MAINTENANCE EVALUATION

THE ESTABLISHMENT OF THE RELATIONSHIP BETWEEN MAINTENANCE TASK AND MAINTENANCE EFFORT IN SHIPS

BY

COMMANDER J. A. OSBORNE, D.S.C., R.N.

INTRODUCTION

The Complementing Objective

Ships companies should comprise sufficient men to operate and maintain ships under various operational conditions, assisted to a planned extent by outside maintenance support. They perform three main functions :—

(*a*) Watchkeeping

(*b*) Maintenance

(*c*) Ancillary and domestic duties.

The whole company must be as small as possible so that the minimum number of men may man the required number of ships (overall economy aspect) and so that, within any ship, the minimum of weight and space need be devoted to housing the ships company (unit economy aspect).

The Present State of Affairs

Up to the present, ships have been complemented with engineering department ratings mainly with regard to the main steaming watchkeeping requirement and with insufficient regard to maintenance. It is true that the complement is assessed to provide for the three states of action, defence cruising and harbour, but in nearly all ships the ' prime ' state is that of defence cruising. Some attempt has been made to relate the maintenance effort which will result to the maintenance task, inherent in the ship, but this has been rather haphazard because :—

(*a*) The maintenance task has never been assessed

(*b*) The maintenance effort, in terms of the number of available men and the time made available to each by his other employment and the ship's operating cycle, has never been assessed.

It would not be quite true to say, in this connection, that no thought has been given to the maintenance effort and its relation to the task, but it is true to say that the one has never been accurately assessed in relation to the other with the object of ensuring that the two are equal and that the maintenance state of the ship can therefore be maintained. The circumstances of comparatively simple ships and large main steaming watch-bills have resulted, in the past, in a fair measure of success in balancing the task/effort account, but the increased extent and complexity of machinery on the one hand (increasing the maintenance task) and the decreasing requirement of main steaming watchkeepers (decreasing the availability of maintenance effort) on the other, has gradually upset this balance to the detriment of the availability and/or the maintenance state of ships.

The necessity to estimate accurately the task and the effort made available to undertake it, and to equate the one with the other, is becoming increasingly apparent. Only by so doing will the extent of the ability of ships to maintain themselves and the degree of outside assistance required to balance the maintenance account be known, and the various factors adjusted. It is, therefore, essential that all ships should be complemented in such a way that they will be enabled to balance their maintenance task/effort account to those conditions of operation indicated by the Staff Requirement. Fortunately, there is becoming available, in the form of Maintenance Schedules, a complete list of everything that need be done to maintain the efficiency of a number of ships, and the time required to carry out these schedules can be estimated with a sufficient degree of accuracy to provide a sound estimate of the whole planned maintenance task. Furthermore, it is now Admiralty policy to maintain ships by the application of ' planned maintenance ', i.e. by the performance of these routine examinations at the prescribed periods. The introduction of planned maintenance has thus :—

(*a*) Set each ship a certain maintenance task which, with the addition of a break-down component, represents the whole maintenance task of the ship

(*b*) Provided a means whereby the extent of this task can be calculated and subsequently checked by experience.

To relate to this task the effort required to undertake it, it is necessary to :—

(*a*) Lay down what proportion of the task is to be undertaken by the ships staff, the depot ship and the dockyard

(*b*) So complement the ship to allow the ships company to undertake their part of the task in the time made available to them under prescribed operating conditions

(*c*) Calculate and provide the necessary depot ship assistance

(*d*) Ensure the provision of the final, dockyard, component which will balance the whole account.

It is the purpose of this article to consider the ships staff component of the whole maintenance effort and the complement of engineering department ratings that must be provided to undertake their part of the task together with their watchkeeping and other responsibilities.

PART I

THE TASK—EFFORT RELATIONSHIP

Maintenance Task

The maintenance task is that which it is estimated will accrue over a given period in carrying out maintenance schedules plus an allowance for breakdown. The period under broad consideration is that which will embrace all planned maintenance schedules (i.e. up to, perhaps, 4-yearly) but it may be reduced to a more practical period of one year or eighteen months provided a component of the maintenance tasks outside the chosen period is included, (if one year is taken, then the task must include a quarter of the four-yearly scheduled maintenance task).

The whole task is made up of scheduled preventive maintenance routines which will be undertaken by naval and dockyard personnel, plus an allowance for breakdown maintenance. The naval component may be made up of any combination of ships staff on the one hand, and depot ship or shore based personnel on the other. The total (annual) task is determined by summating the whole of the monthlies $\times$ 12, the quarterlies $\times$ 4, the 6-monthlies $\times$ 2, etc. Where tasks occur at intervals greater than one year, the index is applied as a divisor, e.g. four-yearlies divided by four. Daily and weekly maintenance schedules have been excluded intentionally for the present and a compensation has been included in the working-week estimates. Estimates of time required to do the various planned maintenance routines provide the basis upon which the whole maintenance task is assessed. These may or may not :—

(*a*) be accurate at present, but experience will provide correction

(*b*) be individually applicable to all types of ship.

Breakdown Maintenance

The extent of the breakdown maintenance task that is likely to accrue is uncertain. For one thing, it should vary inversely with the efficiency of planned maintenance and it may vary directly, to some extent, with the age of the ship, although it is the present endeavour to reduce this extent. Breakdown maintenance will be taken for the present as 25 per cent of the planned maintenance task, for example :—

Planned maintenance task = 10,000 man-hours per annum

Total maintenance task = 12,500 man-hours per annum.

Maintenance Effort

Maintenance effort becomes available from any, or all, of three main sources :—

(i) The ships company

(ii) Depot ship or base (naval) support

(iii) Dockyards (or, in some cases, private shipyards).

Maintenance evaluation will, generally speaking, by determining the extent of (i) and comparing this with the whole effort required, show up the extent of (ii) and/or (iii) that it will be necessary to provide in order to ensure that the total maintenance effort equals the total maintenance task and that, therefore, the state of the ship will not run down. This balance of account may be simplified, however, by assessing and deducting, first of all, the scheduled maintenance (and breakdown component thereof) that will normally be undertaken by dockyard. This should be taken initially as the dockyard component prescribed by the maintenance schedules, although, in the last resort, dockyard assistance may be required to balance the 'maintenance task—maintenance effort' account.

Therefore :—

Whole Task—Dockyard Component = Ships Staff + Depot Ship

As the ships staff component can be assessed (as will be explained) the unknown, which is the extent of depot ship or other naval support required, can be determined.

The Ships Staff Component

The maintenance effort contributed by the ships company is a function of the number of potential maintainers and the time that is made available to each of this number to do maintenance work. Very broadly expressed, this is a function of the size of the ships company and the ships operating cycle ; the latter will determine the time theoretically available for maintenance. It should be noted, however, with particular regard to the engineering complement, that the ships company is made up of :—

(*a*) Those who do little or no maintenance

(*b*) Those who do maintenance work when not otherwise employed (on duties such as watchkeeping)

(*c*) Those who are employed exclusively, or almost exclusively, on maintenance work.

Neglecting (*a*), it should be observed with regard to (*b*) and (*c*) that the ships operating cycle will affect each group to a different extent.

Before considering in detail the effect of the ships operating cycle upon maintenance, two basic factors, namely the number of hours that a daywork hand puts in per week and, secondly, the theoretical number of working-weeks per annum, must be settled.

The Daywork Working-Week

The number of man-hours of maintenance that a man is likely to do in a week is difficult to determine, and estimates vary between twenty-two and a half and thirty. Theoretically, a typical ships routine achieves about 35 working-hours in a $5\frac{1}{2}$-day week and 31 hours in a 5-day week, but there are a great many reasons why men are not on the job for the whole of this time. The most obvious of these, and their estimated times, are :—

Stand easy (and heads)	2	hours per week
Sick bay	$\frac{1}{4}$	,, ,, ,,
Request men and defaulters	$\frac{1}{4}$	,, ,, ,,
Slops	$\frac{1}{4}$	,, ,, ,,
Payment	$\frac{1}{4}$	,, ,, ,,
Dental	$\frac{1}{8}$	,, ,, ,,
Divisional	$\frac{1}{8}$	,, ,, ,,
Recreation	$\frac{1}{2}$	,, ,, ,,
Other causes	$\frac{1}{4}$	,, ,, ,,
Amounting to	4	hours per week

This brings the theoretical total down to 31 or 27 dependent upon the $5\frac{1}{2}$ or 5-day assumption. So many possible causes which will account for a half-day loss per man can be thought of, that it seems advisable to estimate on a 5-day week. Some of these causes are :—

Captains rounds
Messdeck rounds
Divisions (if not held on Sunday)
Long week-end leave (home service)
Sightseeing expeditions (foreign service)
Harbour drills
Damage control exercises
Compensation for shore patrol duty
Oiling and storing ship
Courses and examinations on board and ashore
Compassionate leave
Daily and weekly routines } (which have not been allowed for in
Inefficiency factor } task evaluation)

This brings the estimated effective working-week down to 27 hours and it is considered that no more can be counted upon at present. At the same time, it is suggested that the achievement of 30 hours is both reasonable and feasible. One way in which this could be done would be by working the duty watch or duty part for (say) two hours in the dog-watches. This would increase the effective working-week by four hours per man if the whole duty watch turned to, and by two hours per man if only the duty part is employed. It is considered, however, most undesirable to take such steps unless they are applied to all alike, and not simply to one department. This may not be easy to arrange.

Number of Maintenance Weeks per Annum

On a year's reckoning this equals 52—X (leave period) weeks. Leave period in war-time has been taken as two weeks, which results in the 50-week per annum maintenance calculation period while six weeks leave per annum must be allowed for peace-time conditions. It might be said that such allowances should be greater for home than for foreign service, but various foreign service conditions can be considered as compensatory and will justify the obviously desirable assumption that the home and foreign service working-years are equal. While there will be more leave-loss at home through long week-end leave on a regular basis there will be more social, sporting and sightseeing activity abroad.

Composition of Engineering Department Complement

For the Engineering Department, the complement provided should be that necessary to undertake extraneous duties, to operate the machinery and to carry out essential maintenance according to the Staff Requirements. In short,

this provides for the necessary number of watchkeepers for the three main watchkeeping states (harbour, cruising defence and action) ; for the necessary maintenance effort to make the ship self-supporting for a period prescribed by the Staff Requirements ; and, finally, for the necessary number of men who neither watchkeep nor maintain but perform such functions as writer, sweeper, storekeeper, messman. Note, however, that when not main steaming or standing-by the watchkeepers will contribute to the maintenance effort. Within these bounds the complement of the Engineering Department should be kept to a minumum so that, particularly for small ships, the degree of necessity for outside support may be substantial.

Simple Evaluation of Engineering Complement and Maintenance Effort

Here follows a first, rather tentative, step towards the determination of the relationship between complement and its maintenance capacity or effort.

As has been remarked, the ships complement is composed of :—

(*a*) Non-maintainers, who produce no maintenance effort

(*b*) Watchkeeper-maintainers, who produce maintenance effort when not watchkeeping

(*c*) Maintainers, who produce maintenance effort throughout the ships working-hours when they are on board—i.e. except at leave periods, etc.

For simplicity these are referred to as N/M, W/M and M respectively.

The ships staff maintenance effort in man-hours is therefore :—

$$N/M \times O + W/M \times X + M \times Y$$

Where :—X=period of ships non-availability minus leave periods.
Y=whole time minus leave periods.

In applying this formula the following may now be assumed :—

(*a*) 75 per cent availability of ship (hence 25 per cent non-availability)

(*b*) 50-week working-year (war-time condition)

(*c*) 27-hour working-week.

Typical Example

It may be well to set out here a typical (but entirely theoretical) skilled engineering complement estimation for a cruiser :—

Whole preventive maintenance task	=	20,000 man-hours per annum
Add 25 per cent for breakdown	=	25,000 do.
Deduct dockyard item component including a plus allowance of 25 per cent	=	9,000
Remainder	=	16,000
Number of watchkeepers	=	20

Therefore

Watchkeepers maintenance effort (men × weeks × hours/week)	=	20 × (13-2) × 27 man-hours
	=	6,000

Therefore

Maintenance effort to be provided by maintainers	=	10,000
Each maintainer will contribute 50×27	=	1,350 man-hours per annum

Therefore

Number of maintainers required	=	$\frac{10,000}{1,350}$
	=	7·4 (say 7)
So that total skilled complement	=	27 effective men

Except in submarines, C.E.R.A.s and Ch. Mechs. should be considered supervisory and therefore not part of the total effective force; similarly Ch. and P.O.M.(E)s, if employed as supervisors as distinct from semi-skilled maintainers, must be deducted from the effective force.

Notes

(1) This calculation assumes that approximately 60 per cent (10,000 ÷ 16,000 man-hours) of the whole ships staff maintenance that can be undertaken as progressive maintenance (i.e. that which can be progressed continuously at sea and in harbour, as distinct from block maintenance, which can only be done in harbour).

(2) If, as is quite possible, the ship is not used during the whole available period, the W/M force will become available for maintenance to a greater extent (see later paragraph).

(3) That the watchkeeping component of the complement must be kept to a minimum if the maintenance effort is to be maximum.

(4) The pure maintainer component of the whole complement must be adjusted to the extent of the progressive component of the whole maintenance task.

Relationship between Availability and Usage

If a ship is complemented or assisted by depot ship or base to an extent that will provide for all maintenance being undertaken during the ships non-available time, there will be an excess of maintenance effort (men × time) if the usage is considerably less than the availablity, and it will be apparent that this excess will vary directly as the difference between usage and availability. It is not suggested that all this ' difference-period ' will be available for maintenance, for clearly some of it will be spent at short or immediate notice for steam. While the exact amount cannot be estimated with any accuracy, it would be wrong to assume :—

(*a*) That all the difference-period (d/p) will be available for maintenance

(*b*) That none of the d/p will be available for maintenance.

For this reason, it is assumed for the present that three-quarters of the difference-period will be available for maintenance.

Note

If ' usage ' be defined as that proportion of a ship's life spent at less than normal notice for steam or actually steaming, and ' availability ' as that proportion of a ship's life when she is available at normal notice (or shorter) or is

actually in use, it follows that the difference between availability and usage will be spent at normal notice. The difference-period between availability and usage can, therefore, be assumed to be at the disposal of the maintainers for such maintenance as can be done at normal notice. The change over from watch-keeping to maintenance and the inaccessibility of hot machinery will, however, reduce this theoretically wholly reckonable period by a certain amount. The $\frac{3}{4}$ d/p assumption is therefore preferred to an assumed whole d/p for estimating availability for maintenance.

It is to the W/M element of the ships company that this additional time becomes available and to this element only is it additional time (it would be available to the M element in any case).

Effect of Usage Factor upon Complement and Outside Support Provision

It will be observed that the economic theoretical complement and outside support provision is dependent upon the relationship between availability and usage. If this complement is sufficient to encompass the maintenance task within the non-available period, the W/M element will be ungainfully employed in the difference-period. Thus the complement and outside assistance provided should be less than the maximum so long as usage is expected to be considerably less than availablity. Therefore, with this economic complement provided with regard to the existence of a difference-period, the maintenance effort will be greater than the task when the difference-period is greater than that estimated, and less than the task when the difference-period is less than that estimated. In the first circumstance men will not be fully employed ; in the second, the ship's state will deteriorate unless additional assistance is provided or overtime is worked.

Usage Estimates

Consider a cruiser with the following assumed figures :—

	Usage				Difference period (d/p)	
	As a percentage of availability		As a percentage of whole time			
Percentage availability	War-time usage	Peace-time usage	War-time usage	Peace-time usage	Percentage war	Percentage peace
75	60	30	45	22½	30	52½

From these figures it is thought that a proper assessment of a ships operating cycle, and therefore the W/M maintenance time resulting therefrom, can be made.

Estimate of Complement Corrected for Usage Forecast

This is rather tentative at this stage, when no usage assessment is given in the Staff Requirements, but may be of interest.

Suppose :—

A = Ships available period (generally 75 per cent of whole period)

N = Ships non-available period

U = Usage period (see estimate)

D/P = A—U
L = Leave period
M = Number of pure maintainers
W/M = Watchkeeper maintainers
N/M = Non-maintainers
P = Whole period under review.

Then, having provided N/M as necessary to undertake such tasks and W/M to undertake the prescribed watchkeeping tasks, the maintenance effort available becomes :—

$$N/M \times O + M\,(P—L) + W/M\,(N + \tfrac{3}{4}\,D/P—L)$$

assuming that none of the W/M force is required for watchkeeping in the period $(N + \frac{3}{4}\,D/P—L)$. This assumption is reasonable for skilled ratings, but not valid for unskilled ratings below the rank of petty officer because, for these, there is a variable watchkeeping requirement according to the auxiliary W/K task in the ship.

Example

The earlier estimate of skilled rating engineering complement for a cruiser under war conditions, may be revised as follows :—

$$M\,(P - L) + W/M\,(N + \tfrac{3}{4}\,D/P - L) = 16{,}000$$
$$P - L = 50 \text{ weeks}$$
$$N + \tfrac{3}{4}\,D/P - L = 25 - 2 = 23 \text{ weeks}$$

$$\text{Therefore } M = \frac{16{,}000 - 20 \times 23 \times 27}{50 \times 27}$$
$$= 2{\cdot}66 \text{ (say 3).}$$

So that, theoretically, the initial estimate of 7 pure maintainers is now reduced by 4 and the total skilled complement comes down to 23 ratings excluding supervisory rates. Bearing in mind the fact that the maintenance tasks will allow a decrease as usage decreases, there is a corresponding additional justification for adjusting the complement to both usage and availability.

The Proportion of Usage Period Available for Maintenance

This will be considered under two headings :—

(*a*) Peace-time conditions

(*b*) War-time conditions.

(*a*) The question is not whether there will be maintenance work accessible to the maintainer but rather one of the degree of suitability of seagoing (usage) conditions to the maintainer. It has been assumed up to this juncture that the whole of a ship's life may be considered as time available to the maintainer, but this assumption is not strictly accurate. Very rough weather and extremes of heat, for instance, will render some time unusable for maintenance. The smaller the ship the greater the effect of rough weather upon it and the maintainers within it ; a destroyer operating in the North Atlantic in winter does not provide a good ' maintenance workshop ' and much time will be lost under such conditions. On the other hand, maintenance can be progressed in a large aircraft carrier under almost all seagoing circumstances although very rough weather will adversely affect the output of the maintainer. Fortunately, the ratio of progressive to block maintenance, the definitions of which are given above, is likely to be less in a small than in a big ship. Therefore, the number of pure maintainers affected by the weather varies inversely as the effect of the

weather upon the ship and, therefore, the progress of maintenance. It may be necessary, indeed, it will almost certainly be necessary, to add to any complement estimation formula a factor correcting theoretical times available for maintenance during usage to allow for the adverse effects of weather. This will reduce theoretical whole ' U ' (usage period) to, say, $\frac{2}{3}$ U for destroyers, $\frac{3}{4}$ U for cruisers and escort carriers and $\frac{7}{8}$ U for fleet carriers.

(*b*) In war-time, maintenance conditions at sea may become much worse. Action, action stations, rest periods after either of these, must be deducted, in addition to bad weather and climatic circumstances, from a theoretically whole usage period. It is probable that on this account estimates made for the peace-time condition must be re-corrected and it may be reasonable to suppose that no more than half the theoretically available portion of whole ' U ' will actually be devoted to maintenance in war-time. Figures for war-time thus become $\frac{1}{3}$ U for destroyers $\frac{3}{8}$ U for cruisers and $\frac{7}{16}$ (say $\frac{1}{2}$) U for fleet carriers. It is suggested, however, that although this war influence, which may necessitate an increase in outside support, should be considered, it should not be applied when estimating ships complements. The ships staff skilled maintenance effort formula for a cruiser in peace-time now becomes :—

$$M\ (N + D/P + \tfrac{3}{4}\ U - L) + W/M\ (N + \tfrac{3}{4}\ D/P - L)$$

Similarly, the formulae for various types of ship, in peace or war, may be set out.

By calculations on this basis (of estimated scheduled + breakdown maintenance task), sufficient men should be provided by complement to operate and maintain the ship for the period of self-support required of the ship by the Staff Requirements. For small ships, the ships company maintenance effort plus the dockyard component will not meet the whole task and it will be necessary, therefore, for the deficit to be estimated at both Admiralty and Class Authority levels in order to appreciate and, in the case of Admiralty, provide for depot ship (or similar) outside assistance.

PART II

SOME CONSIDERATIONS

Suppose that the formula established in Part I, be applied to a cruiser whose whole (preventive + breakdown) skilled engineering complement maintenance task is 20,000 man-hours per annum. Take availability as 75 per cent and usage as 25 per cent for simplicity and consider a year as the period under review. Assume also that there are twenty-four E.R.A.s available, that these are divided equally between M and W/M, and that it is peace-time with six weeks leave per annum.

Thus maintenance effort available becomes :—

$$12\ (13 + 26 + \tfrac{3}{4} \times 13 - 6)\ 27 + 12\ (13 + \tfrac{3}{4} \times 26 - 6)\ 27$$
$$= 22{,}400 \text{ man-hours.}$$

Comparing this with the estimated total of 20,000 man-hours of skilled maintenance task it will be seen that, theoretically, this cruiser will have a credit balance of some 2,500 skilled man-hours per annum.

Applying a similar calculation to war-time conditions under which the usage is 45 per cent and the leave period 2 weeks per annum, the maintenance effort available is reduced to 18,750, resulting in a deficit of some 1,250 skilled man-hours.

Comparative Maintenance Effort Under Similar Conditions but with the Skilled Engineering Complement split $\frac{3}{4}$ W/M to $\frac{1}{4}$ M

Peace-time Conditions

Maintenance effort
$= 27 \times 6 (13 + 26 + \frac{3}{4} \times 13 - 6) + 18 (13 + \frac{3}{4} \times 26 - 6)$
for peace-time conditions
$= 27 \times 6 (13 + 26 + 9\frac{3}{4} - 6) + 18 (13 + 19\frac{1}{2} - 6)$
$= 19{,}750$ approx.

and under war-time conditions
$= 27\ 6 (13 + 15\frac{1}{2} + \frac{3}{8} \times 23\frac{1}{2} - 2) + 18 (13 + \frac{3}{4} \times 15\frac{1}{2} - 2)$
$= 27 (6 \times 35{\cdot}3) + (18 \times 22{\cdot}6)$
$= 16{,}600$ man-hours (approx.)

These illustrate the extent to which the maintenance effort available is reduced in both peace and war by the deployment of a large watchkeeping effort.

Peace-time Conditions

3 : 1 split gives	19,750 skilled man-hours
1 : 1 ,, ,,	22,400 ,, ,,
which represents a gain of	2,850 ,, ,,
or	$14\frac{1}{2}$ per cent

War-time Conditions

3 : 1 split gives	16,600 skilled man-hours
1 : 1 ,, ,,	18,750 ,, ,,
which represents a gain of	2,150 ,, ,,
or	13 per cent

According to the conditions of this particular example, the gain in skilled maintenance effort is some 14 per cent if watchkeepers are kept to a minimum. Although this gain is not as high as might be expected it is, in all probability, a true figure because allowance has been made for loss of maintenance time by pure maintainers due to sea and climatic conditions in peace and war and an additional loss attributable to action and other considerations in war-time. In fact the gain would be higher in war-time because the usage is then higher and under such conditions the advantages of employing the maximum proportion of the complement as pure maintainers increase correspondingly, but this is offset by the loss of maintenance opportunity attributable to war conditions.

The Restriction of Pure Maintainer Usefulness Imposed by Active War Conditions

This appears to bring into prominence the question whether it is worthwhile carrying maintainers in the ship, during the usage period (taken as 45 per cent of whole time in the foregoing example) if only $\frac{1}{3}$, $\frac{3}{8}$ and $\frac{1}{2}$ of this period is going to mean useful employment in destroyers, cruisers (and small carriers) and fleet carriers respectively. In the case of destroyers it is clearly uneconomic and, in fact, the minimum of hands above the number required for watchkeeping duties is carried. In the case of cruisers it will mean carrying in the ship half the skilled component for 45 per cent of the time, and getting only half a day's work per day from them during this time. Is this worthwhile ? From the purely maintenance aspect it is not, provided the maintenance that these men are carried to perform could be postponed until the ship returned to base, and outside assistance could be provided there. It is likely, however, that a considerable proportion of the pure maintainer element will be required to undertake,

as best they can, essential progressive planned maintenance that will arise during the period of operation in the cruising defence state. It is also apparent that a number of skilled men additional to the watchkeeping complement will be required for the action state. Whether the number carried for the latter duty will be the same as the number required for essential maintenance is a matter that cannot be decided here.

Increase of Maintainer Working-Hours at Sea

It is apparent from the foregoing that the greater the daily working-hours of the pure maintainer, the more economic will be their retention in the ship during the usage period. It might, therefore, be wise to consider :—

(*a*) increasing working-hours of maintainers at sea

(*b*) decreasing the working-hours of watchkeepers.

It is surely incongruous to suppose a working-week of 27 hours for maintainers at sea while their fellows, watchkeeping, are putting in a theoretical 56 hours per week. While the ratio of maintainer to watchkeeper/maintainer stood (or stands) at 1 to 3 it would be difficult to arrange this satisfactorily, but if, as may come about, through the influence of remote and automatic control of main and auxiliary machinery respectively, maintainers and watchkeepers are on a 50/50 basis, the proposition becomes a much more practical one.

It is important to note :—

(*a*) That the more active and responsible the watchkeeping task, the greater is the need to reduce watchkeeping frequency

(*b*) The greater the proportion of pure maintainers, the greater the advantage to the ship of their putting in as many working-hours per day (at sea) as possible.

If watchkeepers work to a four watch rota they will work 42 hours per week, and if the maintainers have a working-day at sea of some 8 hours, they will put in some 40 effective working-hours per week (two hours dog-watch work Monday—Friday).

CONCLUSION

It is becoming increasingly difficult to accommodate in ships the complement necessary to operate and maintain them and so it is imperative that complements are kept to a minimum. It will be apparent that one way of doing this, in the Engineering Department, is by reducing the necessity for watchkeepers by depending more on grouped remote control and on automatic control. Thus the watchkeeping effort can and will be reduced.

At the same time the maintenance task, though susceptible to reduction and, it is hoped, in process of being reduced, must remain of considerable proportions in the foreseeable future. The net result of these two factors must be that the ratio of watchkeepers to pure maintainers will decrease and the time may quite soon come when it is uneconomic to carry a large number of pure maintainers for whom there may not be available sufficient progressive maintenance task nor, particularly in war-time, the conditions suitable for doing maintenance. It would appear, therefore, that the bigger ships may come to rely increasingly on outside support, as destroyers already do, and so approach the operating cycle of these ships.

The above appears to be the ideal to aim at in working out complements, but it must not be imagined that the change can be implemented for some time. A good many assumptions remain to be verified by experience and the increasing part which it is anticipated will be played by the engineering mechanic branch in assisting with semi-skilled maintenance has yet to be assessed.