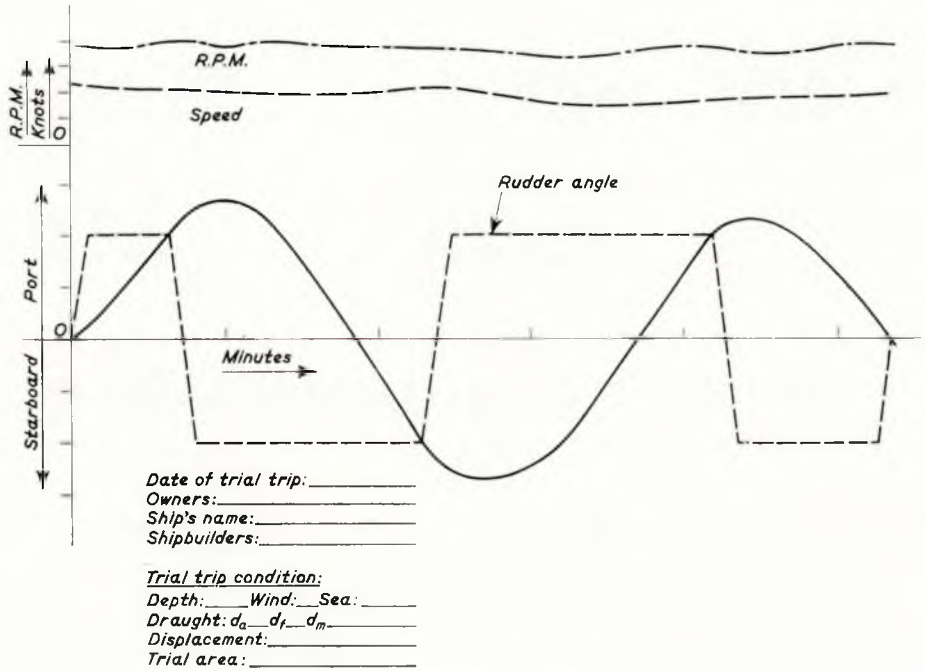

FIG. 4—*Z-manœuvre*

TABLE III.—CRASH STOP AHEAD—DECCA OBSERVATIONS

M.S. T.S.	Lpp		Displacement, tons	100 per cent output,	Initial speed,	Ship stop			Wind/ sea
						time	distance		
	m.	ft.		b.h.p.	knots	min.sec.	m.	ft.	
T	262	860	119,000	28,000	17·5		1,920	6,336	4/0
T	250	820	109,290	24,100	17·3	11 00	2,855	9,421	6/2
T	238	782	90,330	18,250	17·1	10 12	2,450	8,085	1/1
T	238	782	89,250	20,200	17·0	10 40	3,000	9,900	1/1
T	238	782	89,200	21,000	17·0	11 40	3,230	10,659	1/1
T	238	782	91,600	20,900	17·0	10 00	2,630	8,679	3/3
T	238	782	89,200	20,800	16·2	11 40	2,630	8,679	4/–
T	238	782	89,350	20,800	16·8	11 35	3,000	9,900	3/–
M	227	745	25,000	12,600	9·7	10 00	1,390	4,587	6/3
T	227	746	72,750	20,000	16·8	10 00	2,550	8,415	2/2
M	225	742	70,250	21,000	17·0	9 40	2,370	7,821	2/1
M	225	740	67,900	21,000	16·0		1,745	5,758	–/3
M	223	731	71,200	17,600	15·9	6 40			2/1
T	219	715	61,950	22,250	18·4	8 30	2,580	8,514	2/–
T	215	703	63,300	18,000	18·0		1,535	5,065	—
T	215	703	63,300	18,000	16·5		1,515	5,000	5/–
T	215	703	63,300	18,000	14·0		1,240	4,092	8/–
T	215	703	63,300	18,000	18·0		1,285	4,240	—
M	215	705	65,080	20,300	16·4	6 55			—
M	210	689	59,065	14,700	16·5	9 00	2,160	7,128	—
T	209	685	53,810	19,260	17·8	7 20	1,830	6,039	1/1
T	207	679	54,135	19,730	17·5	8 15	1,720	5,676	—
T	207	679	54,050	18,020	18·1	9 15	2,500	8,250	1/–
T	207	679	53,810	19,260	17·8	9 00	2,650	8,745	—
M	207	679	53,150	13,000	15·2	11 00	(2,600)	8,580	0/3
M	204	670	53,350	19,000	17·0	5 00	1,450	4,785	—
T	204	670	51,000	17,500	14·5	8 00	2,050	6,765	5/3
M	199	652	43,980	12,500	15·1	8 20	1,860	6,138	5/4
M	198	650	44,385	10,600	15·0	6 40	1,800	5,940	3/–
M	198	650	46,250	13,900	11·0		990	3,267	0/0
T	197	647	47,500	16,500	16·5		1,480	4,884	1/0
M	196	645	45,100	16,600	16·0		1,705	5,626	5/3
M	195	640	45,200	11,250	13·5	11 00	2,420	7,986	
M	192	630	25,000	12,600	15·0	7 00	1,600	5,280	7/3–4
M	177	580	33,000	12,500	16·3		1,300	4,290	2/1
M	177	580	33,000	12,500	14·5		1,220	4,026	2/1
M	177	580	17,900	12,500	17·0		1,210	3,993	1/0
M	169	551	19,470	7,300	16·4	5 40	1,370	4,521	3/1
M	169	551	17,700	8,750	15·0	5 40	1,350	4,455	4/3
M	167	549	24,175	8,300	12·0		980	3,234	5/–
M	167	549	25,100	8,000	13·5		1,325	4,372	5/2
M	167	548	17,700	7,250	16·5	7 00	1,920	6,336	1/0
M	164	538	24,000	8,100	15·0	6 40	1,580	5,214	–/3–4
M	163	535	26,640	8,750	17·5	4 17	1,400	4,620	5/1
M	162	530	26,120	8,100	15·0	6 40	1,300	4,290	2/–
M	162	530	18,070	12,500	16·0	6 20	1,450	4,785	—
M	150	492	9,100	7,500	18·4	3 45	1,030	3,399	3/3
M	150	492	9,250	7,600	18·4	4 00	1,020	3,366	3/3
M	150	492	9,430	8,000	18·0	5 05	1,300	4,290	3/3
M	149	490	7,360	11,200	18·0		775	2,557	3/2
M	148	481	10,620	7,000	15·0	3 20	1,120	3,696	—
M	148	486	7,900	7,250	17·7	3 10	740	2,442	2/1
M	145	475	13,350	5,800	14·5	5 16	1,190	3,927	3/–
M	144	474	8,700	9,200	17·6	3 20	740	2,442	5/4
M	143	470	10,700	7,500	—	6 00	1,245	4,108	
M	143	470	43,980	12,500	—	3 40	1,070	3,531	
M	143	470	10,620	7,500	16·0	5 00	1,080	3,564	
M	140	461	10,820	5,000	16·0	5 40	1,420	4,686	4/2
M	137	450	7,840	8,750	15·5	5 00	1,200	3,960	3/1
M	137	450	7,020	11,200	19·0		800	2,640	3/2
M	137	450	7,220	11,200	18·0		670	2,211	6/2
M	134	440	7,825	7,000	15·5		1,000	3,300	4/2
M	132	430	6,770	5,800	16·0		570	1,881	4/1
M	132	430	5,900	6,400	15·5		515	1,700	1/0
M	132	430	6,990	5,900	15·0		664	2,191	1/0
M	132	430	7,290	11,200	18·0		520	1,716	6/2
M	125	411	5,290	9,600	18·5	3 40	810	2,673	1/–
M	125	411	5,290	9,600	18·5	2 49	870	2,871	1/–
M	125	410	6,060	7,600	18·5		980	3,234	4/2
M	125	410	6,060	7,600	18·0		1,195	3,943	4/2
M	120	391	6,455	7,500	—	3 00	835	2,755	2/1
M	119	391	6,250	7,500	18·8	3 00	815	2,680	2/–
M	114	375	5,150	5,800	16·5	3 30	1,070	3,531	0/–
M	98	321	3,220	3,000	15·5	1 30	556	1,835	6/–

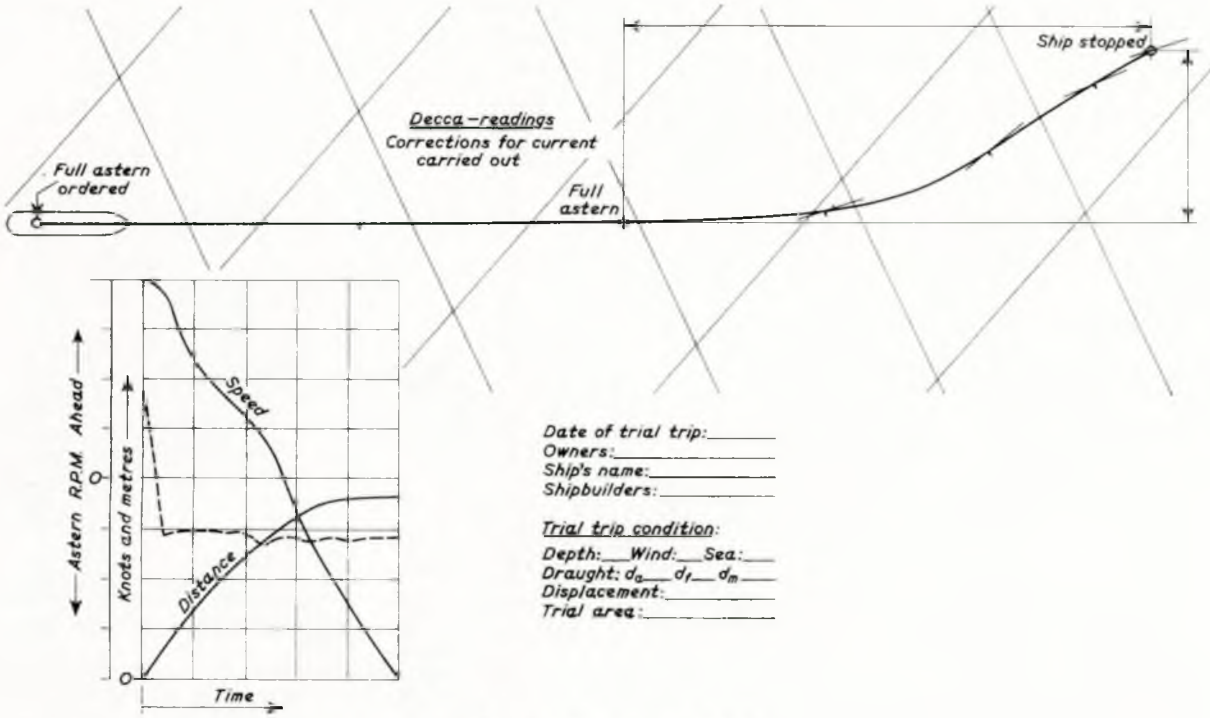

FIG. 5—*Crash stop ahead*

plotted. All results are based on Decca readings. Only tests carried out in reasonably calm weather have been expressed. Corrections for current are made where necessary.

It will be seen that Fig. 8 is based on tactical turning circle diameter and not on minimum turning circles. The reason is that very few tests are carried out in such a way that safe reading of the minimum circle is possible. Further it is believed that the tactical diameter is of major importance when actual manœuvres are discussed.

Some reports upon which the analyses are made give a somewhat larger diameter than those actually observed by Decca. The difference is explained in Fig. 3 Here the diameter ex. indicates the extreme reach of the vessel, and is also indicated in Table II.

The parameter:

$$\frac{D}{Lpp} \cdot \frac{100\ Ar}{Lpp \cdot d}\ \frac{d}{Lpp} \text{ and } C_B - \frac{da - df}{6d}$$

is built up in the same way as explained in reference[7] for minimum turning circles. For stop tests the parameter $\frac{\text{Depl.} \times V}{\text{b.h.p.}}$ is applied as in reference[3].

The measured values are somewhat scattered and do not give a clear mean. The tendency is, however, clear enough.

The reasons for scattering are believed to be:

a) Effect of different time needed for moving the rudder hard over.

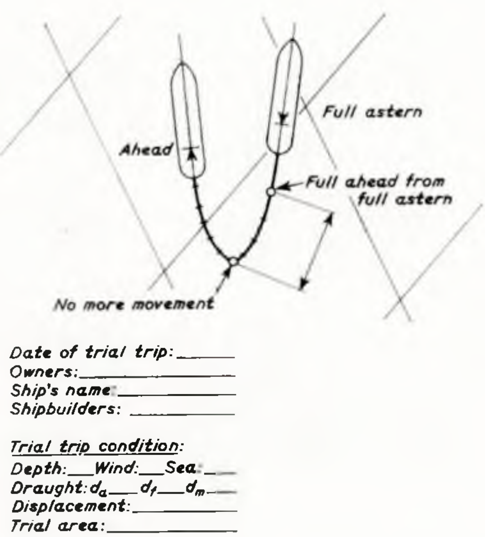

FIG. 6—*Crash stop astern*

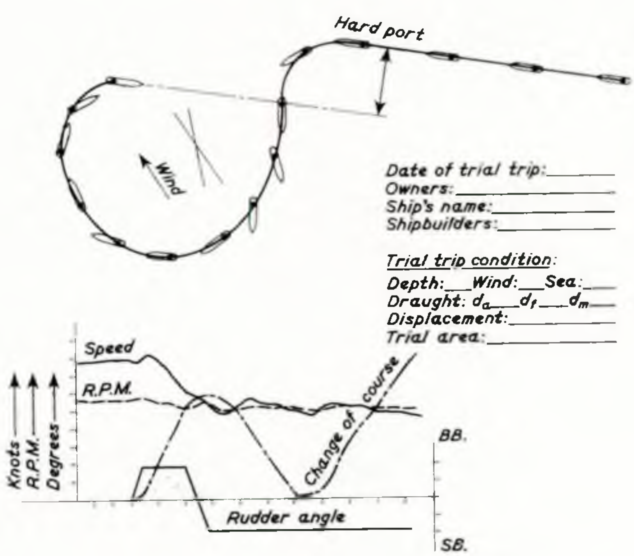

FIG. 7—*Boutakoff's turning test*

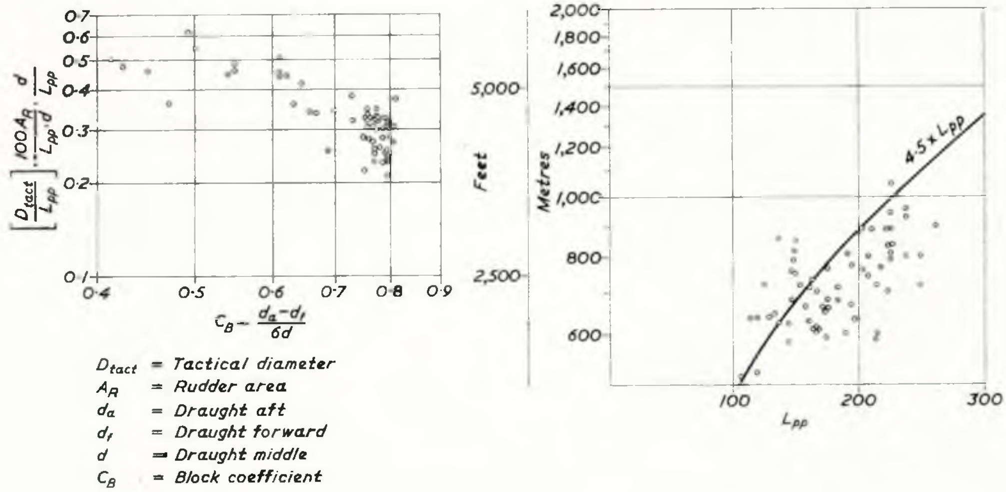

FIG. 8—*Turning circles*

b) Effect of small differences in maximum rudder angle.

c) Effect of shallow water.

It is felt that further research in this field is recommendable especially concerning (c)—Effect of shallow water.

A tactical diameter ratio of $4{\cdot}5 \times Lpp$ is considered as a practicable criterion for merchant ships[8], and may be used when comparing the obtained results.

The dead crash stop test is included as a rule. There are, however, good reasons, which must be appreciated, for avoiding such a heavy load on a new engine.

The importance of the dead crash stop tests are, however, repeatedly stated. If a collision for instance takes place in U.S. waters—or if a U.S. ship is involved—it is most likely that inquiries regarding stop tests will be raised.

Shallow Water (Model test as complement to full scale tests)

The effect of shallow water on manœuvring is not yet quite clear. It is felt that intensive research is needed in this field. No doubt, the importance of the effect of shallow water is intensified by the trend towards larger vessels. The importance of model tests for determining speed and horsepower is generally accepted.

Model tests for prediction of manœuvrability in narrow and shallow waters may perhaps not yet be considered normal practice. Nevertheless, experience during the last few years has shown that the problem calls for attention. Already at the design stage it would be advisable to investigate how a planned vessel will steer in shallow water[9].

Acting on unfortunate experience with large tankers in the Suez Canal the following tests were carried out in a model basin for an 80,000-d.w.t. tanker.

Fig. 10 shows the Suez Canal with a detail of point "Km 51" where the "Eastern Branch" merges with the old canal. Exactly at this point great difficulties have been experienced with regard to steering. Occasionally groundings have taken place.

A cross-section of the "Eastern Branch" (Ballah bypass) is shown in Fig. 11 with the vessel transitting at a draught of 38ft. 0in. It is worth while noting the unusual B/d (3·28) and the water depth underneath the keel of about 11ft. only.

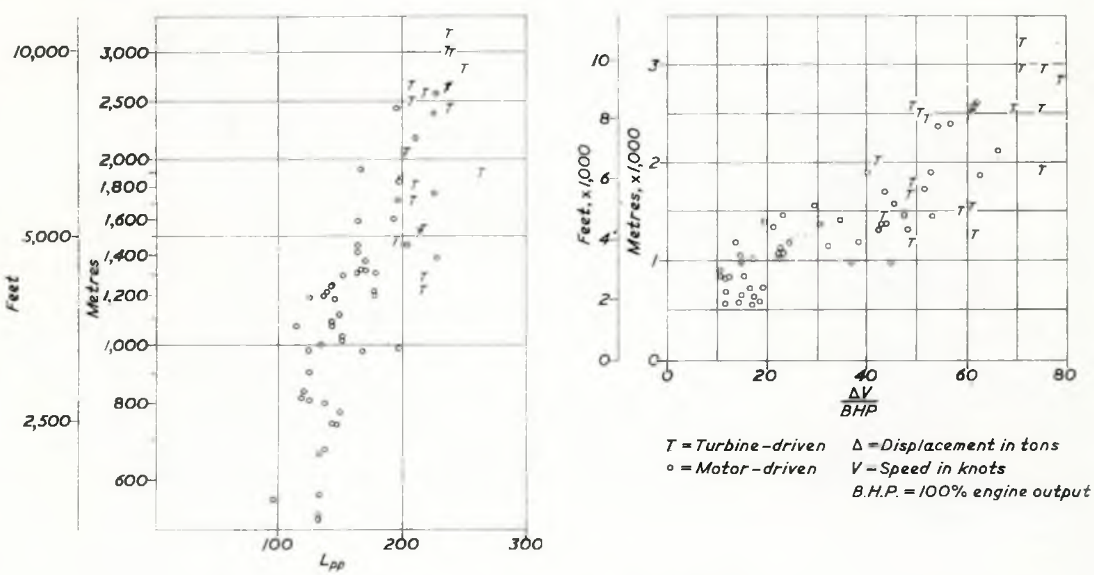

FIG. 9—*Crash stop ahead stop-distances*

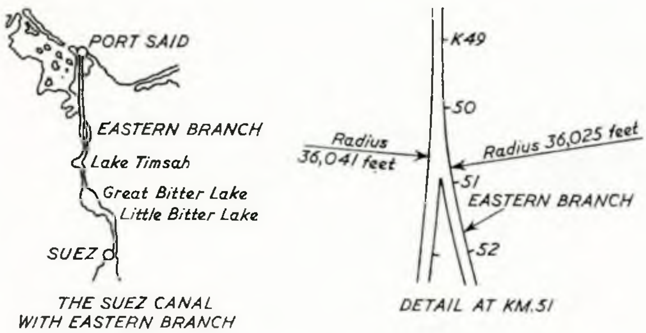

FIG. 10—*The Suez Canal with detail of point "Km 51"*

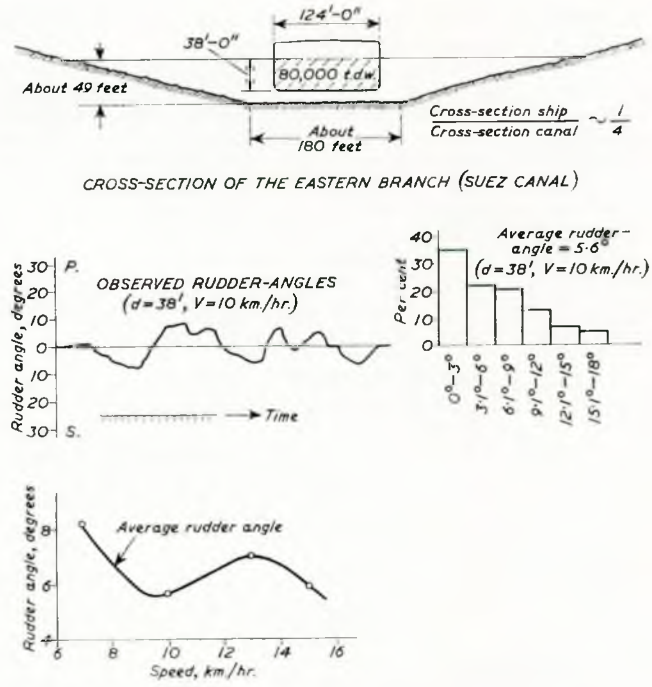

FIG. 11—*Results of tank-test with self-propelled model in the Suez Canal*

Finally a model of the canal, at this point, was built and a self-propelled ship model was steered through a certain number of times (about ten times at each speed).

As indicated the rudder manœuvres are recorded at each run permitting the calculation of average rudder angle. The readings are also repeated at different speeds. Finally a curve may be drawn showing average applied rudder angle as a function of transit speed. It will be seen that the speed of 10 km./hr. (about five knots) is optimal for this vessel.

The foregoing example refers to problems connected with Suez Canal transit. Corresponding tests may, of course, also be carried out in order to ensure safe navigation for a given vessel in other difficult waters.

The Committee considered recommending model tests in shallow water for ships over a certain size ($Lpp > 700$ft.). It was, however, decided not to include any such recommendations in the Trials Code. On the other hand, it is felt that research in this field is urgently needed, particularly because of hazard to large vessels in canals and harbour entrances.

Example 3—Propulsion Machinery

It has already been mentioned that the Trials Code recommends the use of a torsiometer on the trial trip. Further, an example is given of the method recommended for presenting the actual measured values. As will be seen in Fig. 12, the main performance data are given in the same way as major makers publish their test bed results. On the same sheet the actual values measured during the delivery trials are plotted.

For supercharged Diesel engines it is considered of special importance to have exhaust temperature and scavenging air pressure recorded. It is well known that these readings are liable to change considerably during the first period of service.

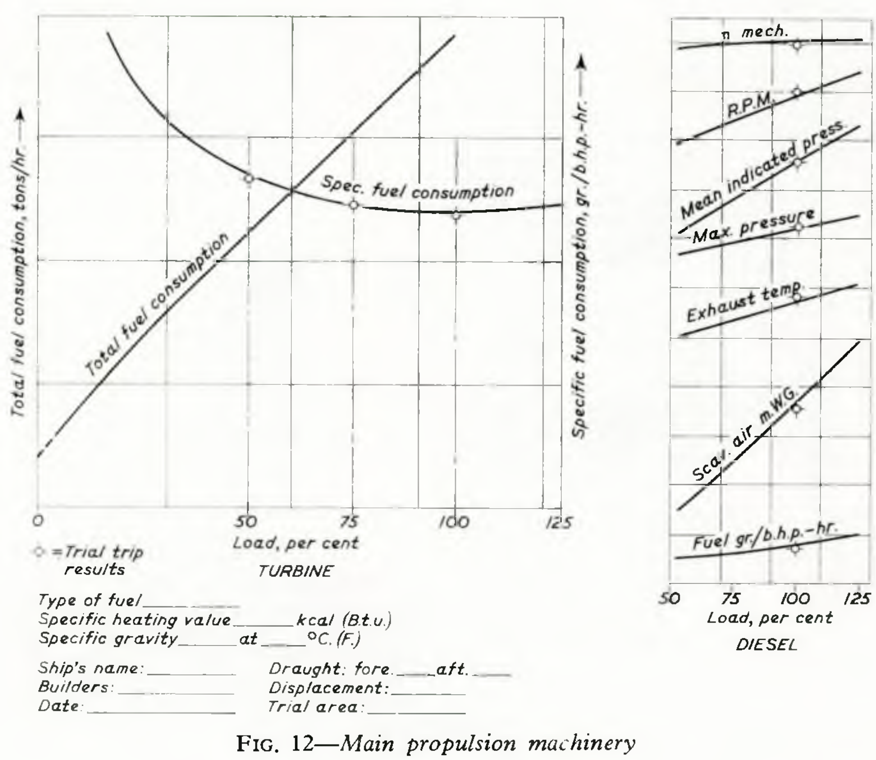

FIG. 12—*Main propulsion machinery*

Very often the exhaust temperature reaches such a height that the output of the engine has to be reduced.

Poor cooling of the scavenging air will create high exhaust temperatures. One degree increase of the scavenging air seems to correspond to at least three degrees higher exhaust temperature. It is therefore, commonly advised that excessive exhaust temperatures be overcome by careful cleaning of the air coolers. There is a limit, however, to how often and to what extent the coolers may be cleaned. It is perhaps more realistic to accept a certain reduced cleanliness as normal.

In Table IV, the readings taken on the trial trip are given and compared with corresponding readings taken after nine years' service. It is evident that the exhaust temperatures are alarmingly high.

TABLE IV.—COMPARISON OF OUTPUT

	Trial trip	After 9 years' service	With new diffusors
R.p.m.	112	101	113
I.h.p. (8,500 = 100 per cent)	7,125	6,300	7,286
Scavenge air pressure, atm.	—	0·17	0·23
Scavenge air temperature, deg. C.	—	51	45
Exhaust temperature, deg. C.	317	470	415

An increase of the air cooler surface was not advisable, although certainly desirable. Following the advice of the makers of the turboblowers, the diffusors in the blowers were replaced by new ones which gave a satisfactory result.

Example 4—Boilers

Recommended presentation of boiler capacity test is shown in Fig. 13. Quantity of fuel oil as well as feed water is based on calibrated meters.

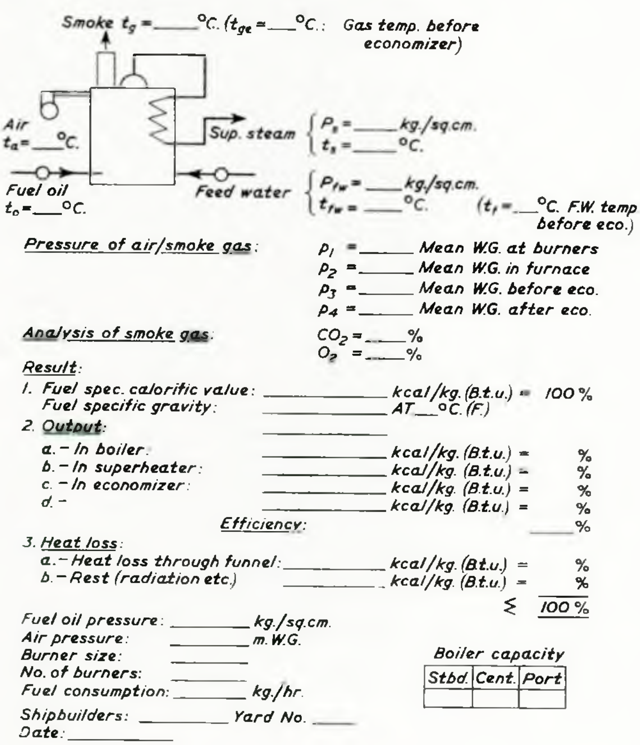

FIG. 13—*Boiler capacity test*

A number of manually taken (Orsat) analyses should be gathered, even if the installation is fitted with a separate electric CO_2 instrument. Based on the readings shown, it is possible to calculate the heat transfer in the boiler and the efficiency of the installation. Naturally the boiler efficiency is of particular importance to the turbine vessel. A close check should, therefore, be taken at regular intervals during the vessel's lifetime. Unfortunately, little is published on this subject. Lack of suitable instruments on board might be one reason. Most likely, missing readings from the delivery trials may also explain why the relative reduction of the boiler efficiency is hard to find.

Data logging and computers will maybe give an answer in the future. This question will be dealt with later.

Example 5—Centrifugal Pumps

The conventional trials trip programme only includes capacity tests for major items such as the propulsion machinery and electric generators.

The auxiliary equipment, including air compressors, sea water and fresh water pumps, evaporators, ventilators and heat exchangers, is merely subject to a check for acceptable operation (Cf. the phrase "to the local surveyor's satisfaction"). Much of the equipment mentioned is specified to have certain capacities: delivered quantities per hour, heat transfer per hour, etc.

In the Norwegian Trials Code, a capacity test of more important auxiliary equipment is included. The actual procedure is simple and requires neither complicated instruments nor advanced calculations.

Provided the characteristics (see Fig. 14) are known for a

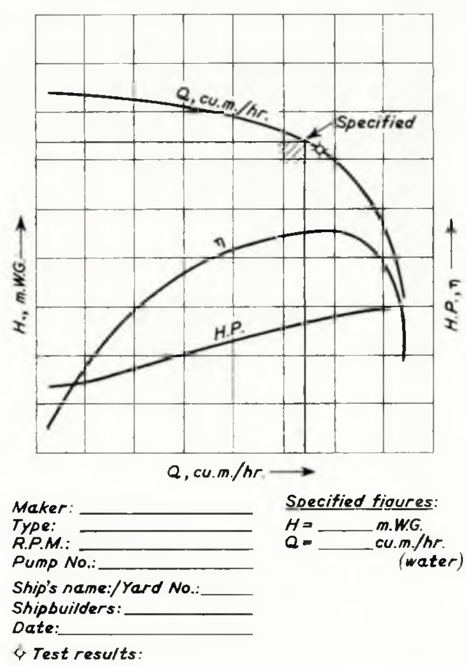

FIG. 14—*Centrifugal pump capacity test*

centrifugal pump, it only remains for measurements to be taken of suction and delivery pressures and r.p.m., before an estimate of the capacity (tons/hr. or cu. m./hr.) can be made.

It often happens that the pump's lifting height, as installed on board, is less than specified. Normal specified lifting height for a cooling water pump (sea water) is, for instance, 25m. (82ft. w.g.). When the actual lifting height is only 15m. it is evident that an increase in the delivery and correspondingly higher water velocities will be the result. The importance of velocities in sea water pipes with regard to corrosion is well known. By checking the overboard valve or by fitting a nozzle plate, the difficulties may easily be overcome.

DATA LOGGER

The present trend in the direction of automation has introduced the data logger for shipboard use. Particularly during trial trips the data logger may be helpful. If the vessel is not equipped with the necessary instruments, it is easy to fit data loggers temporarily.

Another alternative is to fit recorders giving the readings in the form of curves. Such an outfit (excluding instruments and cables) for 12 points costs about £500 and weighs about 60lb. (26 kg).

CONCLUSION

Careful supervision of a vessel's service performance is absolutely dependent on reliable knowledge of the "normal condition". The "normal condition" may be derived from the trials trip results.

For the scientist the trials trip records are invaluable. They could include the measurement of wake, propeller thrust, etc. The scientific execution of such tests demands, however, high accuracy and ample time.

The Committee behind the Norwegian Trials Code wishes to emphasize that the scope of the tests it has recommended goes no further than to request information which is desirable from an operator's point of view. It is hoped that all parties concerned will accept the programme.

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Discussion

MR. H. J. S. CANHAM said that Mr. Wilse's interesting paper seemed to fall into three categories.

The author dealt with the question of trials and clearly was concerned not only with the speed trial, which was primarily a matter of establishing a datum of performance, but also with trials from the point of view of testing procedure. In the space of one to three days, as indicated in Table I, a great deal of testing went on, sometimes at the expense of what he personally considered to be more relevant matters. The author also dealt with the question of service allowance, which was rather a different matter.

Mr. Canham had been personally concerned for many years with the study of the propulsive performance of ships and his remarks would be largely confined to the speed trial aspect, and in particular to the measurement of speed.

Much of this side of it was presumably an account of the Norwegian Trials Code, and it was interesting that it had appeared at this juncture, as the matter had been under discussion by the International Towing Tank Conference for some time now, and there were committees at work on various aspects of ship trials, speed trials, manœuvring trials and so on. How far was the Norwegian Trials Code guided by what had been discussed in the international committees?

An internationally agreed code was long overdue and he looked forward to the time when such a code was in existence. It might seem to some a little curious that a new national code should appear at this particular time.

He was much surprised to see that there was no reference to the B.S.R.A. code of procedure for the measured mile trials, which first appeared in 1947, had been revised in 1954, and again later in 1964, and was now available quite generally as a B.S.R.A. report*. This clearly was the first in the field. It was much more restricted in scope than the American trials code, as it did not cover anything other than the speed trials, but it made interesting reading in the light of what was in this present paper. It had been submitted to the I.T.T.C. by British delegates in the hope that whatever the agreed form of the international code was, it would at least be based to a great extent on what was considered to be good practice. The essential point about an internationally recognized code was that it should set a high standard. The B.S.R.A. code made specific recommendations about the minimum depth of water required for various classes of ship in order to avoid the effects of shallow water, rather than give formulæ such as that quoted by the author. The estimates in the B.S.R.A. code were based on the work done by Schlichting. An article by Mr. Lackenby† had appeared in the shipping press recently describing this work.

B.S.R.A. were now accumulating the results of trials which had been carried out on more than one measured mile course, and where there had been a significant difference in the depth of water between the two courses. The indications were that a pretty reliable estimate could now be made of the effect of shallow water in a particular case. It was also possible to make a reliable estimate of the minimum depth of water necessary to avoid any shallow water effects and, in the code, there were recommended minimum depths for different classes of vessel. The code also gave the minimum length of approach required for various ships at different levels of machinery output in order to obtain a steady speed on the measured mile course. This influenced, quite considerably, the time required to conduct a trial which would produce results satisfactory from the point of view of providing further design data for the tanks and on which to base an estimate of the service performance. For example, a large tanker or bulk carrier required a period of twelve hours in order to ensure that an entirely satisfactory set of data could be obtained, so that one could say that twelve hours out of the one to three days quoted by Mr. Wilse were needed purely for that particular aspect.

The relative shallowness of the water, off the North East Coast of this country, had resulted in certain large ships, built in that area, being taken round to Arran for trials. The result was that these ships spent a good deal more time at sea than would otherwise have been the case. Builders and owners concerned had found that the extra time spent at sea on these trials more than justified the extra cost involved. It gave them an opportunity of separating out completely the trial and the testing phases and that seemed to be to the general benefit of all concerned.

The Norwegian committee concerned with the trials code recommended the use of Decca for speed and manœuvring trials. This was a technique that B.S.R.A. had studied for a long time, and their view was that the Decca Navigator system had fairly definite limitations and had certain disadvantages over the measured mile trial. Firstly, it was essential, for the successful conduct of the trial, that a close check should be kept on the results as they were obtained and, therefore, it was vital to obtain immediately a sufficiently reliable indication of mean ship speed, shaft horsepower, etc., while the trial was in progress. It was far cheaper to repeat a doubtful run immediately than to repeat the trials on another day.

The Decca Navigator system, in the view of B.S.R.A., could not provide speed results of sufficient accuracy, quickly enough for this purpose.

Several years ago an intensive study of the capabilities of the Decca system was made by Shell Tankers. A particular feature of this study was the simultaneous measurement of speed by the measured mile system and by the Decca system, using standard Decca meters, and not specially calibrated versions, provided by the Decca Navigator Company and which they would only operate themselves.

One of the principal findings reported from these trials was that the differences between speeds measured by Decca and in the usual way by stop-watch, on the measured mile, were greater than had been expected according to the conclusions reached by the Dutch Hydrographic Office (quoted in reference 4 of the paper).

The use of the Decca "Hi-fix" equipment was another matter. This was virtually a portable survey system and had been used successfully for speed and manœuvring trials in the Firth of Clyde. This had the precision which was normally

* "Code of Procedure for Measured Mile Trials". B.S.R.A. Report NS56, 1964.

† Lackenby, H. 1963. "The Effect of Shallow Water on Ship Speed". *Shipbuilder and Marine Engine Builder*, Vol. 70, No. 672, p. 446.

associated with survey instruments. At the moment it required special stations to be set up ashore, in a certain pattern, hence its use was restricted to coastal waters. Thus, it was necessary to make allowance for tide current in the usual way. This also applied to the Decca Navigator system, unless used in open waters free from currents. Unfortunately, the potential shelter from the coast was lost in open water and it was doubtful whether there was any real advantage in favour of Decca when the trial had to be conducted in much the same way as the measured mile trial, and there was the risk that the influence of waves would be more material than on the measured mile course.

The limitation of acceptable wind speed (to Beaufort 4 or 5) according to the size of the ship did not, unfortunately, ensure that there were no significant effects of weather on the trial performance if carried out in open waters. This was largely because swells could exist independent of the local wind force. This was also the case in unsheltered coastal waters, but the chances were better that the sea surface would not be materially disturbed.

Clearly there was a need for a method of measuring ship's speed through water directly with high accuracy, to eliminate the necessity for making a double run for speed measurement purposes. Better use could then be made of the time spent at sea on trials. He did not think it advisable to reduce the time spent on acceptance trials, as there was so much testing of one kind and another to be done in any case. He also thought it was important to endeavour to establish the datum of performance as accurately as possible. It was another matter when the ship had entered service, and if the purpose of the trials was to determine the increase in frictional resistance arising from roughening of the hull or fouling. Clearly these checks should be done frequently and done, if possible, with the minimum of time lost in normal service. If they could be done as part of the normal service of the ship, so much the better. Few existing bottom logs were accurate enough for this purpose and all required calibration. This was normally attempted during the speed trials and was one of the items mentioned in the Norwegian Trials Code. Generally the log calibration was altered several times during trials and the final adjustment was usually made right at the end of the trial. This rarely made the log read correctly and there was usually no opportunity for any further calibration. It was therefore much better to make the final adjustment of the log after, say, two double runs had been carried out and then to carry out, say, four more double runs covering the full range of trial speeds, making no further adjustment of the log after this. One might end up with a log which would not be reading absolutely correctly, but an accurate calibration could be derived for it, and this was really all that was needed. Unfortunately, most existing logs had probes which were not long enough to avoid the boundary layer, and since this would increase with changes in the roughness of the hull, this meant that the calibration would change. The answer seemed to be either to produce logs with a sufficiently long probe to avoid this (some had already been produced), or to find some other method of measuring ships' speeds directly.

As to the relationship between trial speed and average service speed, this was a matter of considerable interest and no doubt everybody had firm ideas as to what was an appropriate service allowance.

Was it right that estimates of service performance should be based on the trial performance? Mr. Canham was afraid that there was evidence to show that the trial performance of a new ship was a very transient quality and could vary from day to day in an unexpected fashion.

All were familiar with cases where groups of sister ships had run trials and produced quite disturbing differences in performance for no apparent reason. There were cases on record where the same ship had run trials on the same measured mile, after a lapse of a week or so, and the trial performance had altered quite materially, not always for the worse; sometimes the trial performance had been very much better.

The British Towing Tank Panel had recently been carrying out an intensive investigation into what were called ship correlation factors, which were the result of comparing the actual ship trial performance with the expected result from the tank. While there were many factors identified as causing variations in trial performance (depth of water, weather conditions and so on) there still remained certain imponderables. From time to time one heard of cases of ships with smooth hulls producing unexpectedly poor trial performance, due apparently to a form of fouling. Perhaps it was, therefore, wrong to judge the service capability of a ship from the result of a single trial, which often would take place in a loading condition much lighter than would be the case, on average, in service. Probably a better basis for predicting the average service performance of a ship would be to do the same as B.S.R.A. did for measured mile trials—to use the results of model tests in the tank. It seemed logical to use tank results in the same way, but if this were to be done, appropriate factors of experience would be required, in the same way as for new ships. In this way a much more stable picture might be achieved. He did not deny that a reasonably reliable service allowance could be derived by relating the average service performance to the average trial performance of a group of ships, but there was a danger if one used individual trial units for this purpose.

A good deal of research work had been done in the United Kingdom in recent years on the effect of fouling on the performance of ships in service, mostly concerning tankers, but also to a certain extent on cargo ships, and one thing seemed to be emerging fairly clearly. There had been significant improvement in the standard of anti-corrosive protection applied to new hulls as a result of using descaling equipment and better paints. Consequently there had been less roughening of the hulls due to the incidence of rusting. Nevertheless, it appeared that the effects of fouling became more marked in these circumstances. Results were now being obtained on the large ships, showing power increases of the order of 40 per cent after 12 months in service, or something like 10 per cent reduction in service speed, and this seemed to be primarily due to fouling. The need for more effective anti-fouling compositions was quite clear.

One other thing emerging from this work was that, if a ship's hull were allowed to become rough and then one tried to grit-blast it back to its original condition, in certain cases it was possible to get quite close to the original trial performance, even though the hull did not appear to be restored to anything like the original condition. On the other hand, there were cases on record where the reverse had applied and there seemed to be a marked reduction in the degree of roughness, unaccompanied, however, by the expected recovery in performance. On balance one tended to get back more than one expected by virtue of the roughness. This had puzzled them for a time and still did to some extent. He thought the answer was that the hydrodynamic roughness of a ship's hull could differ substantially from the geometric roughness and that this was reflected in the trials results.

The average service allowance was not only a function of roughness, but also a function of weather. He suggested that weather routing might play an increasingly important part in ensuring that owners were able to meet the guarantee requirements of the charterers as to average speed in service. It had often been assumed in the past that there was little one could do about the effect of weather, and he agreed that this was true on fine weather routes where the contribution of weather to the overall service allowance was small, but on the North Atlantic it was quite a different matter.

The considerable effects of weather had been emphasized by some results recorded on a Shell tanker of 18,000 d.w.t. in the Atlantic, in a sea which corresponded to between Beaufort Force 7 and 8. In head seas, there was a speed reduction of 30 per cent at normal service power, as a result of the waves. This was a fairly severe sea state, and normal service power would not have been maintained for long in those conditions. By changing course, the loss in speed was reduced to five per cent with the waves on the beam. Here was a case of a ship steaming at normal service power in the particular set of weather conditions and its speed varying from $11\frac{1}{2}$ knots to something over 14 knots, depending on its heading to the waves. On northerly routes in the North Atlantic one might expect to encounter winds exceeding Force 7, once or twice during a passage in winter. Since the weather component of the service allowance was averaged over a long time, there was distinct possibility, at least on the North Atlantic routes or other routes that were not renowned for fair weather conditions, that one could achieve a reduction in the weather allowance by improved navigation.

Owners were becoming increasingly aware that substantial speed losses had sometimes been incurred in the past, as a result of poor hull maintenance, and it seemed to him that they might have to go to considerable lengths, in the future, if they were going to be able to guarantee the average service speeds required by the charterers.

Dealing with manœuvring aspects of trials, Mr. Wilse had shown a diagram relating to crash stops, on which there was considerable scatter of the results. Doubtless, one reason for this was the fact that when a ship went full astern it became directionally unstable and therefore the distance it carried was very largely a function of the attitude taken up in the early stages of the manœuvring. This attitude could be influenced by the way the rudder was used. Mr. Jourdain, in France, had shown the degree to which the carry could be influenced in this way, and it was necessary to do more than one crash stop in order to determine what the stopping characteristics of the particular ship might be.

How did Mr. Wilse make corrections for current in the results of crash stops, since it was apparent from Fig. 5 that such corrections were made? This also applied to turning circles where these were measured by such a system as Decca Navigator, which measured position relative to the ground. The effect of the tide current could distort quite materially the tactical diameter in a large ship. Undoubtedly, a knowledge of the turning characteristics of a ship was valuable to masters who had to sail in them, but one might ask what value they were for design purposes. It seemed to him that a standard was lacking here and that something should be done about formulating a standard against which to judge what was good or bad turning behaviour.

He was looking forward to studying the Norwegian Trials Code which had been made available, and was grateful to Mr. Wilse for providing this opportunity of seeing it.

MR. S. ARCHER, M.SC. (Member of Council) said that the paper discussed, in an admirably terse and objective manner, a subject which had not often been covered in the TRANSACTIONS before and was thought-provoking.

He had had the privilege of knowing the author for a good many years and had in fact served in one of his company's earliest tankers, of 12,000 d.w.t. and with Sulzer air injection engines, certainly with advantage to himself, although he was not sure that he did much to increase Mr. Høegh's dividends.

It must in some ways be very frustrating to be in technical control of a large fleet powered by different prime movers, forming in itself a huge floating laboratory, and, for a man of Mr. Wilse's scientific training and inclinations, particularly difficult at times to have to forego the opportunity of making scientific measurements on trials, knowing full well that the charter was waiting and that every hour on trial added to the cost.

The effect of depth of water was of increasing importance now with the larger sizes of tanker and bulk carrier. From calculations made at Lloyd's Register of Shipping one or two figures were available which could usefully be compared with Mr. Wilse's results.

For a 60,000-d.w.t. tanker, 46 fathoms seemed to be the minimum if bottom interaction were to be avoided, and for a 100,000-ton vessel, 56 fathoms; thus, on the Polperro measured mile, one could expect something like a four per cent speed loss with the latter.

With regard to the Decca system for measured mile trials, he (Mr. Archer) was not competent to judge as to its accuracy since it was such a specialist problem, but it seemed to him that an appropriate course could be chosen with better advantage relatively independent of wind and sea, using Decca rather than being tied to the conventional trials course.

On page 181 of the paper (left-hand column) the author dealt with the effect of fouling on two large tankers. A colleague had drawn Mr. Archer's attention to the fact that this passage was a little ambiguous, in that it was not clear whether in the first case the increased resistance was due solely to out-of-dock fouling or whether it was, in that case, merely due to roughening, in other words, comparing undocked condition with undocked condition after five years. In the second case it was quite clear that this was due to the combined effect of fouling and roughening.

With regard to the crash astern or crash ahead manœuvre, there were arguments both for and against this type of test. Naturally, in building a ship, one was concerned not to jeopardize the possibility of a ship entering service by some important component failing, due to over-enthusiastic testing, but there were several cases a few years ago which seemed to demonstrate that it was perhaps better, within reason, to have any trouble "outside the hospital" rather than on the high seas. In one particular case of a geared turbine tanker, the specification called for crash stops ahead and astern, and everyone thought that the trial had gone well, but when the gearcase was opened up, after returning from the trials, the superintendent inspected the main gearwheel (welded centre with a shrunk rim) and found it in the condition illustrated in Fig. 15.

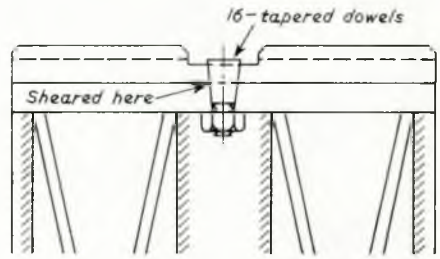


FIG. 15—*Damage to tanker main gearwheel after ahead and astern crash stop trials*

The rim was a rather light shrink on to the welded centre and was secured by a number of tapered radial dowels. The superintendent noticed that several of the dowels stood very slightly proud. He called for a hammer and sounded one of them and, to his amazement, found he could lift it out. It transpired that all these dowels had sheared and the rim had moved several inches round the centre in the ahead direction. It was a classic example of how powerful a crash stop could be. Naturally, it caused considerable delay to the ship, and, in fact, the test revealed that there was a design weakness there; namely, the shrinkage allowance was, first of all, too low, and secondly, the surface finish of the rim bore and its mating centre was very bad. When similar gears fitted in other ships were examined, evidence was found of slip movements there also.

With regard to the effect of surface overstressing of gear teeth, this was something owners sometimes had to pay for rather dearly, and the question of scuffing in the early life of a set of gears, possibly due to too brutal an application of full load before being fully run-in, was very important; one naturally would not subject one's motor car to such severe conditions.

Had owners ever considered putting a clause in the contract whereby the power would be increased gradually during the first, say, six months of service and only after the guarantee drydocking would the gears be put through an overload test which should thereby ensure no danger from scuffing, and possibly also from pitting? Had Mr. Wilse ever considered that possibility?

Mr. R. Cook, M.Sc. (Vice-President) said that, like Mr. Canham, he was surprised that the author had not mentioned the B.S.R.A. code of procedure for measured mile trials; but perhaps the author might feel that the less said about it the better. However that might be, the B.S.R.A. code concerned itself almost entirely with hull performance, and machinery was only mentioned in respect of power and thrust measurement. He noted that, in the new Norwegian code, it was to be recommended that the main engine output be measured by means of a torsionmeter and that the author quoted the accuracy of indicator cards as ±5 per cent as compared with ±2 per cent in the case of torsionmeters. He would agree with these figures with the proviso that the torsionmeter accuracy only applied the readings of more than one-third of full-scale deflexion. B.S.R.A. had done a good deal of work over the years to try to improve the accuracy of their power and thrust measurements, and he had, in 1951, read a paper* to the Institute giving the results of tests made to determine the accuracy of a Siemens Ford torsionmeter and the Michell thrustmeter. His conclusion was that these instruments, properly fitted and used, could both give an accuracy within ±2 per cent. Since then a considerable programme of development had been carried out to try to improve on these figures, but they would still not claim an accuracy of much greater than ±2 per cent even under ideal conditions. What they had achieved, however, was the ability to obtain an accuracy within ±2 per cent with greater regularity. For example, to obtain the highest possible accuracy it was formerly essential that the meter and shaft should be calibrated on a static strain rig. This was a very expensive process and, moreover, could not always be arranged for. It was therefore seldom carried out in normal commercial practice. To overcome this difficulty they had developed an alternative which the most exhaustive tests had shown to give an accuracy comparable with that of static calibration. This consisted of a two-part operation. First of all the Siemens Ford torsionmeter was calibrated as an instrument for measuring optical twist on a special optical rig; secondly, the value of the modulus of rigidity was determined by a method which involved timing the passage of an ultrasonic wave through the periphery of the shaft. This latter operation could be and, indeed, often was, carried out after the shafting had been installed in the ship. The total cost of this method was between one-sixth and one-twentieth of that of static calibration.

They had also investigated the accuracy of the latest forms of electric wire resistance strain gauge technique for power measurement, since they sometimes had to employ this technique when, for one reason or another, a torsionmeter could not be fitted. Careful measurements with these techniques, during test bed trials of a large slow speed Diesel engine against an accurate hydraulic brake, had shown that under the very best conditions the accuracy of strain gauges could not be guaranteed to greater than ±3 per cent and then only if the skin stress was above 2,600lb./sq. in.; between 1,500 and 2,600lb./sq. in. skin stress, the corresponding figure was only ±5 per cent. He mentioned this because there had been undue optimism in certain quarters regarding the accuracy of strain gauges.

A great deal of work had also been carried out to improve methods of measuring transient torque and thrust, but such techniques were, of course, more applicable to research problems than to normal merchant ship trials. All these matters to which he had referred concerning torque and thrust would be fully dealt with in a paper to be given by a colleague before the Institute later in 1965.

It was also interesting to note that the new code was to contain a paragraph concerning noise level measurement, since there was no doubt that shipowners were becoming increasingly concerned about noise, and this concern was reflected in the greater interest taken in the subject by the builder. Did the new code lay down acceptable noise levels in machinery and accommodation spaces and on the bridge, or did it merely deal with the techniques of measurement to be employed? In the past twenty years B.S.R.A. had done a great deal to establish the relative importance of air-borne and structure-borne noise in ships and to determine the value of various methods of suppressing noise, but they had certainly not garnered the wealth of information possessed by their Continental friends concerning the actual noise levels obtaining in various types of ship. This was a situation they were busy rectifying, since it had an obvious bearing on noise level specifications.

* Cook, R. 1951. "Marine Torsionmeters and Thrustmeters". Trans.I.Mar.E., Vol. 63, p. 115.

Mr. R. M. Duggan, M.A. (Associate Member of Council) said that he was very interested in Table I, which was concerned with time. What really mattered was what was done in that time. It was no good spending a week at sea on tests which could be done with the ship alongside. In the same way, long endurance runs were equally vague and there were too many transient conditions occurring, so that obviously there was a right time for doing the right part of the trial. He thoroughly agreed that many shipowners were not even interested, or sufficiently interested, in the trials.

He was more concerned with the trial part than the test.

With regard to the code, he was delighted to see that fuel consumption was measured. As the B.S.R.A. code had been mentioned specifically once or twice, he would point out that fuel consumption, as far as he knew, was not incorporated in it at all. In the list on page 180 there did not appear to be any mention of thrust. Thrust was a difficult measurement, like fuel. From the paper and the discussion so far it seemed that it was the measurement of these parameters which was so difficult and was very often ignored because it was too difficult. Until the demand was made by the particular shipowners and, he hoped, shipbuilders in due course, the instrument manufacturers would not even produce the instruments.

With regard to the presentation of results, he was a little surprised to find in (b) that Beaufort 5 in a ship of 450ft.-plus was acceptable. The weather was blowing pretty hard in these conditions and according to his own company this would not be a Class A trial condition. The Decca system had been mentioned at some length already but it was worth mentioning that some trial comparisons, had been conducted some years ago. For example, at Polperro there were extremely good results, ±1 per cent, as against 5 per cent or even 13 per cent in other places. More recently there had been a startling result, unexplained, which was worth mentioning. It related to an 80,000-ton tanker built in France. The trial was going to be conducted over the Penmarche measured distance. The weather conditions, as so often happened on that coast, were poor, and that part of the trial had to be abandoned—the marks could not be seen—so the ship went round into the entrance to the channel and carried out a Decca trial. The British and French teams, using their different methods, each worked out the result independently, and photographs were sent to Decca, who computed the result. The ship then went to Malta and did a full measured trial. As far as was known, this was a highly accurate trial, with Class A good weather conditions and so on. The result was that at 17,000 h.p. the Malta trial showed 16·2 knots. The French curve and the British curve for the channel trial were very close, and the speed was 15·3 knots. The Decca computation was 14·2 knots. Obviously something had gone adrift somewhere which had not been resolved and never would be. This ought to be enough to indicate that a degree of caution was required in accepting this type of trial.

He deplored the use of indicator cards on a Diesel ship trial, particularly with the increasing number of cylinders, trying to synchronize everything together and having calibrated instruments. The obvious solution was to try to have an accurate torsionmeter which could cope with Diesel shaft torque fluctuations and record. These were not readily available at present, but work was being done on this as the requirement was there. He thought this was the right way to approach it.

Mr. Wilse had said that it was considered to be of major importance to introduce a fairly simple code which would be acceptable to all parties concerned. He hoped that all codes aimed at a very high standard, the highest possible, and then if the conditions were not suitable, one could gradually come down; but to start low and work up was pretty well impossible.

The figures quoted in the third paragraph on page 181 of the paper were very interesting but might, he suspected, be at least ten years old. It was interesting to note that the figures which his company were now getting from accurate trial results in service, indicated the same sort of order, but for rather a different reason. An 18,000-ton ship built in 1954 had a hull roughness of 0·0075. She was flame-cleaned, which was the vogue at the time, and it was not a particularly good surface. Another ship, four years ago, showed a figure of 0·0057, which was a considerable improvement on the first one, and a further ship, about three years ago, had the full treatment of shot blasting and gave a figure of 0·004. This was the best ever measured. However, each of these three ships were returning comparable figures now. They had become rougher, but that was not the major cause. It was due to weed-fouling—to algae, in fact. The first six feet under water on the sides was the vital region, and even a small proportion of slime caused a great deterioration in the performance figures.

He personally believed the performance aspect to be far more important that turning circles, stopping trials and so on.

Turning to the model tests in the Suez Canal section, he could not see the purpose of the bottom curve. These curves were considerably less exact than his company had measured in a ship of that size in the Suez Canal in 1961. Down the straight sections, the rudder movement had been 20 degrees to 25 degrees from side to side, not staying in any one position for more than a few seconds. The figures here were obviously less than 10 degrees.

As for the model tests, there was a member of the audience who had tried these tests himself, and apparently great skill was required by the model operator, but with that skill the results improved pretty considerably.

The differing pilots in the Suez Canal had considerably different systems. There was an infinite variety of methods of treating a helm going down the Canal, and he suspected that many of the fast, rapid movements did not have any material effect on the ship, but were, in fact, over-zealousness on the part of the pilot or the operator on the ship.

With regard to Fig. 12, he considered that the methods used by his company were preferable to extrapolating the curve downwards. Again it depended on having accurate instruments.

With regard to Fig. 13, it seemed that a lot of quantity measurements were involved. These were extremely difficult in practice. Eight different types of meter had been tested, and none of them appeared to stand up to service conditions. Certain of them stood up to short-term trial conditions, but even so they were still coming back from trials with a paper bag full of collapsed pieces of instruments, and this prevented the re-calibration of the instruments afterwards, which was a great problem. The need was for more people to state what they wanted to measure accurately. The sooner this happened, the sooner there would be some accurate measurements available.

With regard to the fuel specific calorific value in Result 1, surely the heat put into the fuel would have to be taken into account there?

Finally, under the heading of "Data Logger", this was an ideal, but they were a long long way from it, and he could not conceivably imagine an instrument that could be rushed on board and plugged in, with all the basic transducers feeding into it and some magnetic tape output which could be readily analysed afterwards. Mr. Cook had mentioned the Siemens Ford instrument, but that was very difficult to attach to a recorder. There was still a big need for an accurate torsion-meter that would record.

MR. J. TH. VERSTELLE said that the reason for the presence of a chartmaker (he was a Senior Civil Hydrographic Officer, Royal Netherlands Navy) at a meeting of professional shipbuilders was that he had developed certain methods and operational procedures for ship's speed and manœuvring trials which had found a fairly widespread application. This was why the author had asked the Secretary of the Institute to invite him to the meeting.

As a surveyor he felt competent only to deal with those aspects of the paper that were related to the methods of position-fixing, on which a number of trials in a ship's performance programme had to be based.

In the trials code, as adopted in Norway, it was recommended that the Decca method be used for speed and manœuvring trials. This recommendation, of course, was based on the Norwegian confidence in the accuracy and reliability of the Decca method.

Many shipyards and owners in other countries had similar confidence in this method and based this type of trial on Decca. Some others, however, still seemed to doubt its accuracy, probably because they were thinking in terms of the *navigational* accuracy offered by Decca, which, as such, admittedly did not normally meet the considerably higher accuracy requirements for ship's trials. He would therefore mention the main facts on which this confidence was based.

In hydrographic surveying, extensive use was made of radio position-fixing, and a surveyor was in an excellent position for making certain types of observations from which reliable accuracy figures could be derived. The good survey results obtained by Decca explained the fact that he had developed a personal interest in the application of this system to ship's speed and manœuvring trials.

Contrary to navigation, which required position-fixing in an absolute sense, ship's trials were based on *differences* between successive positions only. In this respect the requirements were lower than for navigation.

On the other hand, however, the actual measurements in the patterns of radio "Lines of Position" (L.O.P.) required the highest possible degree of accuracy, which, in survey as well as in ship's trials, was achievable only by the use of special precision receivers. It was absolutely essential that this type of receiver be employed.

The main requirements for ship's trials, therefore, were the following:

a) sufficiently stable patterns of radio L.O.P.;
b) sufficiently accurate knowledge of the propagation speed of the radio-waves, being the factual yardstick for conversion of the radio fixes to terrestrial distances.

From tens of thousands of British, Netherlands and other observations on Decca Navigation chains, it could be shown that:

1) the short period L.O.P. instability was very small during the day and of acceptable magnitude at nights;
2) the short period instability was of a mainly random character;
3) the yardstick was accurate to within 0·01 per cent or better.

Detailed figures were given in various of his own publications.

The operational programme was based on this general information and experience and on the fact that discrepancies might be treated as random errors. Speed runs were of 9½ minutes' duration, with photographically-recorded Decca fixes every half-minute. As this offered a large number of redundant fixes—18 in a 9½ minute run—the use of suitable observational programmes and computational techniques:

a) increased the final accuracy by a factor equal to the square root of the number of redundant observations;
b) enabled the standard error in the final speed to be computed from a least square adjustment of all available fixes (figures of actual standard errors would be given later in his contribution).

The method of adjustment described in the author's reference 4 was an approximation and nowadays should be regarded as obsolescent. It could be shown that a rigorous least square adjustment was not a strict necessity, but nevertheless was to be preferred. On an electric desk computer this was a matter that took considerable time and computational experience (most large tankers made as many as 50 runs). However, in these days of electronic computers, time and experience no longer constituted an objection. Since 1960, all Netherlands Decca speed and manœuvring trials were, for these reasons, electronically computed by the Netherlands Ship Model Basin at Wageningen (the computer programme was based on the formulæ developed by the speaker).

An earlier speaker had said that it took quite a lot of time before results could be obtained from the Decca trial. The method in the Netherlands was to take visual observations during the trial and compute the preliminary speeds from the first and the last fix of the run, by means of a desk hand-calculator, this took about half a minute, and, just after the trial, the preliminary speed was available. From about 200 ships with a couple of thousand runs, the experience was that the difference between the preliminary speed and the final speed was seldom more than ½ per cent of speed, which was good enough for a preliminary speed.

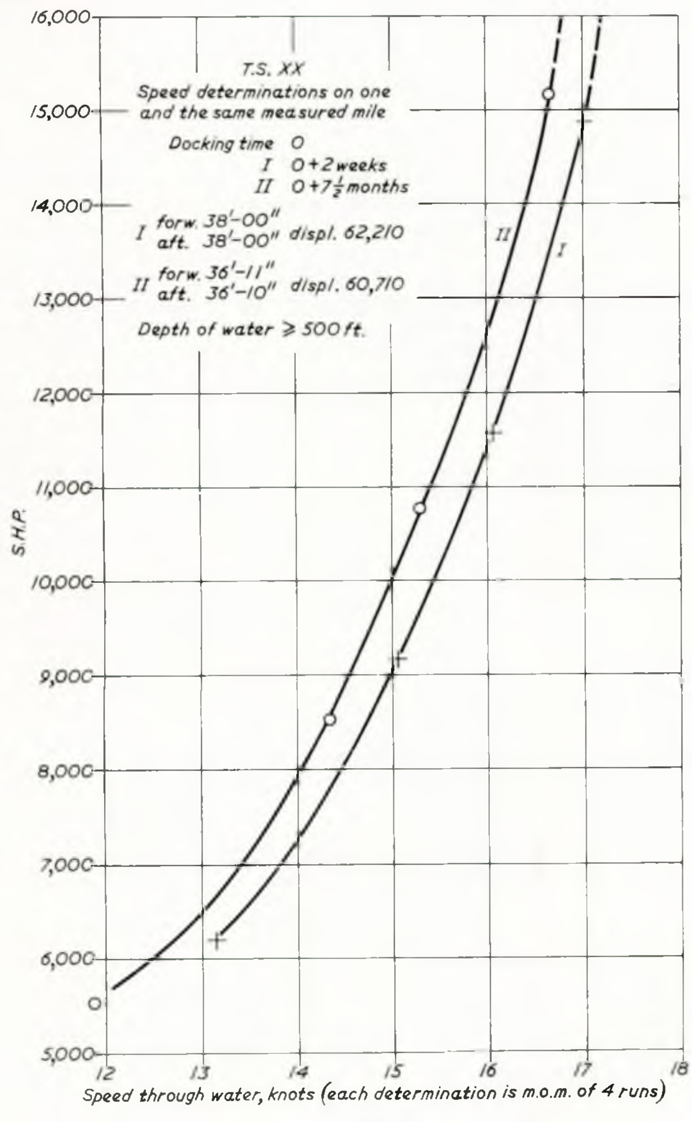
The electronic computation took very little time and the first results were made available within 24 hours.

Neither the Hydrographic Office nor he himself had anything to do with the practical execution of ship's trials, so that he was therefore not speaking here in any official capacity.

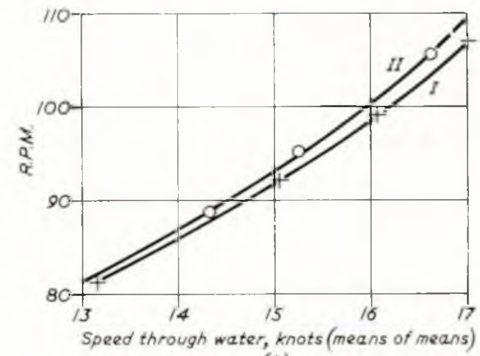
Since about 1952, the speed and manœuvring trials of an ever-increasing percentage of Netherlands new buildings (and also some warships) were based on the Decca method. They were carried out by I.N.A. in Rotterdam, being the Netherlands Decca agents. The position of I.N.A. should be seen as a sort of contractor to the shipbuilding yard or shipowner, solely furnishing the information on speed, turning circles, stop-ways, etc. (further details of this would be given later). As already mentioned, the mathematical analysis was carried out by means of the computer in Wageningen.

Final reports about results, including computed standard errors, were made up by I.N.A. and sent to the shipyard, and a number of copies to the owner and to the Model Basin.

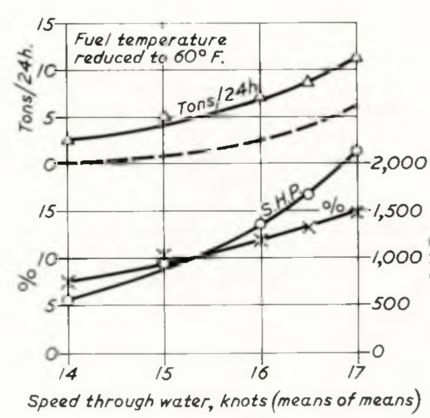
His next remarks related to Mr. Wilse's paper, first of all with regard to page 180, the right-hand column, requirement (c). Today the results of about 200 Netherlands trials were available. The standard error in the speed varied between 0·1 and 0·3 per cent (also for fast warships) and with a very few exceptions fell down to 0·5 per cent. Figures up to 1961 had been published in the Journal of the British Institute of Navigation (there was one case in which the standard error was about 0·9 per cent; this was a small ship of 3,000 tons, and with a Force 8 wind).



(a)



(b)



(c) and (d)

a) Means of means—S.h.p./speed
b) Means of means—S.h.p./r.p.m.
c) Increase in fuel consumption (propulsion only)—7 months
d) Increase in s.h.p.—7 months

FIG. 16—*Resistance effect*

This degree of accuracy was considered to be more than good enough, because uncertainties in other equally important parameters—such as s.h.p. and fuel consumption—were considerably larger. It was nevertheless felt to be an advantage that the speed parameter could without any extra effort be obtained with greater accuracy.

His next point related to requirement (d). Information on s.h.p., fuel consumption, r.p.m., course stability, etc., was usually supplied to I.N.A. Their reports did not contain diagrams of the type in Fig. 1, because this was felt to be the responsibility of the shipyard, and not of the Decca agent.

With regard to the paragraph following (d), he completely agreed with "some members of the Norwegian Committee" that the report should include some details of used procedures and accurate figures about instruments used and final results. This was done in the I.N.A. reports.

By taking into account all accuracy figures of all parameters, I.N.A. had a number of times been able to discover systematic errors in s.h.p. or fuel consumption.

Accuracy figures were anyway of theoretical importance and were needed for improvements in methods.

With regard to page 181 of the paper, the left-hand column dealing with increase in resistance, a striking example was that of a 62,000-d.w.t. tanker. The last docking was on 8th May. There was a speed trial on a very deep water measured mile, two weeks later, and a speed trial on the same measured mile seven months thereafter. In both speed trials there was a smooth sea and a wind force of 1 to 2. The results were as set out (also see Fig. 16):

Increase in s.h.p.	*Increase in fuel consumption*
for 14ft.— 7·2 per cent (550 s.h.p.)	for 14ft.— 2·5 tons/24 hr.
15ft.— 8·9 per cent (940 s.h.p.)	15ft.— 4·1 tons/24 hr.
16ft.—11·9 per cent (1,330 s.h.p.)	16ft.— 6·8 tons/24 hr.
17ft.—15·0 per cent (2,120 s.h.p.)	17ft.—11·1 tons/24 hr.

With regard to page 186, the left-hand column, dealing with shallow water, for the results of extensive shallow water tests, reference was made to a very interesting report by Shell Tankers in 1962.

Other extensive tests with large tankers were made by the Netherlands Rijkswaterstaat (Ministry of Public Works) in relation to the building of the new harbours of Ijmuiden and Europoort; they included model as well as full-scale tests. As far as was known, the results had not yet been published.

With regard to Fig. 2, in the Netherlands trials the speed trial programme of large tankers was usually:

4 runs fully loaded (ballasted) ... full power
4 runs fully loaded (ballasted) ... 70 per cent power
4 runs fully loaded (ballasted) ... 50 per cent power

The same programme of 12 runs was followed for the half-loaded (ballasted) and empty conditions. The total number of speed runs was 36. In addition, two or three consecutive turning circles were made to starboard and the same number to port, crash stops and steering capacity runs.

The Ship's Sallog was always calibrated against the Decca final speed.

With regard to the interesting and often raised question as to the length of approach runs of large tankers, he referred to his paper[4] on this subject.

Finally, he wished to take this opportunity of warning against basing speed trials on too small a number of runs. There was little practical advantage in making more than four and it was not advisable to reduce the number below three (assuming there were no adverse conditions). With a still smaller number of runs, the elimination of tidal stream and current became uncertain.

Mr. E. A. Bridle, B.Sc. (Eng.) (Associate Member) said that he was certainly in full agreement with Mr. Wilse's comments on the inadequate time usually made available for sea trials. This was particularly true of the machinery, where it was often due to a lack of appreciation of the engineers' problems. Whether this was the fault of the shipowner or the shipbuilder he did not know; it might be a combination of both.

A ship had recently gone on trials with a prototype design of geared turbines, a prototype design of main boiler, and the prototype of a fully automatic control system designed for operation of the main machinery from the bridge. The preliminary sea trials were allocated 1½ days and the acceptance trials three days. It was everybody, except the engineers, who was a little surprised when things did not go quite according to plan.

The time allowed for fuel consumption trials was frequently too short, and in consequence the results could be quite misleading. From their experience with steam turbine machinery, Pametrada recommended that at least six hours should be allowed, after conditions had been set, before any consumption figures were accepted. During this period the specific fuel consumption could improve by as much as seven or eight per cent, while the new machinery settled down and while the trials party familiarized themselves with the correct operation of the steam and feed system.

The author had remarked that some members of his Committee wanted to include more details on the accuracy of readings and types of approved instruments. Mr. Bridle assumed that the author associated himself with this view. In Mr. Bridle's own opinion this was most important, as the standard of instrumentation in many ships was deplorable. If performance measurements were to be of any real value all instruments must be calibrated and correctly installed. It was no good calibrating a temperature indicator if the thermocouple on the other end was not in the correct position.

It was also high time that the method of measuring fuel consumption was standardized. One commendable way was that used by an Italian shipyard, where a special calibrated tank was installed for the duration of the trials and afterwards removed from the ship. In most of the trials he had attended, the fuel consumption was measured by three methods at once. Far from assisting accuracy, this just confused matters by giving three different answers, often with ten per cent between the highest and the lowest. Those which did not agree with the design estimate were usually assumed to be the least accurate. When the probable torsionmeter error of ±2 per cent was taken into account as well, one could not help admiring the confidence with which the finally agreed fuel rate was quoted to the third place of decimals.

He was also interested in the author's comments on crash astern manœuvres, and to see that he had demolished the popular fallacy that the Diesel engine was more manœuvrable than the turbine. The crash astern manœuvre had a value, particularly in small vessels such as ferries, which had to operate in confined waters and under very difficult conditions sometimes. The British Railways ferry *Avalon,* which had twin-screw turbine machinery, had carried out a crash stop during her sea trials and was brought from 22 knots to "dead in the water", in two minutes, having travelled less than four times her own length. Mr. Archer would be reassured, following his account of a slipped gearwheel rim, to know that the main gearwheels were still intact at the end of this trial.

Mr. B. C. Tonkin (Member) said that the paper was a very useful one, particularly to the technical departments of shipping companies, and Table I was certainly of interest. Possibly the reason for the difference in duration of tests was due to the greater commercial pressures in shipping for example, cargo having to be lifted at a certain date, and the fact that there was a Charter Party cancellation date. Most companies at some time or other had taken delivery of ships in which the trials were held the day before, and that certainly did not give anybody much of a chance to prove machinery. Those builders who held their actual sea trials one week or ten days before the ship was due to be handed over had the best method. It would be interesting to know whether the new code made any comments on when trials should be held.

With regard to fuel consumption, did the code set any standard for Diesel engines or turbines? Most of the engine builders and shipbuilders would not guarantee a Diesel fuel consumption within about three per cent.

On page 180 the code talked about the measured deadweight and so on. The conventional method of lightweight calculation, inclination experiment, subtracting and adding weights to forecast deadweight more often than not gave a reasonable result. Some superintendents would have seen cases where it had not, and although the contract usually penalized the builder if he was short on deadweight, it would be useful to know whether the code laid down any percentage error for deadweight.

Turning to page 181 and the prediction of expected service speed, the author described it as a headache to the owners, and that was just about what it had been. It was encouraging to see that he had stated a figure for the average service speed over a period of eight years as approximately 72 per cent of the service power on fully-laden trial. To most, that seemed quite a reasonable and acceptable figure and it would be interesting to hear the author's reply to a previous speaker who wanted to have the calculation based on the model predictions.

Mr. K. E. Bostrom said that, as one responsible for trials in Sweden, he had a few figures that might be of interest.

Off the west coast of Sweden, there was a measured mile, where most of the ships up to 15,000 tons had carried out their trials up to now. The measured mile was about 1·3 miles in fact. There was also a Decca measured mile in the same area; the two measured miles did not cover each other, but were very close. During the eight years over which he had made these trials, the differences in speeds, between the measured mile and the Decca mile, in about 50 per cent of the runs, were less than 0·1 knot, with speeds ranging between 15 and 20 knots. In 40 per cent of the runs the difference was less than 0·2, at the same speeds, and, in the remaining 10 per cent, the biggest difference recorded was 0·33. Which was wrong, the optical measured speed or the other, was not known.

In another area, with a Decca mile, tests had been carried out on big tankers and, there, the water depth was between 120 and 200 metres. The speed measurement carried out in that area had been pretty good; at least, all the big shipyards were sending vessels there to carry out their speed trials. They spent one night going up, testing, and then, after drydocking, another night was spent in fuelling the ship before trials. From Rotterdam, it took two days.

One of the speakers had mentioned the long time lag between ascertaining the preliminary and final speeds. Normally, in Sweden, it took from one to three weeks, but, by virtue of the way in which the trials were carried out, in Sweden, the difference between preliminary and final speeds was usually less than 0·1 knot or one per cent. Sometimes it was as high as 0·25 knot, but very seldom. If there were something suspicious about a certain run, the final speed could always be calculated within an hour on board. The trials were not carried out in the same way as in the United Kingdom or in Holland. The Swedish method, using a Decca measured mile, of course, limited the choice of courses, but, on the other hand, gave a good accurate preliminary speed and very rapidly, a final speed.

There had to be a crash stop test, but no code today, so far as he knew, said how this was to be done and he did not think that anyone knew the answer.

Correspondence

Mr. G. Lowenhielm wrote that he had read Mr. Wilse's paper with great interest and welcomed his initiative in bringing up these questions for discussion. He was pleased to find that many of the tests, recommended by Mr. Wilse as standard for the delivery of a vessel, were being carried out on the vessels built at his company's yard. These tests were, however, not concentrated solely on the short duration of the actual trial trip, but were carried out simultaneously with the testing of the various pieces of equipment during the weeks prior to the sea trials. However, capacity tests of the various pumps were not normally carried out. Such tests had only taken place in exceptional cases and had mainly been concentrated on the oil cargo pumps of tankers. Such a capacity test could, of course, be carried out, even if it meant a certain amount of time-consuming inconvenience.

The manœuvrability tests carried out at sea trials varied according to owners' requirements, and the results obtained were recorded and illustrated in his companys sea trial minutes. It must, however, be borne in mind that the majority of vessels were tested in either the ballast or fully-loaded condition so that the manœuvrability of a vessel was established for one condition only. It should, therefore, be of great value if the vessel's officers made such tests in other conditions also and reported the results obtained to the builders, to enable them to widen their range of experience.

Mr. Wilse's observation that there was at present no continuous follow-up check on the performance of the various pieces of equipment was quite correct. It would, therefore, be of considerable interest for the yards to receive running information, even after the end of the guarantee period, provided always that the service performance data supplied were reliable and the information given was complete. For instance, in order to be able to form an opinion of the engine's performance one had to have data, not only on the number of revolutions, temperatures, effect and speed, but one must also know something about the weather conditions prevailing at the particular time, the time elapsed since the latest docking, etc.

The experience thus gained, enabled the yards to estimate, with greater accuracy, the size of the margins required for the vessel to fulfil the specific demands which the owner was entitled to have on her and on which, after all, the vessel's profitability depended in the last resort.

He wished to make one more point. In his view, Table I.—"Comparison of Duration of Delivery Tests" did not give a wholly true picture as far as ships were concerned, considering that the testing of the various pieces of equipment was going on for a comparatively long period of time prior to the actual trial trip, and it must also be considered to be normal that the whole engine plant, including all its parts, would be tested in its entirety alongside the quay for about a week before sea trials.

Mr. A. Norris (Member) wrote that he could well understand the decision to produce a Norwegian Trials Code to achieve parity of trials procedure, in view of the world wide location of their shipbuilding suppliers. Such a code—wherever initiated—was necessary with the machinery complications in modern ships. Since extension of sea trials time was expensive, the requirements must, however, be imposed and clearly stated by the owners before the shipbuilding contract was signed.

The writer's company found, some years ago, that a standard was desirable, and had built up a procedure which covered many of the features mentioned in the paper. Initially it was found that time spent at sea on trials was inadequate to enable automatically-controlled valves and systems to be adjusted. The company then insisted on two trials being carried out—a preliminary trial to enable such adjustments to be made and to bring any defects to light and an acceptance trial to prove that the equipment was working as designed.

There was a distressing tendency for some builders to defer adjustments and proving of equipment until the ship was actually at sea on trials. Should any unusual snags develop it was possible, then, to be in the position of using a large ship—the services of which plus trial costs might well be more than £3,000 per day—as an expensive test bed for some small component. There was thus a strong case for making all possible adjustments and for preliminary testing before a ship left for sea trials. This was particularly true for tankers, where a large artificial load could be built up in port by using the cargo pumping equipment, and so enable combustion control systems, generating plant and so on, to be set up.

The present trend towards increasing the number of automatic controls and providing centralized instrumentation made adequate pre-setting even more important. Such work could easily take a week and the related machinery components required to be completed before the setting-up could be commenced.

It might be that the pre-trial procedure was already covered by the Norwegian Trials Code. If not, it should perhaps receive consideration.

As he had attended many trials as an owner's superintendent, he trusted that the following detailed comments might be of value.

Item (c) on page 180 recommended that speed trials be recorded by means of Decca readings. These could give accurate results. Special locations for speed testing by this method would still be required, since Decca areas normally covered well-used shipping lanes and it could be distressing, on a full speed trial, to have to reduce speed or take avoiding action as the "give way" ship if another vessel entered the trials area.

He thoroughly agreed with power measurement by means of torsionmeter instead of indicator cards. Apart from the ± 5 per cent accuracy of pv-indicators mentioned in item (d) on page 180, working out the cards took some time and the results could be influenced by the optimism of those doing the computing.

Referring to the comments on Speed Results, it might be of interest to add that, even with a new ship, the speed trials could be significantly affected by the time out of dry dock and the fouling which could rapidly occur from heavily polluted river waters in industrial areas. A recent example of this was found where a ship met the contract speed, but was slower than others of the class. On drydocking, the bottom was found to have a coating of slime and after cleaning, the trial speed increased by 0·65 knot.

The power allowances to cover service deterioration of hull and propeller, as given on page 181, were based on past experience and were normally adequate but there was no direct experience to draw upon for the mammoth ships mentioned in the paper. At present, it was still essential, particularly with Diesel engines, to ensure that the propeller pitch was suitably adjusted to enable the required power to be obtained when this deterioration had occured, and without overloading the engine. If this was not done initially, it might be necessary to crop the propeller blade tips and adjust the pitch—with some loss of efficiency—or fit a modified propeller at a later date.

If the present work on external cathodic protection and improved external hull painting was successful in reducing service deterioration, however, engineers might lose their present major headache of deciding what excess power should initially be provided, to ensure that the speed would be obtainable after years in service. They would then be in a happy position of being able to fit a smaller main engine than at present.

The essential manœuvring tests given in Example 2 were all that his company normally required for each ship. They only carried out extended manœuvring trials, which included among others, the optional tests mentioned in the paper, on one ship of each class, and placed copies of the results aboard the other ships of the class, for reference. Since the full manœuvring trials took a minimum of 12 hours to complete, and included loaded and ballast conditions for tanker, they deferred them until the ship was in service.

His company also included the effect, on r.p.m. of the engine, when making the turning circle test. This effect could be quite pronounced and in their larger ships they included a helm-angle indicator in the engine room. The provision of this fitting enabled the engineer to check rapidly if any sudden fall-off in r.p.m. in service was due to this most common cause, or if it were due to some engine defect which required urgent action on his part.

It was interesting to note the comments on pages 187 and 188 on exhaust temperatures. He would not agree with the author that one degree increase of scavenge air temperature always meant three degrees increase in exhaust temperatures. This might have been true of some of the early turbocharged engines, but the turboblowers now available were much more efficient than the earlier ones. He would suggest that this increased efficiency and later experience were the factors which enabled the improvement, shown in Table IV, to be obtained.

The paper stressed the importance of careful cleaning of air coolers. While this was important, fouling of the coolers could be easily deduced by comparison of temperature readings. The factor which could not be easily assessed was the reduction of air flow, due to dirty air filters on the blower inlets, and he considered this fouling to be one of the major causes of rapidly-increasing exhaust temperatures. Perhaps Mr. Wilse would express his opinion on this point.

Mr. J. N. Wood (Associate) wrote that much of the paper was concerned with the trials of the larger types of vessel, but the writer's experience had been confined to the trials of small craft, particularly tugs. With this type of vessel the free speed was often not the major criterion of performance and those trials were invariably carried out using a laid out measured mile. There were two points, however, upon which the writer would like Mr. Wilse's comments:

1) Did the Norwegian code include a paragraph on bollard pull and towing trials and if so, what standard was called for?
2) What were Mr. Wilse's comments on the usefulness or otherwise of the Dieudonne spiral?

This latter manœuvring test was now carried out as standard practice by one British Tank and would appear to offer some scientific advantages over the turning circle.

One last point was that experience had shown that, with tugs, the ratio of tactical diameter to L.b.p. would appear to be much nearer 3·0 than the 4·5 quoted by Mr. Wilse. With vessels fitted with rotatable shrouds this ratio often fell as low as 2·25.

Mr. A. J. Vosper, in a written contribution, said that the importance of many of the aspects of ship trials with which the author had dealt, in this very comprehensive paper, was such as to merit greater attention and further study, and he proposed to confine his comments to a few of these.

First of all, it seemed singularly unfortunate that there was, as yet, no internationally accepted trials code and that so many different nations were individually trying to establish their own national codes. The International Towing Tank Conference had already virtually agreed at its 11th meeting, in 1963, to a speed trials code, and the Manœuvrability Committee of this same organization had set out an agreed code of manœuvres, covering circle, zig-zag and Dieudonne spirals. All these formed an excellent foundation for a more comprehensive trials code.

Turning to the prescribed general requirements in the section on "Presentation of Trial Results", it was suggested that whilst it was important to lay down limiting wind speeds depending on the length of ship, it was even more important to decide on limiting sea states since this was likely to have a greater effect on trials performance. It was also difficult to agree entirely with the Norwegian Committee's preference for Decca recording for speed and manœuvring trials. Whilst this method was certainly quick and convenient, it was essential for accurate results that local shore-based "slave-stations" were available. Reference was also made to a torsionmeter accuracy of ±2 per cent. This was unfortunately only achievable at full power, and was unlikely to be better than ±4 per cent at half scale. Even so such accuracy could only be attained if special care was taken when setting up the torsionmeter and adequate time must be allowed for a thorough check on the meter immediately before using it on a trial. In this connexion "crash stop" trials should never be performed between the time of checking the torsionmeter and its use on a speed trial, if the accuracy of the readings on the speed trials was to be maintained.

In regard to the manœuvring tests, it was considered that in these days of very large single-screw tankers and similar high block coefficient forms with doubtful directional stability, too much importance could not be placed on the need for a spiral manœuvre referred to in the tests as an optional item under "course stability". As mentioned earlier, the Manœuvrability Committee of the I.T.T.C. had laid down standards of circle, spiral and zig-zag manœuvres and a standard of presentation for such items, and in this respect it was desired to point out that the Advance and Tactical Diameter shown in Fig. 3 were not in accordance with this code. These items should be measured at 90 degrees and 180 degrees change of heading respectively, and not as drawn.

The value of the data in Table II on circle test Decca observations would be very much enhanced if the author could include figures for the speed of the vessel on approach and the rudder angle used. Some of the results in the table incidentally seemed rather inconsistent and emphasized the need for more accurate measurement.

The data on turning circles included in Fig. 8 bore out the fact that larger ships had smaller tactical diameter/length ratios, so that a criterion of 4·5 independent of the size of the ship seemed likely to be somewhat misleading.

The author's opinion that intensive research was needed into the effect of shallow water on manœuvring was fully supported, although it must be stressed that steering experiments of the sort described could only give a guide to full-scale ship performance. The difference in time scale between model and ship, and the Reynolds' number effects on the model would both create control difficulties. Also the remoteness of the operator from the model was bound to lead to lack of any anticipation in steering.

Finally, the figures mentioned in the early part of the paper on the effect of hull fouling on power requirement were noted with interest. Unfortunately the increase in resistance due to fouling depended on so many factors that it was impossible to generalize. It might be possible to establish reliable figures for a particular ship engaged on a regular service, but these would still depend very largely on the time of year and the type of bottom composition used.

Mr. P. R. Salisbury (Member) wrote that the author mentioned the S.N.A.M.E. Trials Code which was unfortunately too little known in British yards, although often employed for Japanese-built vessels. The B.S.R.A. provisions issued in 1947 were mainly concerned with measured mile speed trials. Torsionmeters should be standard equipment in all Diesel vessels, for use in checking performance during the ship's life, as well as on initial trials.

Crash stop procedure should be standardized, it generally being more effective to trail the propeller, stopped, for a while, rather than to put the engine astern while there was still considerable headway on the vessel.

The unfortunate haste with which many owners brought vessels into service without adequate trials was to be deplored and the importance of fully loaded trials did not seem to be properly appreciated. With Diesel general cargo vessels it was quite impossible to obtain realistic service results from a ballast trial. Under these conditions the torque/r.p.m. relationship of the engine was quite different and it was usually impossible to produce maximum power without exceeding the permissible r.p.m. Not only did this affect engine consumption, exhaust temperatures, etc., but propeller efficiency could not be properly determined.

Similarly, with oil tankers, the output cargo pumps, when discharging salt water, could be very different when the liquid was oil. Net positive head was altered and the likelihood of gasification and cavitation increased, leading to loss of efficiency.

Author's Reply

In reply to the discussion, Mr. Wilse first thanked all the contributors. He said that their comments and criticisms were much appreciated and enhanced the value of the paper considerably.

Mr. Canham gave, in his paper[5], read in March 1962, very valuable information regarding "The Propulsive Performance of a Group of Intermediate Tankers". The service allowance indicated in the present paper was partly based on Mr. Canham's own data, but covered purely Mr. Wilse's own views in that respect.

The Trials Code itself showed to what extent I.T.T.C. recommendations were included. It must, however, be borne in mind that very detailed requirements regarding procedure were not included in the new Norwegian Code. B.S.R.A.'s most valuable "Code of Procedure for Measured-Mile Trials" (1947 and revised 1954) dealt, however, closely with all data required and the manner of recording. Speed trials carried out according to the B.S.R.A. Code would certainly match the speed trial section of the new Code.

He agreed that reference should have been made to this B.S.R.A. Code. He considered that the Code, however, had been so well known for many years that separate reference was thought unnecessary. It should, however, be appreciated that "depth of water" and "length of approach" were easier to accommodate when Decca speed trials were used.

He was surprised to learn that B.S.R.A. still doubted the accuracy of the Decca Navigator system. The Swedish Shipbuilding Research Foundation gave, in their Report No. 28, valuable comments regarding this problem.

Further, however, he fully agreed with Mr. Canham that service performance of a ship should be based on results of tests in the model tank. This was also indicated in Fig. 2. The prediction of service speed must in addition often be given a long time before the trial trip took place.

Corrections for current were made, if necessary, not only for crash stops, but also for turning circles. Personally, he preferred the graphical method, in which the current was considered constant during the observed space of time.

It should be remembered that current in the Skagerrak, Kattegat and the Baltic was mainly negligible. If at all present, the current normally had a low speed and did not follow any tide.

By using Mr. Verstelle's methods, even the influence of strong current might be compensated for.

TABLE V

Ship	Minimum depth, fathoms		Remarks
	Mr. Archer	Code	
60,000 d.w.t.	46	42	*Basis:* Lpp=750ft. d =41ft.
100,000 d.w.t.	56	50	Lpp=810ft. d =50ft. Both 17 knots

Finally he agreed with Mr. Canham in his desire to obtain a standard in regard to what was good and bad turning behaviour.

Mr. Archer gave some interesting information about effect of depth. His figures for minimum depth seemed to be about ten per cent in excess of the Code's figures, provided that data shown under "Remarks", in Table V, were applied.

Further, Mr. Archer stressed a very delicate problem, i.e. avoiding maximum load on gears before they were run in. With the higher outputs, this problem seemed to increase in importance, not only with regard to gears, but also cylinder liner wear and ring wear on large-bore Diesel engines.

During recent years some engine builders had given 12 months' guarantee on their deliveries, including boilers and gears. This was a step in the right direction. From a technical point of view there should be little reason not to accept reduced output—say 75 per cent load—on the trial trip. When the results—with reduced output—were compared with the tank test predictions, it should be easy to see whether the vessel's speed was acceptable or not.

If, however, reduced output in connexion with delivery trials was accepted poor rim shrinkage—as mentioned by Mr. Archer—might lead to heavy expense and the yards would hardly agree to involve "off-hire" losses in their guarantee.

Personally, Mr. Wilse hoped that ships in the future would be delivered with all engines "run-in". At present, the revolution counter indicated 250,000-500,000 revolutions when the vessel was taken over by the owner. With not less than 1×10^6 revolutions behind them, he thought that normal main engines (Diesel and turbine) could be considered as "run in" and ready for maximum load. Mr. Archer's remarks about avoiding overstressing a new motor car seemed very appropriate in this connexion.

In reply to Mr. Cook's inquiry about noise level measurement, the author confirmed that the Code contained two reference curves. One curve was the I.S.O. noise rating curve N-90 and served as a reference for engine room noise, whereas another curve, N-50, might serve as a reference for noise in the superstructure.

The curves mentioned were not to be considered as absolute upper limits which could not be exceeded. The curves were however, from the work published by Scandinavian Group for Noise Problems on board Merchant Ships (Bulderkommiteen).

In Mr. Duggan's opinion Beaufort Force 5 was pretty severe and would not permit class A trial conditions. The wind force (B4 respectively B5) was taken from the S.N.A.M.E. Standardization Trials Code and appeared in the Norwegian Code in a somewhat revised condition. Where S.N.A.M.E. stated "smaller ships", the Norwegian Code introduced L>450 feet (I.T.T.C.).

Most shipbuilding contracts referred to "calm weather" "good weather" or "fine weather" during the speed trials. French contracts put Beaufort 2, German and Belgian contracts had Beaufort 3 as the upper limit. At Heligoland (German Bay) 360 days were reported in 1960 with wind force more than Beaufort 2 (and 322 days with wind force over Beaufort 3[3]. A strict interpretation of the contract conditions would thus only leave *six days in one year* when speed trials would be reliable and covered by guarantee.

It was interesting to note that Mr. Duggan's figures indicated the same sort of order as those quoted by Mr. Wilse for resistance increase. He agreed that the performance aspects were very important. By technical calculation it should be fairly easy to arrive at a reasonable service speed, provided model tests or reliable trial trip results were at hand. Nevertheless, it seemed, today, that the big tanker charterers supported those owners who provided low consumption and high speed—although both parties ought to know that the speed would drop and/or the consumption would increase after a short space of time.

With regard to the model tests in the Suez Canal section, it was perhaps right to mention that the tests were carried out in Hamburg in 1964. The difference in rudder movements might have been caused by scale effect. At the end of 1964, additional tests were carried out in order to ascertain the frequency of striking the bank in relation to the speed of advance. The results showed (for Km 51):

Speed km. per hour	*Frequency of striking bank*
9	0 per cent
11	25 per cent
13	75 per cent

Mr. Duggan and Mr. Cook had both stressed the use of the torsionmeter. The author had, for the last eight years, followed vessels with torsionmeters (six vessels with b.h.p. of more than 12,500). None of the torsionmeters was however, of the recording type, but had proved to be most useful.

Questions raised with regard to the Decca Navigator's accuracy should have been thoroughly dealt with by Mr. Verstelle and Mr. E. Boström. Both gentlemen had vast experience in Decca trials.

Mr. Wilse was especially pleased to note that the difference between preliminary speed and final speed was generally negligible.

Mr. Bridle had asked whose fault it was that the trial trips were of such short duration.

Maybe conditions would improve when those responsible for the economic side of the companies realized the risk they took in accepting complex machinery which had not been properly "run in". With time for "running in" period there should also be an opportunity to obtain the best possible adjustment of instruments and outfit. He completely agreed with Mr. Bridle in his recommendation regarding time allowed for fuel consumption tests.

To Mr. Tonkin, the author must admit that the new Code did not give any comments on when the trial should be held. The different shipbuilding centres had different practices. Some yards already had about one week's trial; other yards had a much shorter time. An actual example referred to a yard where the boilers were lit on Monday and the vessel delivered on Friday. The Code did not stipulate any permitted margin for fuel consumption. For deadweight, however, "a deviation of $\mp\frac{1}{2}$ per cent is regarded as acceptable".

Mr. Norris' remarks, about time for trials, were much appreciated. The comparison with his own company's standard was also very interesting. To Mr. Norris and Mr. Löwenhielm, the author might add that manœuvring tests had been carried out on several Norwegian vessels in service[3]. Not many of the officers had however, proved able to take exact observations. Only too often, well-performed tests had been spoiled by inaccurate or scanty observations.

It was difficult to see how the efficiency of the turboblower, mentioned by Mr. Norris was involved, as long as the scavenge air temperature was measured after the blower. It had been stated that one degree increased temperature of the scavenge air meant two degrees increased exhaust temperature, regardless of blower efficiency*.

Further, the author fully agreed with Mr. Norris that not only the coolers needed close attention, but also the air filters on the blower inlets.

Mr. Löwenhielm certainly expressed the shipbuilders' point of view—and Mr. Wilse appreciated it. Several tests might be carried out at the quayside, but one of the main intentions of a substantial trial trip, would be to "run in" the machinery.

In reply to Mr. Wood, he confirmed that the Code concerned larger types of vessels. Thus, towing trials had, unfortunately, not been included.

Dieudonne's spiral, for checking the course stability, was intended to be included in the Code. Finally, however, a simpler method was introduced as a "recommended additional test".

Regarding Mr. Vosper's reference to the I.T.T.C. trial codes, it must be remembered that these codes only covered a fraction—although an important one—of the trials procedure. The Norwegian Code put more stress on the usefulness of the results. The I.T.T.C. Code might very well be followed as long as the results were given in the recommended form.

Only too often, actual test results were given without stating contract conditions or compared with expected figures (curves). In the same way, separate speed curves were given in relation to revolutions, and separate horsepower curves in relation to the same revolutions. It often seemed as if the reports had been made by two entirely different nations, lacking means of communication, i.e. the shipbuilders on one side and the engine builders on the other.

He admitted that maximum rudder angle should have been mentioned in connexion with Table II. Major steering-gear makers all preferred a maximum angle of 35 degrees and he expected errors to be fairly small if this figure was accepted as standard.

The speed of approach did not play any important part[3, 7].

He agreed with Mr. Vosper that increase in resistance due to fouling depended on many factors. Nevertheless, it was considered more realistic to accept an estimated increased resistance, than to play with charter party figures which, evidently, were far too optimistic.

Mr. Salisbury had recommended a standardized crash stop procedure. Such standardization would certainly be ideal, but one must realize that not all propulsion machinery manœuvred equally well. The crash stop procedure was partly dependent on the manual ability of the operator and partly also dependent on the extend of load the different engine builders accepted.

Although it was desirable to carry out fully loaded trials, it must be admitted that such conditions for dry cargo vessels would involve considerable expense.

Provided, however, that model tests had been carried out for ballast condition also, as recommended in the code, a quite realistic analysis of the vessel's performance should be possible.

In conclusion, the author thanked all those who took part in the discussion for their positive and kind reaction to his paper.

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* Hansen, S. "Driftskontrol af Dieselanlaeg i Skibe". N.S.T.M. 1959.

INSTITUTE ACTIVITIES

Minutes of Proceedings of the Ordinary Meeting Held at The Memorial Building on Tuesday, 9th March 1965

An Ordinary Meeting was held by the Institute on Tuesday, 9th March 1965, at 5.30 p.m., when a paper entitled "Some Comments on Merchant Ship Trials" by Th. Wilse, Civ.ing., M.N.I.F., M.R.I.N.A., was presented by the author and discussed.

Mr. W. Young, C.B.E. (Chairman of Council) was in the Chair and eighty-six members and visitors were present.

In the discussion which followed nine speakers took part.

The Chairman proposed a vote of thanks to the author which received prolonged acclaim.

The meeting closed at 8.10 p.m.

Section Meetings

Bombay

Annual General Meeting

The Annual General Meeting of the Bombay Section was held on Wednesday, 24th February 1965, in the offices of the Jayanti Shipping Co. Ltd., Bombay, at 6.00 p.m.

The annual report which had been circulated was taken as read and adopted. In proposing the adoption, Mr. B. S. Sood (Local Vice-President) said that the highlight of the year had been the visit to India of the Chairman of Council, Mr. W. Young, C.B.E., and Mr. J. Stuart Robinson, M.A. (Secretary), and gave a brief resumé of the inauguration meeting in Delhi.

The financial statement which also had been circulated was presented by the Honorary Treasurer Mr. C. S. Sundaram and was adopted.

Messrs. T. Berry, N. Ramamurthy and C. C. Shah were elected to the Committee in place of the retiring members Messrs. E. R. Dastoor, A. N. Mukherjee and S. Ratra.

The Committee for 1965 is therefore as follows:

Local Vice-President: B. S. Sood
Chairman: S. A. Samson
Committee: T. Berry
M. K. Jagtianie
A. Krishnan
Cdr. V. S. P. Mudaliar, I.N.
N. Ramamurthy
S. Ratra
R. S. Rawal
C. C. Shah
Honorary Secretary: D. Dyer
Honorary Treasurer: C. S. Sundaram

Following the Annual General Meeting, Mr. R. S. Rawal, in introducing the scheme for the training of marine engineers, said that during the visit to India of the Chairman of Council and the Secretary, the Minister of Shipping had suggested that the Indian Division should submit proposals for this scheme, and a special panel to study the matter was formed.

Mr. A. T. Joseph, a member of the panel read out the scheme and a lively discussion followed.

The Honorary Secretary, Mr. D. Dyer, thanked the members for attending, and expressed his appreciation to the retiring members of Committee. Mr. Dyer also said he was sure that everyone would join in thanking the Jayanti Shipping Co. for the excellent arrangements.

A vote of thanks to the Chairman was proposed by Mr. Ratra and the meeting closed at 7.30 p.m.

Calcutta

Annual General Meeting

The Annual General Meeting of the Calcutta Section was held on Wednesday, 10th February 1965 in the British Council Lecture Hall, 5, Shakespeare Sarani, Calcutta-16, at 5.30 p.m. with Mr. T. K. T. Srisailam (Member of Committee) in the Chair.

It was proposed by Mr. J. E. D'Souza and seconded by Mr. S. V. Ramchandani that the statement of accounts be adopted. This was unanimously approved.

The following members were elected to serve on the Committee during 1965:

Local Vice-President: B. Hill
Committee: J. E. D'Souza
K. S. Oberoi
S. K. Paul, B.Sc.
K. D. Pradhan
K. Ramakrishna
S. V. Ramchandani
T. K. T. Srisailam
C. Tye
D. Vincent
Honorary Secretary: K. S. Chetty
Honorary Treasurer: B. S. Makhija

Owing to a recent motor car accident it was regretted that Mr. Chetty would be unable to carry out his duties for a time. Mr. C. Tye and Mr. S. D. Srivastava had agreed to perform the duties of Honorary Secretary.

Following the Annual General Meeting a film show was arranged by courtesy of the British Information Services and three films, News Reel; Seawards, the Great Ships; and Ship Shape were shown.

The meeting ended at 7.15 p.m. with a vote of thanks to the Chairman.

Ceylon

Annual General Meeting

The Fourth Annual General Meeting of the Ceylon Section was held on Wednesday, 16th June 1965, at the Naval Education Services Centre, the Volunteer Naval Force Headquarters, Kochchikade, Colombo, at 5.15 p.m.

Mr. C. W. V. Ferdinands (Local Vice-President) who was in the Chair said in his report that the activities of the Section had been confined to four committee meetings and one Student/Apprentice meeting. He expressed his appreciation of the willing assistance provided by commercial establishments and public departments in making the Student Apprentices' visit a success.

The Chairman explained that a statement of accounts had not been prepared in time for the meeting but would be read at the next committee meeting.

Mr. Ferdinands wished to thank those who had appointed him to his Office, and had attended and assisted in, the activities of the Section.

In the election of Office Bearers for 1965, the following were elected to serve on the Committee:

Local Vice-President: C. W. V. Ferdinands
Committee: A. G. Bartholomeusz
B. E. J. Borkett
S. M. B. Dolapihilla
A. L. S. Fernando
D. C. R. Goonewardene
A. L. Gunawardene
A. J. Hill
B. H. F. Jacotine
Instr. Lt. Cdr. M. G. S. Perera, R.Cy.N.
A. H. Singarayer
Honorary Secretary: Cdr. (E) E. L. Matthysz, R.Cy.N.
Honorary Treasurer: L. A. W. Fernando

Annual Report

The Annual Report for 1964 shows the membership of the Ceylon Section at thirty-one.

During the year four meetings were held. On Thursday, 24th September 1964, a Student/Apprentice meeting was held attended by twenty-six Student/Apprentices of marine and allied branches of engineering.

During the visit to Ceylon of the Chairman of Council, Mr. W. Young, C.B.E., the Secretary, Mr. J. Stuart Robinson, M.A., and their ladies, a meeting was held on Monday, 2nd November 1964 when the question of the Institute and the Engineering Institutions Joint Council was discussed.

E. L. Matthysz (*Honorary Secretary*)

Visakhapatnam

Annual General Meeting

The Second Annual General Meeting of the Section was held on Monday, 29th March 1965.

In the absence of the Local Vice-President, Mr. H. C. Raut, B.Sc., and Mr. A. W. De Lima (Chairman of the Section), Commander D. C. Chopra, I.N. was in the Chair.

In presenting his annual report, Mr. A. Prakash (Honorary Secretary) said that there had been three technical meetings during 1964, three social gatherings and four committee meetings. The attendance at technical meetings had been discouraging and members had not taken part in the discussions. Mr. Prakash emphasized that the unstinted co-operation of all members was of paramount importance in making the Section worthy of the standards of the Institute.

In the absence of the Honorary Treasurer, Mr. R. S. Grewal, the statement of accounts was read by Mr. Prakash.

The following were elected to serve on the Committee for 1965:

Local Vice-President: H. C. Raut, B.Sc.
Chairman: A. W. De Lima
Committee: R. P. Chitra
Cdr. D. C. Chopra, I.N.
M. J. Godiwala
R. S. Grewal
M. M. Nambiar
Honorary Secretary: K. K. Banerjee, M.Eng. (Sheffield)
Honorary Treasurer: A. Prakash

A tribute was paid to Mr. Prakash by Mr. K. K. Banerjee, for his services to the Section.

Mr. Prakash thanked the members for the excellent co-operation extended to him during his term of office and proposed a vote of thanks to the Chairman.

West of England

On Thursday, 20th May 1965, some thirty-five members of the Section, amongst whom were Mr. J. P. Vickery (Chairman of the Section), and the Local Vice-President, Mr. F. C. Tottle, M.B.E., enjoyed a pleasant and interesting day with the Royal Navy, when by kind permission of the Commanding Officer, Captain W. B. S. Milln, R.N., they visited the Royal Naval Engineering College at Manadon, Plymouth.

The party left Bristol in the early morning arriving at the College in time for lunch.

After lunch, members were accompanied to the lecture theatre by the College executive staff and final year students, where an appreciation of the College and its work was given by the senior officers. Mention was made of the history of the College, the traditional Naval training of students, and of the courses and sub-specialization courses which were held.

The party was shown round the various departments including the laboratories, engine test houses—both internal combustion engines and steam—and the workshops, where they were shown some fine exhibits of work done by the students in the various sections of the craft trades. They went on to see a comprehensive range of marine machinery, including turbine sets complete with gearing, self-contained turbo-generator sets, many sizes of Diesel engines, and a small marine type watertube boiler supplying steam to various installations of steam machinery.

Mr. Vickery, on behalf of the members, expressed his thanks to Captain Milln, for the very generous hospitality received and for the wonderful way in which the work of the College had been explained. He also spoke of the fine work that was being done in all the various sections of engineering, especially by students from so many different countries.

The party left the College at 5.30 p.m., after tea in the Great Hall, arriving in Bristol at 10.45 p.m.

Election of Members

Elected on 22nd June 1965

MEMBERS

Barton Ballou Cook, Jr.
John Coyle
Dennis Dettman
Daniel George Downing
Ian Robert Dumbreck, Cdr., R.N.
John Stewart Fairley, B.Sc. (Mech.) (Belfast)
Pallathucheril Varkki George, Capt., I.N.
Robert Kay Gibson
Homi Dinshah Kapadia, Capt., B.Sc. (Bombay), I.N.
Thomas Middlemiss
Mushtaq Ahmed Khan Niazi, Cdr., B.Sc. (Eng.), P.N.
James Ronald Parkinson, B.Sc. (Eng.) (London)
Nazareno Franco Pittaluga, Dot. Ing.
William Robertson
Kenneth Stevens
Harry Stewart
Arthur Edward Thompson
William J. Young

ASSOCIATE MEMBERS

Robert Thirlwell Anderson
Francis Donald Lawson Barnes, M.A., (Cantab.)
James Frazer Black
Thomas Brankin, A.R.C.S.T.
Harry Anthony Brown
Homi Sorabji Buhariwala
John Frederick Cameron, Eng., Lieut., R.N.
David Newman James Cole
Derek Charles Cole
Antony J. Dalton
Behram Dinshaw Daruvala
John Wilfred Davies, M.A. (Cantab.)
Vincenzo De Stefanis
John Anthony Edmunds
Walter James Elsdon
Brian Alfred Fewtrell
Suresh Kumar Gupta, B.Sc. (Agra)
Anthony John Halliday
Robert James Hargreaves, Lieut., R.N.
Jack Holt
Donald Stewart James
Michael Kavanagh
Francis James Peter McKeown
William Maitland

Kadalangudi Subramanyam Krishna Murthy, B.Sc.
John Shaw Napier
Molleti Sankara Narayana
Joseph Owen Dunstan Pereira
John Frederick Potter
Saiyed Abad Husain Rizvi
Frederick Stanley Sapsford
Krishnaswami Seshadri
Ram Gopal Singh
Even Arnfin Skraastad, B.Sc. (Glasgow)
Narayana Swaminathan
Michael John Thompson
John Williams, B.Sc. (Mech.) (Wales)
David Vivian Wilson

ASSOCIATES
John Theodore Anderson
Hugh Aldwyn Callender
Anthony Ramsey Cameron
John Carmichael
Mohammed Bashir Choudhry
Trevor Huntley Harris
Mohd. Fazlul Karim
Mathys Michael Johannes Laubscher
Paul Henry McDaid
Theodoor Nieuwpoort
John William Richardson
Keith Edmund Tucker
John Walker

GRADUATES
John Cyril Matthew Bell
James Scott Bramwell
Joseph George Cheetham
Robert Clive Davis
John Gwyn Howell
Roy Stanley Kirkham
Jacob Korver
Bishnu Pada Sharma
Colin Gregory Stonebridge
Syed Meraj Ali Zaidi

STUDENTS
John Frederick Derrick
John Greenhalgh
Michael Leslie Hill
Kenneth James McCallum
Alan Maxwell Methven
John Eric Stevens
Robert Shankley Turnbull

PROBATIONER STUDENTS
John Howard Bedford
David Brighouse
David George Michael Carpenter
Ian Doctor
William Vincent Figgess
Alan Thomson Hamilton
Brian James Harris
Alexander Stewart MacGlashan
Edward Alfred Senner

TRANSFERRED FROM ASSOCIATE MEMBER TO MEMBER
Alan Lindsay Budd
Denzil Anthony John Clarke
Derek Crockett
Mostafa Nayer El-Mamoun, Cdre. (E), B.Sc. (Cairo), U.A.R. Naval Forces
Ernest Norval Geldart
James Jackson
Raymond Henry Moore
Frederick Bernard Price
David George Reeve
Constantine George Stavridis, B.Sc. (Eng.) (Glasgow)
James Watson
Cyril George Wood

TRANSFERRED FROM ASSOCIATE TO MEMBER
John Barry Cooling
Robert Cyril Charles Crews
John Miles Duckworth
Robert Kavanagh
Victor John McLeod

TRANSFERRED FROM ASSOCIATE TO ASSOCIATE MEMBER
William Blackburn
Bhag Singh, Lieut. (S.D.) (M.E.), I.N.

TRANSFERRED FROM GRADUATE TO ASSOCIATE MEMBER
Brian Arwyn Bailey
Surinder Singh Bawa, Lieut. (E), I.N.
Alan Blackwood
Derek Ralph Chamberlain
Ian Jeffrey Day
Campbell Crawford Gawn
Douglas Neill Gray
William Donald Harris
Darrell Alfred Frederick Hilleard
Keith Marcellus John
Bryan David Lee
James McDade
Jai Nath Misra, Lieut (E), I.N.
David Glynn Owen
Basil John Reed
John Michael Howard Saint, Lieut., R.N.
George William Tilby
Sharad Shantaram Vartak

TRANSFERRED FROM PROBATIONER STUDENT TO ASSOCIATE MEMBER
Brian Roland Sangster

TRANSFERRED FROM GRADUATE TO ASSOCIATE
Thomas E. Colvin
William Edward Green
Robert Douglas Hastings
Roger Arnold Miles

TRANSFERRED FROM STUDENT TO GRADUATE
David Charles Ashton
Donald Lindsay Paul Milligan

TRANSFERRED FROM PROBATIONER STUDENT TO GRADUATE
Keith Knowles Stevenson
Jeremy Charles Tottle

TRANSFERRED FROM PROBATIONER STUDENT TO STUDENT
Anthony Harold Dugdale
Paul Simon Ross
Philip Kennedy Williams

OBITUARY

NORMAN BURKE (Member 9697) died on 25th February 1965 in Donaghadee, Co. Down.

Mr. Burke was educated at Trinity Public School and Bangor Grammar School, Northern Ireland, and served his apprenticeship with Musgrave and Co. Ltd., Belfast. At the same time he took courses in mechanical and electrical engineering and building construction at Belfast College of Technology. He later worked as a draughtsman at Sirocco Engineering Works, Belfast, and returned to Musgrave and Co. as assistant chief draughtsman and later London manager.

In 1931 he joined James Howden and Co. Ltd. and was soon appointed sales director, in which capacity his ability and record of outstanding success earned him an immense reputation. He eventually joined the board of the company and became technical sales director, which post he held until his sudden death.

Mr. Burke was also a member of the Institution of Mechanical Engineers, The Institute of Fuel, The Institution of Heating and Ventilating Engineers, The Electrical Power Engineers Association and the American Society of Mechanical Engineers. He leaves a widow and one son.

DOUGLAS CHRISTIE CARSON (Member 9012) died in Dublin on 7th November 1964, after a fairly long illness.

Born in October 1884, Mr. Carson first went to sea from 1906 to 1914, and gained his First Class Board of Trade Certificate during that period. In 1914 he became an engineer draughtsman and in 1916 went to Humber Graving Docks, Immingham, as assistant engineer manager. He was elected a Member of the Institute in 1939, during which year he also went into business on his own account as a partner of the firm of Carson and Potts.

During the Second World War he was Controller of a Ship and Repairing Section in Germany, after which he returned to his own business. Mr. Carson left a widow.

ALFRED NICHOLAS HAGAN (Member 10256) died in February 1965, after a long illness.

After serving an apprenticeship with H. and C. Grayson in Liverpool from 1922 to 1926, Mr. Hagan joined Elder Dempster Lines Ltd., with whom he gained his First Class Board of Trade Certificate in 1931. He then served with the Booth Line and British Tanker Co. From 1939 to 1945 he worked as assistant departmental manager (production) at D. Napier and Sons. In 1945 Mr. Hagan went to Barker and Dobson's Liverpool factory as chief engineer, where he remained until his death. He was first elected a Member of this Institute in 1932.

SAMUEL MCNEILL (Member 8839) died suddenly on 19th November, 1964, aged seventy-one.

Mr. McNeill was apprenticed with Coombe, Barber and Coombe, Belfast, and joined the Royal Navy in 1915. He served in destroyers in the Dover Patrol, for four years, during which time his ship was torpedoed three times and he was one of the survivors from H.M.S. *Natal* when this vessel was blown up with a total loss of 500 lives.

After demobilization he joined the Royal Mail Steamship Co., where he gained his First Class Board of Trade Certificate and Motor Endorsement. Some years later, he went to the Belfast Steamship Co. and was appointed inspector of new tonnage for Coast Lines Ltd. Eventually he was appointed superintendent engineer in London in 1938, which post he held until his retirement in September 1959.

Mr. McNeill, who was elected a Member of the Institute, in 1939, is survived by his wife.

ROBERT COCKBURN RODGER (Associate 20008) died on 23rd December 1964, aged fifty-six years.

He was of the fourth generation of the family controlling the valve-making firm Cockburns Ltd. of Cardonald, Glasgow, and joined the company in 1932, as assistant works manager, after a period of engineering training with West of Scotland firms, following his graduation as a chartered accountant. Appointed a director in 1935, he became managing director in 1948 and held this office until June 1964, when he was appointed chairman of the company.

Mr. Rodger was also chairman of the subsidiary companies, Cockburns (Springs) Ltd. and Cockburns Nederland N.V., and he travelled extensively in connexion with their business, as well as that of the parent company.

Mr. Rodger was elected an Associate of the Institute on 12th March 1958; he was also a Member of the Institute of Chartered Accountants of Scotland and of the Iron and Steel Institute of Scotland.

He leaves a widow.

ROBERT SMITH (Member 6568) died in August 1964. Mr. Smith served his apprenticeship with George Clark Ltd., Sunderland, and started his sea service in 1906 as fourth engineer. He gained his First Class Board of Trade Certificate during this early sea service.

During the First World War, he served as a trooper and corporal in the Royal Horse Guards, and subsequently as an Engineer Lieutenant in the Royal Navy.

On demobilization in 1920, he went to John Stewart and Sons Ltd. as assistant manager, and later to the Blackwall Point Dry Dock, Greenwich, as manager. He then worked as mechanical engineer and agent for Scotland for the Tilbury Contracting and Dredging Co. Ltd., and as assistant port engineer in charge of dredging contracts, Port Trust Workshops. He was also an examiner of engineers for the Indian Government in Aden. From 1949 onwards he was employed at Head Office, Ministry of Transport.

Mr. Smith was elected a Member of the Institute in 1930. He is survived by a daughter.

H. STEVENSON (Honorary Life Member 1572) died at Littlehampton on 12th January 1965. He was associated with the Institute for a great many years, having been elected a Member on 8th November 1901.

Mr. Stevenson was born on 19th January 1871, at Carrickfergus in Northern Ireland. His apprenticeship was served with Harland and Wolff Ltd., of Belfast, and he first went to sea in January 1893, in the employment of Messrs. Ashley and Beechley, also of that city. His seagoing career, during which he gained a First Class Board of Trade Certificate, continued until April 1906. Three of the ships in which he sailed were *Star of New Zealand, Star of Victoria* and *Star of Ireland*. After leaving the sea, he was, for six years, chief engineer at the Purfleet Paper Mills in Essex, until 1912, when he joined the staff of Stevenson's Marine Engineering Academy in Cardiff. Apart from the year 1915 to 1916, when he returned to seagoing duties as chief engineer of the *Argyllshire,* on Admiralty service, he remained with the Academy for the next twenty-eight years, being appointed Principal in 1925. When the Academy was closed by enemy action in 1940, he became a consultant engineer with Curran's Engineering Company in South Wales, and was again engaged on Admiralty service. He remained with the company until his retirement from business in 1945. He was a very happy resident of the Guild House at Littlehampton, from 1957 until the time of his death.

DONALD GRANT STEWART (Associate Member 13153) died on 5th November 1964, aged 40.

Mr. Stewart was apprenticed to R. Kellie and Sons Ltd., of Dundee. During the Second World War, he served with the Royal Naval Air Branch, and after the war, he returned to R. Kellie as a journeyman fitter. In 1949 he went to sea as fourth engineer for Bullard King and Co. Ltd. and gained his Second Class Steam Certificate.

He joined Esso Transportation Co. in 1950, and served in, altogether, fifteen Esso tankers. In August 1964, Mr. Stewart was chief engineer on board the ill-fated *Esso Norway* which caught fire after an explosion off the coast of Arabia. Mr. Stewart volunteered to stay aboard the ship with the captain, and was among the last to be rescued by the naval ship *Anzio*.

He was elected an Associate of the Institute on 8th January, 1951 and transferred to Associate Member in April 1956.

Mr. Stewart is survived by his wife and a baby son.

WILLIAM STOTT (Member 4915) died suddenly of coronary thrombosis on 15th May 1965, aged 76.

Mr. Stott was born at Uddingston, Lanarkshire, in 1888. He served his apprenticeship at Alley and MacLellan and A. and W. Smith, of Glasgow from 1905 to 1908, and then with Beliard and Crighton of Antwerp, as a fitter, until 1909. He also attended technical colleges in Glasgow and marine schools in South Shields and Greenock.

His seagoing career started with service as fourth engineer in s.s. *Vennachar*, where he obtained his Second Class Certificate, then in s.s. *Berwick Law* from 1911 to 1912, during which time he gained his First Class Board of Trade Certificate. He gained an Extra First Class Certificate in July 1914, while serving in s.s. *Fenay Lodge*. In September 1914 he joined the Royal Naval Reserve and served in H.M.S. *Antrim*, and H.M.S. *Attentive*. Later he served at Dover, Le Havre and Cherbourg, supervising repairs to minesweepers. In 1919 he was demobilized from the Navy with the rank of Engineer Lieutenant.

He then joined Messrs. Brigham and Cowan, of South Shields, as foreman in charge of installations of oil burning machinery, and later worked as a journeyman draughtsman at Dunlop Bremner, Port Glasgow, until 1921. He later returned to Beliard and Crighton as assistant manager, and was subsequently promoted to manager. In 1940 he left the firm because of the war, and worked for Barclay, Curle in Glasgow, rejoining Beliard and Crighton in 1945. He continued working for this firm until his retirement in 1951. He was an enthusiastic gardener and a keen bridge player.

Mr. Stott was elected a member of the Institute in 1923. He leaves a widow and one son.

ERNEST THOMPSON, M.B.E. (Associate 15270) died on 28th February 1964, at the age of sixty-seven.

From 1911 to 1916, he served his apprenticeship with Vickers Ltd. and, for four years after completing his indentures, was employed as a naval architect at Vickers College at Barrow-in-Furness. In 1920, he joined the staff of James Pollock and Sons, shipbuilders and engineers of Faversham in Kent and, apart from two brief periods of other employment—two years with the Marine Section of the London, Midland and Scottish Railway Company and one year with the Ardrossan Shipbuilding Company—remained with that concern for the following ten years, finally as manager. From 1930 to 1949, he was employed as an inspector by the Marine Branch, Harbour Works, at Takoradi on the Gold Coast (now Ghana). During the war years of this period, he was on Admiralty service. He retired from the Colonial Service, Marine Branch in 1950.

After leaving the Colonial Service, he remained on the Gold Coast and, from 1952 to 1953, was chief inspector, maritime works, with Messrs. Rendel, Palmer and Tritton, consulting engineers. In June 1954, he joined the firm of Sir William Halcrow and Partners, and was employed on the construction of the Port of Tema as a member of the site staff of their chief engineer. For the greater part of this period he was chief marine inspector. He left Ghana, on repatriation to Australia because of ill health, on 11th November 1963. He thus completed thirty-four years' service in Ghana, where he had the unique experience of being actively associated with the construction of the two largest Ghanaian ports—Takoradi and Tema.

Mr. Thompson was elected an Associate of this Institute on 4th October 1954. He was also a Member of the Royal Institution of Naval Architects and a Fellow of the Royal Geographical Society. He leaves a widow.

ANDREW MORAY WALLACE (Member 4313) died in Llandough Hospital, near Cardiff, on 7th March 1965.

He was born on 12th April 1883 in Oxford, where his father, William Wallace, M.A., LL.D., was Professor of Moral Philosophy and Librarian of Merton College.

He was educated at Lynam's School, Oxford and South Eastern College, Ramsgate. He then went to Glasgow and began what must have been one of the first sandwich courses offered by the University. This was in 1903. During the course, he served an apprenticeship with Messrs. Caird of Greenock, the Siemens Electric Works and Parsons Turbine Works. He graduated with the degree of Bachelor of Science in 1907.

Then followed a period as engineer officer in ships belonging to Lloyd Triestino where he was the only English-speaking officer. He then spent some time ashore with John Brown on Clydebank and with Harland and Wolff in Glasgow.

He joined the Royal Navy in September 1914 and a full list of his ships appears on the silver napkin ring which all naval officers owned at that time. Amongst them appear *Aurora* and the famous *Dreadnought*. At the end of the Great War he was a Lieutenant-Commander (E), Royal Navy, and was Chief Engineer of the destroyer *Relentless*.

Mr. Wallace was the holder of an Extra First Class Certificate.

After the war he had a few months with the Tenbury Motor Company. On 20th September 1920 he was appointed to teach Marine Engineering at Cardiff Technical College and he was there until his retirement in 1948.

Mr. Wallace was an exceptionally gifted teacher. He was especially good at explaining a complex mechanism and used original diagrammatic sketches, often in colour and perspective, and models of his own to this end. He was an artist with chalk or pencil and his sketches were bold and often enlivened by humorous additions. He made immediate personal contact with his students and soon won their respect, admiration and affection. He liked nothing better than a marine engineering problem to tackle and he would not rest until he had found the solution and a way in which it could be simply explained to a student. He made use of a number of memory aids and old students will remember one particularly for Inch Trim Moment.

He was an enthusiastic motorist and had a two-seater Metalurgique which he ran for sixteen years. He was a keen gardener and the crankshaft of the old car ended its life as the pillar for a sundial in his garden in Cyncoed.

Mr. Wallace joined the Institute in 1921 and attended the meetings in Cardiff regularly until 1964.

After retirement he went back to sea as Chief Engineer of a tramp steamer and has left a notebook full of sketches of things he saw on his last voyages. These range from seagulls in flight to Chinese junks.

Mr. Wallace is survived by his wife.

He was not a big man physically but he was cast in an heroic mould. He will long be remembered as a tutor and friend.