PLANNED MAINTENANCE IN SHIPS

BY

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In the last issue of this *Journal* there appeared an article by Captain D. J. Hoare entitled 'Reflections on Ship Upkeep'. In this, he considered various factors which affect the availability for use of a warship and discussed some of the ways in which action might be taken to improve the final figure. Most of these fields of action lie outside the ship herself but their results must be measured in the ship, and some standard or system is essential for such an evaluation. Moreover, however well organized the individual ship may be, there is a considerable variation in both method and effort throughout the fleet, and even between ships of the same class. An essential factor in any general effort to analyse and improve the maintenance, and thus increase the availability of ships, is the provision of some form of Upkeep or Maintenance Plan for each class of ship. It is the purpose of this article to review some of the factors involved in the production of such a system and in its application to the Engine-Room Department of a ship.

THE BASIS OF A PLANNED MAINTENANCE SYSTEM

The Assessment of the Task

The first requirement for any sort of maintenance plan is to have assessed the task as accurately as possible. When one considers that the engine-room complement, the range of on-board spares and stores, the types and quantity of workshop or test equipment, and the length and periodicity of self-maintenance and refit periods are all functions of the ship's maintenance task, it is surprising that detailed evaluations have not always been carried out for each class of ship, if only to check that the allowances in each case are correct. At present, the initial estimates are made for the most part by rule of thumb, born of experience of similar types of ship. These rules have given good service, but the changed and more exacting needs of the post-war navy have shown up their deficiencies. To meet present day needs, a detailed assessment of the maintenance task is required.

Presentation in Plan Form

There may be times when the proper upkeep of the ship is a secondary factor —periods of high operational demand in war are obvious examples—but generally speaking, the prevention of deterioration and the maintenance of the designed performance of a ship, and therefore of any item of machinery or equipment therein, should always be one of the aims of any Command for, unless it is achieved both in peace and war, the ship will possess that much less reserve of serviceability to meet emergency demands for a very high rate of usage. It may be true that there is often failure to achieve this aim and that this is frequently due to a lack of appreciation of the maintenance needs on the part of the user. However, it is also true that, with few exceptions, the maintainer has not only failed to establish exactly what those needs are, but has also failed to present them in a form suitable for the operator's purposes. For a given ship with a given job, there ought to be an optimum usage-maintenance cycle which

will give the operator the highest availability, while meeting the maintainer's needs. The facts of life will probably interfere with this cycle more often than not, but so long as a detailed assessment and plan has been presented, the results of the alterations and the compensating adjustments required to maintain the serviceability will be apparent. The second requirement of a planned maintenance system is, therefore, that it should present the task in a suitable form.

Properly Designed Record and Reporting System

One serious result of the failure to establish a ship maintenance plan is the absence of recorded facts and figures, in a form suitable for analysis of the maintenance effort. Action to remedy the causes of wasted effort, or to improve the means of maintenance, is correspondingly slow and infrequent, and well-known maintenance stupidities are repeated from class to class until they appear to have become traditional and inviolable. If the total effort which has gone into the repair and maintenance of steam systems through the years had been recorded and appreciated, a much greater design effort would surely have been applied to this problem. A third requirement of the system is, therefore, that it should record and report accurately the details of the whole upkeep effort, so that an analysis can be made, and action taken, to improve the facilities or lessen the task.

On the face of it, this third requirement calls for an increase in records kept and data reported, and therefore in paper-work and clerical effort. However, partly because the introduction of a new system presents the opportunity for a complete revision of present methods, and partly because a comprehensive maintenance plan in itself provides a basic index which automatically reduces the variety of records and the amount of writing, there ought to be an appreciable reduction in clerical work. In any event, a fourth requirement of the system is not only to restrict the paper-work to a minimum, but also to concentrate as much as possible of the overall clerical effort ashore, and thus relieve the ship's staff.

Lastly, it is clearly desirable that the system should, if possible, be capable of universal application. The ideal arrangement for a squadron of inshore minesweepers is unlikely to be exactly the same as that for the *Ark Royal*, certainly as regards the mechanics of applying a planned maintenance system and probably in the documentation also. Nevertheless, the basic principles involved must be the same and as many as possible of the details ought to be identical.

THE MAINTENANCE TASK

Neglecting the training and divisional tasks, the work of the Engine-Room Department can be considered in four categories:—

(*a*) General ship duties.
(*b*) Watchkeeping.
(*c*) Defect rectification.
(*d*) Preventive maintenance.

General Ship Duties

This covers all the ship or service duties which are not directly related to the machinery, hull or equipment for which the Engineer Officer is responsible, but in which the Engine-Room Department shares and on which some of the available man-power is expended ; e.g. shore patrols, divisions, messmen. These duties are primarily matters of ship organization but at present they are not assessed individually and as a result an adequate allowance for this part

of the whole task is not usually made. Moreover, in identical ships a different effort is frequently demanded of, and sometimes provided by, the Engine-Room Department towards the common task. There is obviously scope for investigation into the real needs in this category and the methods of meeting them. Questions spring to mind whether the present arrangements for Requestmen, Defaulters, Pay Musters, or Turning-to are to the best advantage. Factors other than the mere addition and subtraction of man-hours are, of course, involved in this ; however, the point is not whether or how these particular efforts should be made, but that they should be assessed and allowed for in the complementing and other calculations. The work itself is outside the maintenance plan, but will adversely affect it, if not allowed for.

Watchkeeping

The details in this category are dependent on rules which are not inherently functions of the maintenance task. As with the ' general ship duties ', the point is that the assessment of this work, and the allowances made to meet it, must be outside the maintenance plan. In practice, this requirement is already met in that the sea and harbour watch-bills are specifically calculated and allowed for in each class of ship. However, there are usually variations in their application which tend to affect the maintenance effort. For example, the harbour watchkeeping load frequently varies with circumstances, places and ideas, and this affects both the total maintenance bill and the man-power available for meeting it. Again, variations in the watch-bill in the Cruising Defence state will have a considerable bearing on maintenance if this state has to be supported for any length of time. These variations will probably continue to exist, but this is not important so long as the results of these deviations from the plan are apparent and compensation is provided.

Defect Rectification

As Captain Hoare points out in his article, there are two kinds of maintenance : ' breakdown ' and ' preventive '. Together, they make up the maintenance task proper. For various reasons, certain items may be designed on a ' breakdown ' basis but, in general, material in warships should be ' predictable ' and/or ' inspectable ' and therefore susceptible to Planned (Preventive) Maintenance. Breakdown items, on the other hand, are in the defect category.

One of the current difficulties in the field of maintenance organization is nomenclature. ' Defect Rectification ' is a horrid expression but at this stage of development it does explain rather more clearly than more usual terms the difference, for the Maintenance Planner, between work which he expects and plans to perform (in the way of preventive maintenance) and defects or deficiencies which are outside his calculations (the result of breakdowns). These can be due to a variety of causes : mal-operation, design or material failure, bad workmanship and insufficient or wrong maintenance. In the matter of defects, the requirement for a planned maintenance system is that it should throw up *all* defects so that the cause can be determined and wherever possible eliminated. If this cause happens to be insufficient or wrong maintenance the remedy may be to alter the details of the maintenance plan, but in the first instance the work is ' defect rectification ' and not preventive maintenance.

At present it is not easy to make a realistic allowance for this part of the maintenance task. There is little data available on a form suitable for such an estimate. In any case, planned maintenance has not yet been applied, either for long enough, for a sufficient period to gauge its effects in the shift of effort from defect rectification to preventive maintenance. However, it is considered that ultimately the division of the maintenance task should be of the

order of 10 per cent breakdown to 90 per cent preventive. The present planning figure for new construction, or fully refitted ships which are put on to a planned maintenance system, is 20 per cent breakdown to 80 per cent preventive maintenance.

PREVENTIVE MAINTENANCE

For every piece of machinery or equipment there is, for a given usage, an ideal amount of maintenance—basically, the least which will ensure against breakdown or against deterioration or drop in performance, in excess of the calculated rate. The details of this ideal will only become exact with experience of each particular machine; but it is possible in the first instance to make out a schedule of maintenance operations from consideration of the design factors, prototype testing data and experience of similar machinery or equipment. Thereafter, the mechanics of the system must be such that these schedules are automatically adjusted with running experience, so that the maintenance plan is kept realistic and data is accumulated for the production of subsequent schedules and plans.

There is, of course, a wealth of experience available now; the only difficulty is that nearly all of it remains in the memories of individual officers and men and is not committed to paper. In the dockyards also there must be a vast store of refitting data, but this information is not easily available in a suitable shape. However, as a library of maintenance schedules covering all Engine-Room Department items is gradually built up, and adjustments resulting from practical experience are fed back into it, this deficiency will be overcome and the initial maintenance schedules produced for future classes of ships should become increasingly accurate.

Maintenance Schedules

A maintenance schedule aims at setting out in standard form the details of all the work which it is necessary to carry out on the equipment concerned, to maintain it in a fully serviceable condition. A typical example is shown in FIG. 1. At the top of the sheet are the identification details, including, on the right-hand side, the number of this particular schedule in the Schedule Volume: viz. ER 9. Below this the work details are set out in their various time intervals: Daily (d), Weekly (w), Quarterly (3m) and so on. Ideally, each separate operation should be separately numbered. There is a practical limit to how far this principle can be carried, but omnibus terms such as 'Carry out top overhaul' are to be avoided. Where one operation is dependent upon another, a decimal system of numbering is used: thus, in FIG. 1, the '3m 1·4' operation is dependent upon the basic operation '3m 1·1.'

Maintenance Schedule Volume

The schedules for the whole of the Engine-Room Department are grouped together in sections—normally, these correspond to the administrative sub-divisions of the Department. Each section has a title page which lists all the work items and schedule numbers for the section, as shown in FIG. 2. In certain small craft it may be found to subdivide by types of machinery, or even by the duties of the officers or others of the ship's company, but whatever the internal arrangements, the sections are assembled to form a 'Maintenance Schedule Volume' which thus provides the overall maintenance task for the Department.

Man-hours Assessment

The title page shown in FIG. 2 is provided with columns against each schedule in which are entered the man-hours—skilled and unskilled, taken to complete

MAINTENANCE SCHEDULE—H.M.S. *NONSUCH*

Item	*Makers*	*Type and No.*	*M.S. No.*
Feed Pump	*G. and J. Weir*	*T.F.P.20/4 fitted*	*ER/9*

Period	*No.*	*Operation*	*Class*
Daily	d.1	Turn pump by hand.	
	d.2	Drain out water from oil sumps.	
Weekly	w.1	Oil Tachometer.	
	w.2	Check operation of stop valve trip gear and system.	
Monthly	m.1.1	Dismantle pressure governor.	
	m.1.2	Check fit of throttle valve in steam chest cage and examine cage and throttle for signs of scoring.	
	m.1.3	Check truth of throttle valve spindle and for wear or pitting of spindle in way of steam gland.	
	m.1.4	Examine pressure governor plunger for signs of scoring or hard spots.	
	m.1.5	Check that spring adjuster is free in lower spring carrier.	
	m.1.6	Remove and clean pressure governor strainer.	
	m.2	Flush through bearing sumps renew oil.	
Quarterly	3m.1	Check axial position of turbine by gauge.	
	3m.2	Measure axial movement of centre bearing.	
	3m.3	Take bridge gauge readings of all bearings.	
	3m.4	Measure axial clearance between labyrinth packing and leak off plug.	
	3m.5	Check truth of shaft at bearing journals by clock gauge.	
	3m.6	Set centre bearing in correct axial position.	
	3m.7	Check fit, axial position and condition of oil baffles.	
	3m.8	Examine tachometer coupling spring and driving square.	
	3m.9	Anneal pressure governor supply pipe.	
Six Monthly	6m.1	Bed in carbon packing segments.	
	6m.2	Gauge and inspect condition of journals in way of carbon packing.	
	6m.3	Refit carbon packing drain valves.	
Annually	a.1	Anneal all cooling water pressure gauge and leak off pipes.	
Two-Yearly	2a.1	Dismantle pump.	DY
	2a.2	Check shaft for truth.	DY
	2a.3	Gauge all journals and bring back to standard size.	DY
	2a.4	Examine impeller for signs of erosion.	DY
	2a.5	Examine labyrinth packing.	DY
	2a.6	Bring leak-off plug clearance back to standard.	DY
	2a.7	Bring centre bearing axial clearance back to standard.	DY
	2a.8	Bring oil clearances of all bearings back to standard.	DY
	2a.9	Check diametrical clearances of impeller packing rings.	DY
	2a.10	Gauge erosion of packing ring threads, housing or pump casing.	DY
	2a.11	Check condition of gland pieces and lantern rings.	DY
	2a.12	Dismantle and examine stop valve.	DY
	2a.13	Dismantle and examine overload valve.	DY
	2a.14	Check axial clearance of turbine.	DY

FIG. 1

Machine or Unit	*M.S. No.*	*Daily*		*Weekly*		*Monthly*		*Quarterly*		*Six Monthly*		*Annually*		*Two-yearly*	
		Uns.	*Ski.*	*Uns.*	*Ski.*	*Uns.*	*Ski.*	*Uns.*	*Ski.*	*Uns.*	*Ski.*	*Uns.*	*Ski.*	*Uns.*	*Ski.*
S.F. Main Feed Pump	.. ER 9 1	·10	—	·10	·10	·30	3	—	7	—	9	—	1	30	45
P.F. Main Feed Pump	.. ER 9 2	·10	—	·10	·10	·30	3	—	7	—	9	—	1	30	45
S.A. Main Feed Pump	.. ER 9 3	·10	—	·10	·10	·30	3	—	7	—	9	—	1	30	45
P.A. Main Feed Pump	.. ER 9 4	·10	—	·10	·10	·30	3	—	7	—	9	—	1	30	45
S.F. Extraction Pump	.. ER 10 1	—	—	·10	·15	—	·15	—	4	—	9	·15	1	35	50
P.F. Extraction Pump	.. ER 10 2	—	—	·10	·15	—	·15	—	4	—	9	·15	1	35	50
S.A. Extraction Pump	.. ER 10 3	—	—	·10	·15	—	·15	—	4	—	9	·15	1	35	50
P.A. Extraction Pump	.. ER 10 4	—	—	·10	·15	—	·15	—	4	—	9	·15	1	35	50
S.F. Main Circulator	.. ER 11 1	—	—	·10	—	—	—	·15	·15	3	9	—	8	30	45
P.F. Main Circulator	.. ER 11 2	—	—	·10	—	—	—	·15	·15	3	9	—	8	30	45
S.A. Main Circulator	.. ER 11 3	—	—	·10	—	—	—	·15	·15	3	9	—	8	30	45
P.A. Main Circulator	.. ER 11 4	—	—	·10	—	—	—	·15	·15	3	9	—	8	30	45
F. Turbo Exhaust Fan	.. ER 12 1	—	—	—	—	—	—	—	—	—	4	—	4	25	40
A. Turbo Exhaust Fan	.. ER 12 2	—	—	—	—	—	—	—	—	—	4	—	4	25	40
S.F. F.L. Pump ..	.. ER 13 1	—	—	·10	·15	—	·30	—	4	—	12	·15	40	40	50
P.F. F.L. Pump ..	.. ER 13 2	—	—	·10	·15	—	·30	—	4	—	12	·15	40	40	50
S.A. F.L. Pump ..	.. ER 13 3	—	—	·10	·15	—	·30	—	4	—	12	·15	40	40	50
P.A. F.L. Pump ..	.. ER 13 4	—	—	·10	·15	—	·30	—	4	—	12	·15	40	40	50
For'd L.O. Purifier ..	.. ER 14 1	2	—	—	—	—	2	—	6	—	—	—	—	—	—
After L.O. Purifier ..	.. ER 14 2	2	—	—	—	—	2	—	6	—	—	—	—	—	—
For'd O'Flo Fd. Pump	.. ER 15 1	—	—	·10	—	—	—	—	·15	—	·30	—	4	15	35
After O'Flo Fd. Pump	.. ER 15 2	—	—	·10	—	—	—	—	·15	—	·30	—	4	15	35
No. 3 F. & B. Pump	.. ER 16 1	·15	—	—	·15	—	·30	·15	4	—	12	—	48	25	40
No. 4 F. & B. Pump	.. ER 16 2	·15	—	—	·15	—	·30	·15	4	—	12	—	48	25	40
No. 6 F. & B. Pump	.. ER 16 3	·15	—	—	·15	—	·30	·15	—	—	2	—	48	25	40
No. 7 F. & B. Pump	.. ER 16 4	·15	—	—	·15	—	·30	·15	—	—	2	—	48	25	40
TOTAL MAN HOURS ..		5·40		3	3·40	2	21	2½	81½	12	193	2	408	720	1070

FIG. 2. FIGURES SHOW HOURS AND MINUTES

the schedules daily, weekly, monthly and so on. These hours are an average figure. In practice, the daily, weekly and many monthly figures establish themselves quickly and accurately. The larger items present more of a problem, not only because they are inherently less easy to 'average' but also because, as they usually provide the main part of the bill, accurate analysis is required if the maintenance task is to be reduced by the removal of snags or the improvement of facilities. The final method of producing these details is as yet uncertain, but some form of job card seems the probable answer.

The Total Bill

Referring again to FIG. 2, the summation of the individual figures gives the section's maintenance bill in man-hours daily, weekly and so on. The transfer of these totals for each section to a Maintenance Schedule Volume Title Page (which lists the sections) will in the same way give the total maintenance bill for the whole Engine-Room Department.

THE MAINTENANCE PLAN

The ultimate objective of any maintenance planning is to provide the greatest availability, consistent with the proper upkeep of the ship. This integration of the usage and upkeep requirements depends upon a number of factors which often conflict in time and importance. It is the function of the Class Authority, having first evaluated the upkeep bill for the ship, to consider these factors in relation to the user's intentions and thence to produce the optimum operating-maintenance cycle for the guidance of Commands and Authorities. In doing so, the first question which has to be settled is that of the basis of the maintenance schedules.

From an engineering point of view, the proper basis for a maintenance schedule is normally either some combination of running hours and the number of starts, or the rate of corrosion or wear. For the ship operator, however, 'time' is the only satisfactory basis for his plans, as indeed it is for the Dockyard also. Even within the ship, it would be difficult to integrate maintenance arising from running hours with such items as tank cleaning in any overall plan except on a time basis. In general, therefore, the engineering ideal has to give way and maintenance schedules are converted from running hours to time and are set out as shown in FIG. 1.

However, there are some machines and equipment whose usage (and therefore maintenance) is not dependent upon the ship usage: for example, boats, evaporators or hull and fire pumps. For these, the maintenance schedules can remain on a running hours or other engineering basis and, in general, their maintenance should be progressed irrespective of self-maintenance or refit periods, in order to reduce the quantity of work in such periods. In producing the overall plan, it is necessary to differentiate between these two sorts of maintenance and they have been called 'Block' and 'Progressive' maintenance respectively. Block maintenance is that part of the upkeep bill which is carried out at specified periods. Progressive maintenance is that part of the upkeep bill which can be carried out irrespective of self-maintenance, refit, or other specified period. On the one hand, the less the block maintenance component, the less the time required for self-maintenance and refit periods, and therefore the greater the ship availability. On the other hand, to be able to undertake progressive maintenance, facilities must be provided on board in the way of complement, workshop equipment, spares or possibly even an additional machine, so that inspection or dismantling is without prejudice to the action needs of the ship: the price for this is a larger ship. In arriving at the best

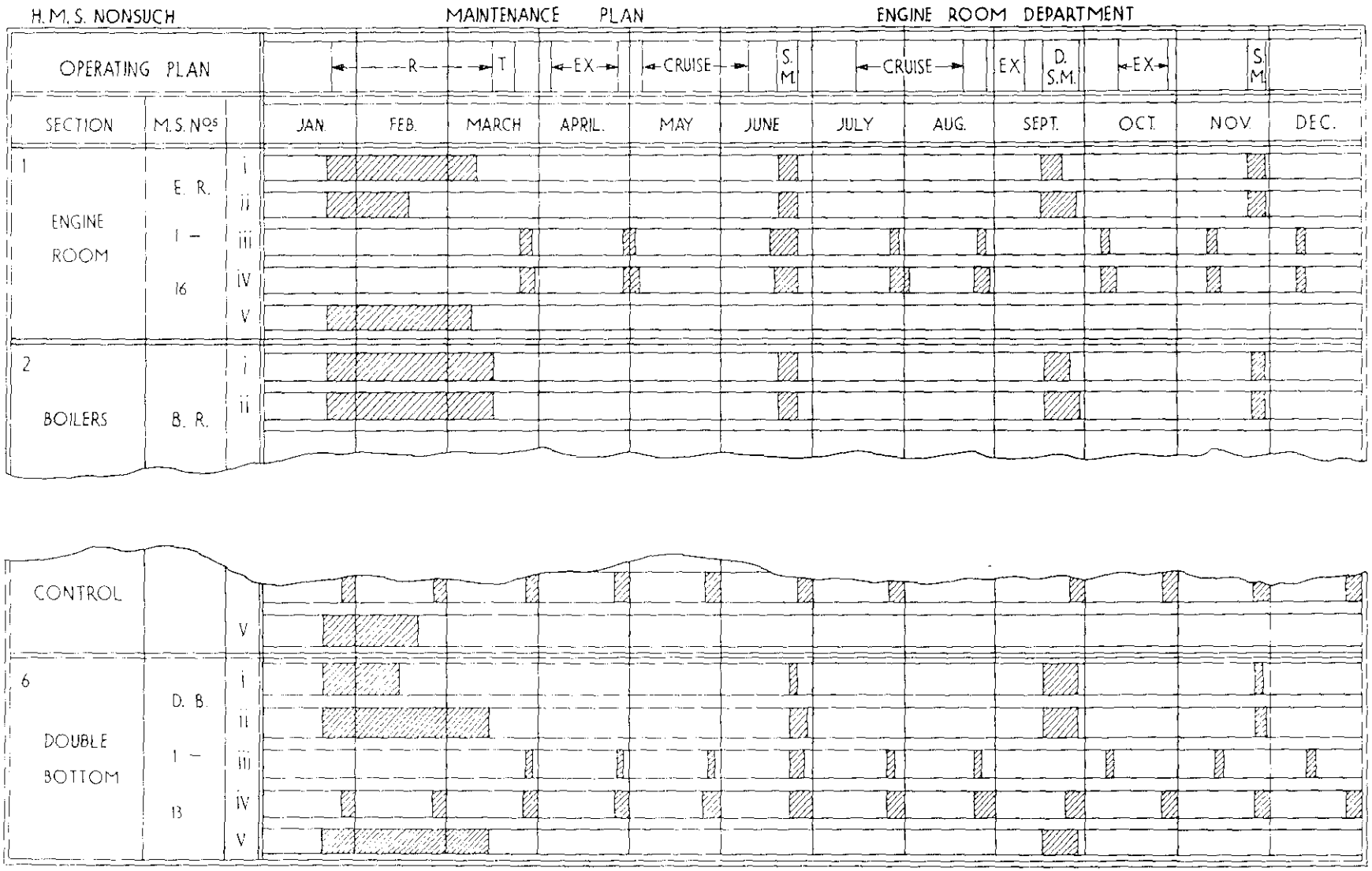
H.M.S. NONSUCH
MAINTENANCE PLAN
ENGINE ROOM DEPARTMENT
OPERATING PLAN
R
T
EX
CRUISE
S.M.
CRUISE
EX
D.S.M.
EX
S.M.
SECTION
M.S. Nos
JAN.
FEB.
MARCH
APRIL.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
1
ENGINE ROOM
E. R.
1 — 16
i
ii
iii
iv
v
2
BOILERS
B. R.
i
ii
CONTROL
v
6
DOUBLE BOTTOM
D. B.
1 — 13
i
ii
iii
iv
v

FIG. 3

answer, a balance must clearly be struck between the two. The matter is primarily one of design but there is some flexibility in most classes of ship and the intended division must be shown in the Maintenance Plan.

Dockyard and Depot Ship Items

Another division which has to be considered is what part of the whole task is to be undertaken by the dockyard and, in the case of the smaller ships, the base and depot ship. A certain number of items decide themselves, being of necessity dockyard work because they involve special equipment or techniques, or for some similar reason. In other cases, economics may decide because it would be unprofitable to provide each ship with the special equipment or extra man-power if its employment was infrequent. As in the case of block *v.* progressive maintenance, a balance has to be struck, and the intended division shown on the plan. In the first instance, this appears on the individual schedule where ' BS ' for base or depot ship or ' DY ' for dockyard items appears on the right-hand side against all operations planned to be carried out by other than ship's staff (*vide* FIG. 1 Two-yearly items). From the subsequent man-hour totals, the dockyard component is abstracted and shown separately on the overall plan.

In the Maintenance Plan itself, there are now five categories of work: -

(*a*) Block : skilled
(*b*) Block : unskilled
(*c*) Progressive : skilled
(*d*) Progressive : unskilled
(*e*) Dockyard.

In each of these the planned man-hours are known and, dividing by the man-hours available (complement allowed for preventive maintenance working hours), an overall period for the various tasks is obtained. With other factors, these results are considered by the Class Authority in the production of the optimum cycle for the ship. It must be remembered, however, that this optimum cycle is a guidance one and it is the responsibility of the individual Engineer Officer to fit the details to his own ship's plan. This would normally be done by sections and the results, when transferred from the sectional plan to the departmental plan in the same way as the man-hours, might look something like that shown in FIG. 3.

For ease of demonstration the cycle has been taken as twelve months between refits. The proposed ship's operating plan is shown at the top : R for Refit, T for Trials, S.M. for Self-maintenance periods and D for Docking. The annual items have all been planned for the refit period but the docking period is too short to allow all six-monthly items to be done then, and these have had to be staggered with the quarterly items. Where possible, skilled progressive maintenance is not done during the refit and docking periods in order to use that part of the complement on block maintenance in the limited time available. Daily and weekly maintenance operations are done as a matter of routine and do not appear on the plan. The work squares have here been shown filled in but would, in practice, be blank and only filled in as the work was completed. At any one time, the plan then shows the maintenance state of the Department.

The detailed plan for each section is of greater interest and assistance to the Engineer Officer than a departmental one as here shown. However, put on to a larger scale, a visible index of this type is at present being used with some success for the control of maintenance work. Some form of properly designed office equipment, using this principle, may therefore be the standard method of presenting a picture of the Maintenance Plan.

DOCUMENTATION

Of the basic requirements for a planned maintenance system which were listed at the beginning of this article, the assessment of the task and its presentation in some form of plan have now been considered. The other three requirements are all concerned with the associated clerical effort : i.e. the method and form of applying and controlling the system. A number of experiments in the mechanics of planned maintenance, and the possible forms of records and returns, have been going on during the past year in various types of ships. A good deal of information has been obtained, and so far as the Engine-Room Department was concerned, the probable answers were beginning to emerge, at the time when the Class Authorities were established. In the process of setting up these authorities, however, is was decided that the time was opportune for a review and re-design of *all material* records and returns, not merely those which were the concern of the Engineer-in-Chief, and a ' Documentation Panel ' was set up for this purpose.

The terms of reference of this Panel are :—

> ' To examine the whole structure of material documentation and the use of forms in the Fleet and those forms used by Administrative Authorities, Class Authorities and the Admiralty for the purpose of receiving and analysing information from ships, with a view to overhauling the system radically and effecting a substantial reduction in the paper-work of the Fleet.'

The Chairman of the Panel is the Deputy Engineer-in-Chief (F.M.A.), and the standing members are representatives of the Director of Naval Electrical Department, the Director of Naval Construction and Organization and Methods Branch. Other Controller's Departments and Specialist Schools concerned with the development of their own documentation are co-opted as required.

In these circumstances, there is no point in anticipating the findings of the Panel by describing a possible system for the Engine-Room Department. When the new arrangements have been decided upon, and the mechanics of applying planned maintenance in ships has been related to them, a further article on this aspect of the upkeep problem can be published.

TAIL-PIECE

The words ' planned maintenance ' have an ugly ring in the ears of some. They seem to imply a rigidity of direction, and a degree of external control, ill-suited to a warship. Certainly, the strict application of a predetermined and detailed plan presents a threat to the initiative of the individual. Moreover, there are distinct undertones—or is it overtones?—of the air-world and everyone has heard of the inflexibility of its maintenance system and the appalling floods of paper-work. Perhaps it is worth recalling that Nelson was an excellent, if sometimes thwarted, maintenance planner and that since his days there have in fact been many excellent, if usually thwarted, individual maintenance planners. However, it is not the intention to embark here on a comparison ; sufficient it is to say that, for a variety of reasons, it has been decided that in the present-day navy some form of maintenance planning is essential, and that there is something to be learnt from the air world in this matter, from its shortcomings as much as from its virtues. In point of fact, because when something goes wrong a ship usually floats but an aircraft often crashes, and because, starting from scratch, it should be possible to abstract the good from the experience of others, a simple, flexible planned maintenance system can be developed in a way which leaves the maximum of initiative and the minimum of paper-work with the ship.