PAPER

By Mr. E. A. Voss (British European Airways Corporation).

The Chairman, introducing Mr. Voss, said: Mr. Voss was initiated to the helicopter during his period of employment in the Experimental Department of Messrs. General Aircraft, when he came into intimate contact with the earlier types of Sikorsky helicopters. During the latter stages of the war, he served in the Royal Armoured Corps, at the Specialised Armoured Development Establishment, devoting his energies mainly to the development of tanks and armoured cars. He joined the B.E.A. Helicopter Unit at its inception in 1947, and I have known him personally since then, and had ample opportunity of appreciating his skill and enthusiasm in the helicopter operational engineering field. Until recently, Mr. Voss was the B.E.A. Helicopter Unit Station Engineer at Speke, and as such he was largely responsible for much of the maintenance of the helicopters used on the First Regular Scheduled Helicopter Passenger Service, into which operation the progressive system of maintenance was introduced.

HELICOPTER MAINTENANCE

By E. A. Voss.

1. *Principle of Application.*

In the field of commercial aviation, the Helicopter is a comparatively new vehicle and, to my mind, one requiring considerable development in respect of servicing, maintenance and overhaul.

As we are all aware, serviceability has an important influence on an aircraft's revenue flying time. Therefore, I think that it is essential for us to grapple with maintenance problems at an early stage and try to place them in their true perspective.

From my point of view, as an engineer, it is most important to use the aircraft at a high " Utilisation Rate," without impairing its safety. To do this, one must have a high " Utilisation Potential," and the factors affecting this are as follows :—

(*a*) *Operational Limitations.*

(*b*) *Serviceability.*

Of the former, there are such things as :

(*a*) 1. Commercial Potential ;
2. Flight Limitations and Weather ; and
3. Embodiment of operational modifications.

Of the latter, we have :

(*b*) 1. Standing time spent on routine servicing and maintenance ;
2. Standing time associated with random failures ;
3. Embodiment of functional modifications ;
4. Standing time waiting for spares ; and
5. Test flying time necessary to clear the aircraft as serviceable after " grounding."

The Operational Limitations are not the Engineers' direct concern, but the servicing factors definitely are, and it is the charge of the engineering

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personnel to make a " Maximum Potential " available to the Operator with the minimum of effort, *i.e.*, man hours per flying hour.

This term, " Utilisation Potential," has been defined by our Chairman in a British European Airways Engineering Report as :—

$$\frac{\text{Hours Flown}}{\text{Hours Flown} + \text{u/s Time}}$$

By this expression, it can be seen that the aircraft life is defined in Flying Time, not Calendar Time. Also, it enables the Maintenance Engineer to see clearly how much the Operator relies on him, when carrying out a successful business venture.

2. *Various Responsibilities*.

A high " Utilisation Potential " is obtained by the efforts of the engineering staff in keeping the u/s time down to a minimum ; also, a great deal depends on the informed planning and manipulation of operating schedules. Bearing this in mind, I think it would be beneficial to examine the factors applicable to this particular problem.

For an engineer to carry out his maintenance successfully, not only must he be equipped for the job in hand, but he must also know, in theory and in practice, how to accomplish his aim. Similarly, the Operator must have a thorough understanding of the Engineers' maintenance problems, in order to obtain the maximum utilisation of men and aircraft.

To enable the Operator to gain this understanding, he must have full knowledge of the following factors :—

(*a*) Adequate information regarding the length of " Component Lives " ;
(*b*) The Maintenance cycle ; and
(*c*) The amount of man hours required for working the various stages of the maintenance cycle.

The quantities associated with these points are, obviously, dependent on the skill of the designers.

After analysing all I have said previously, the following important points are apparent :—

(*d*) It is the designer's responsibility to ensure that there is adequate detailed and factual information available to the Operator concerning the type of aircraft he intends to operate ;
(*e*) It is the Engineer's responsibility to have a serviceable and safe aircraft to meet the maximum operational requirements ;
(*f*) It is the Operator's responsibility to assist his Engineers in this aim, by co-operative planning of schedules to prevent dislocation.

In general, the successful operation of a profit-making helicopter is mainly dependent on the efforts of the designer, the operator, and the engineering personnel and, without complete co-operation and team work between them, the operation of this type of transport can be a very haphazard affair.

3. *The Application of the Maintenance Cycle.*

On this subject, I would like to try and illuminate some relevant points that will help to make available a " Profitable Utilisation Potential " to the Operator.

The Engineer and the Approved Maintenance Cycle. The Approved Maintenance Cycle states that various checks must occur x times during y flying hours ; also that certain component overhauls must be carried out at the end of that block of flying time.

Providing these checks are done and the " component lives " are renewed at the specified times, the responsible body governing the airworthiness of the aircraft does not mind how the " Approved Maintenance Cycle " is applied. Bearing this in mind, the helicopter lends itself particularly well to the following two applications of the maintenance cycle because its transmission can be so easily segregated.

Block Maintenance. If the operation is of a nature where fairly moderate utilisation and irregular flying hours are entailed, it would be beneficial to apply the " Maintenance Cycle " in the following manner (See Fig. 1A) :—

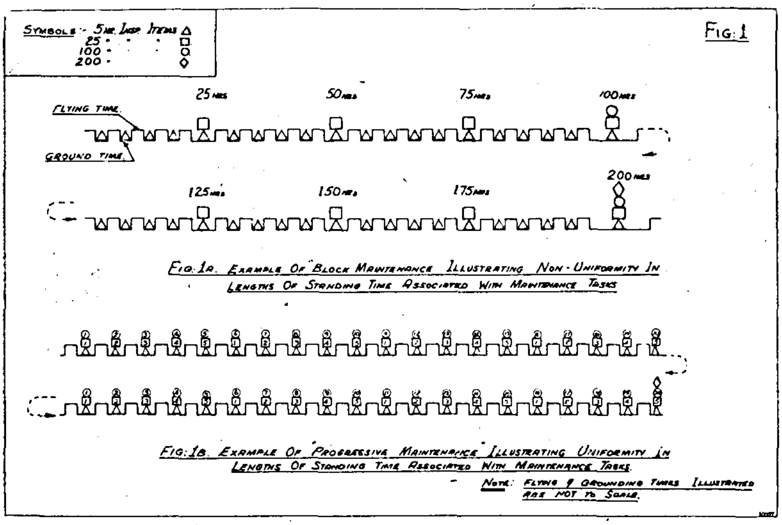

Fig: 1A. Example Of Block Maintenance Illustrating Non-Uniformity In Lengths Of Standing Time Associated With Maintenance Tasks

Fig: 1B. Example Of Progressive Maintenance Illustrating Uniformity In Lengths Of Standing Time Associated With Maintenance Tasks.

Note: Flying & Grounding Times Illustrated Are Not To Scale.

Firstly, everyday Servicing, such as :

(*a*) 1. Refuelling the aircraft with petrol and oil ; and
2. Cleaning the airframe and cabin.

Secondly, everyday Maintenance, such as :

(*b*) 1. Greasing, as specified by the Lubrication Chart ; and
2. Visual inspection of certain parts of the aircraft.

At the end of the cycle of flying, which we shall assume to be 200 hours, the components to be overhauled are replaced by " Sealed Components," thus enabling the standing time to be greatly reduced, over that, associated with grounding the machine while the components are being overhauled.

This application is not ideal, since it entails " continuous grounding " for periods long enough to carry out all the work associated with each task. It does, however, enable the engineer to give the Operator a higher utilisation potential. On the other hand, if an Operator has a schedule ahead of him with regular and consistent flying, it would be more advantageous to apply

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the " Progressive Maintenance System " as developed by the B.E.A. Helicopter Unit.

Progressive Maintenance. This means exactly what the name implies, that is, the maintenance is applied and carried out progressively.

For example, if the block of flying is 200 hours and the " Maintenance Cycle " calls for two 100-hour inspection and eight 25-hour inspections, apart from certain airframe and engine checks and " Component Overhauls " to be done at 200 hours, progressive maintenance may be achieved in the following manner :

With reference to Fig. 1B, it will be seen that a " 5-hour flying day " will give us 40 flying days in which to complete all that the " Maintenance Cycle " requires during that period.

Therefore, the 100-hour inspection is broken down into 20 parts and the 25-hour inspection is broken down into 5 parts. Accordingly, at the end of each " flying day " there will be issued with the Daily Inspection one part of the 100-hour and one part of the 25-hour inspection, and these parts will follow each other consecutively through the 40 flying days, until the whole cycle is complete.

The aircraft is then grounded for a short " Standing Time " to do the changing of " Sealed Components " and the 200-hour inspection items.

Although the effort expended on the latter method probably does not decrease very appreciably, it does enable an Operator to run a scheduled service with a smaller reserve fleet.

For instance, on " Block Maintenance " of 200 hours of flying, the Sikorsky S.51 has to be withdrawn from service on eight different occasions, ranging in duration from part of a day to several days, but, on " Progressive Maintenance," the aircraft remains in service for the whole 200 hours, as it is never withdrawn for periods longer than four hours per flying day. In addition there is a relatively shorter grounding time at the end of the cycle. Of course, included in both these methods are progressive Certificate of Airworthiness items, leaving only items fixed by Calendar Time to be done.

Apart from this attractive advantage, regarding Progressive Maintenance, I have this personal point of view to add. I find that this method does break up, very considerably, the monotony of routine Daily Inspection and it keeps one mentally alert and interested in the maintenance.

4. *Maintenance and the Designer.*

It has already been mentioned that factual information, effort required and flexibility of the Maintenance Cycle is of prime importance to the Operator. Let us now consider the operating Engineer's point of view.

When an Engineer is carrying out this Maintenance Cycle, he likes to feel that three principles of maintenance were adhered to when the aircraft was being designed. These are :

(*a*) Long life of components ;
(*b*) Rapid and independent replacement of components ;
(*c*) General access for servicing and maintenance.

We all agree that the longer an aircraft is " grounded," the less money it has the chance to earn. Having realised this very necessary point, the engineer is confronted by these problems, which I will endeavour to put before you.

The helicopter, being a "short haul" vehicle, needs to be refuelled and serviced rapidly, with the minimum amount of man-power. To achieve these aims, I would suggest the following points :

(*d*) Standardize the greases and grease guns, or, better still, have "packed" bearings with a life ;

(*e*) Standardize the oils for gear-boxes and engines ;

(*f*) Make aircraft parking covers easily fitted and adequate for the job ;

(*g*) Have the filler necks on petrol tanks within easy reach ;

(*h*) Have positive means of determining petrol level in the tanks.

To shorten the Standing Time associated with maintenance, I would suggest these improvements :

(*i*) A new method of tracking the blades, without risking damage to blade tips ;

(*j*) Simple but effective means of locking various components ;

(*k*) Easy removal of the battery, since it requires frequent maintenance ;

(*l*) Design all replacement components so that they can be assembled and fitted without complex rigging or fitting adjustments ;

(*m*) Design the instrument panel installation so that instruments may be changed individually, without removing the panel.

Lastly, we have to consider Component Overhaul. When we realise that approximately 40% of the effort expended on maintaining helicopters is devoted to Overhaul alone, it makes one realise how much development still needs to be done.

Basing my remarks once again on personal experience, I would like to feel that these four important factors are receiving the closest possible attention :

(*n*) Components should be capable of lasting their predicted life, thus decreasing the risk of random failure ;

(*o*) The skill necessary during overhaul should be of a lower order than that with which we are accustomed, to allow a lower grade of engineer to be used, also to allow quicker re-assembly ;

(*p*) Components should be easily "bench tested," so that they can be fitted to the aircraft with a reasonable degree of certainty of correct functioning ;

(*q*) Finally, every component, irrespective of its origin, should be capable of being fitted to any aircraft of a type, thus avoiding unnecessary effort during major overhauls.

5. *Conclusions.*

The helicopter, complicated as it is, with its transmissions, clutches, fans and gear-boxes, has a great redeeming feature. That is, it can be easily segregated into components.

Bearing this in mind, I would say that, if the Designer concentrates on the policy of "Sealed Components" which can be independently and

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rapidly changed, he will have greatly enhanced the Operator's chance of a " Profitable Utilisation Potential " in his helicopter.

With the little time left to me, I would like to emphasize one more point, this being the *Mutual Responsibility of the Designer and the Operator.*

To quote an adage, " Prevention is better than Cure," I often think of this when a modification is issued to alter the aircraft to facilitate servicing and maintenance in the field. The point I wish to make is that it is the mutual responsibility of the Designer and the Operator to have in their teams some person who is capable of *foreseeing* maintenance difficulties on the drawing board. In this way they can eliminate the early maintenance " headaches " and consequent modifications which do so much harm to all concerned. The consequent loss of earning capacity is a luxury which we cannot afford. Such a mutual maintenance responsibility will benefit the helicopter movement as a whole.

In closing, I would firstly like to express my thanks to the Helicopter Association of Great Britain for honouring me by asking me to read this paper. Secondly, I take this opportunity of thanking the British European Airways Corporation for allowing me, a member of its staff, to prepare it and base it on the work with which I have been closely associated over the last three years.

PAPER

By Mr. A. Bristow (C.B. Helicopter Hire Limited).

The Chairman : Our first paper was read by a speaker intimately concerned with the work of a regular schedule operator. It is our wish to have our second paper read by a speaker associated with non-regular scheduled operations, since we felt we might thus have an opportunity of ventilating differences in operating techniques. We had hoped to have a paper by a speaker employed by Messrs. Pest Control Limited, but unfortunately their representative is overseas and unable to be with us today. Mr. Bristow has very kindly offered to present at short notice a paper based on his recent experience in the non-regular scheduled operation of helicopters, and it a great pleasure for me to accept his offer on behalf of the Association. Mr. Bristow is well-known to most of us, but for the benefit of those who are not familiar with his work, I would mention that he was introduced to the helicopter during his service in the Royal Navy. Subsequently, he was a test pilot at the Westland Aircraft Company, and he then did good work with the original Sikorsky S.51, and later with the Westland Sikorsky S.51. His work included demonstration flying, Certificate of Airworthiness testing, and he played a leading part in the rescue of the Wolf Rock Lighthouse and the " Hare and Tortoise Project," which you will remember linked London and Paris by the quickest possible means, using jet fighters and helicopters. Mr. Bristow was, until recently, Technical Manager for Messrs. Helicop-Air Limited, in Paris, and in that capacity he operated the helicopter in Europe and as far away as Indo China.