

computing equipment is designed for remote stowage on the S B A C racking system. There are no controls on these units which must be accessible in flight, but the equipment should be so mounted that at least the power supply unit is readily accessible for maintenance check procedures.

(3) *The Controls and Display*

All control units are designed to conform with the S B A C standard system, and can be incorporated, therefore, on switching and control consoles without difficulty.

The display system, however, does not conform with any agreed standard. Of the two standard instrument sizes, one is too small and the other is larger than necessary for the meters. They are arranged therefore, to be as small as is reasonable from engineering and readability considerations.

The flight log cannot be made to fit into any standard display system size, and has in the past been made to occupy approximately 12½" by 5½" of panel space. It is interesting to note that though panel space is always difficult to find, a number of Decca users are asking for larger flight logs which show more terrain. These same users complained when they first fitted the flight log of the large panel space required for the Decca system. This is the great problem, getting the panel space—the correct piece of panel space—on the initial installation. It is suggested that it is no good having a correctly positioned and grouped set of blind flying instruments unless these instruments are suitably positioned in relation to the navigational aid.

We need more "system engineering". We must consider the helicopter, its instruments, its radio communications and its navigational aids as an integrated whole. Only then can the difficulties we have been discussing be minimised.

Discussion

The **Chairman** said that judging from the attendance there was a great deal of interest in the Papers. Not everybody would agree with everything which had been said, but it had been pointed out that there were installation difficulties and it was some comfort to helicopter designers to know that other people had their problems. One feature which had struck him was that when the Authors drew sketches on the board of a helicopter it appeared that there was only one design of helicopter in existence! Far be it for him to give a boost elsewhere, but he thought they ought to try another shape! That might have something to do with the difficulties which had been encountered.

Sq Ldr J R Dowling (*Air Ministry*) (*Member*), said he wanted to thrust a small, sharp pin into what appeared to be a great deal of self satisfaction on the subject of V H F. Two speakers had stated that this was definitely the most suitable form of radio communication for helicopters, but he challenged this statement. In his view, from some angles it was the least suitable equipment, and it could be used widely only in one particular field—the passenger helicopter flying from an airfield or from one prepared landing ground to another. Even then, it could be used widely, perhaps, only in England. It was natural that that type of operation should be considered here to be very important, but he suggested that it was by no means the only one. The helicopter was essentially a flexible machine and it had many other uses. Who was to say that we should continue indefinitely in this country to think of the helicopter purely as a passenger carrier from town to airfield or from one town

to another ? Certainly he did not feel the Association should limit the operations of the helicopter in that way

Not long ago there had been some publicity given to the handing over of keys to A A boxes to pilots of a well known squadron in the North of England. These keys enabled them to open the telephone boxes of the A A without being a member of the A A. All the helicopters in question were fitted with very efficient ten-channel V H F sets. These were sets of very high serviceability, and nobody had any complaints from that point of view, yet as soon as the pilots were ten minutes away from base they were liable to have to land, open an A A box with a key and ask their operations room by telephone, what to do next. In such circumstances, the V H F set seemed to be a waste of time.

Similar circumstances existed in Malaya. For a long time, until someone had been able to put an extremely powerful V H F relay station on top of the central mountain range, the pilots had been in great difficulty. One could hardly expect to find a powerful relay station on top of all the local hills when flying from place to place.

He suggested that H F would be generally much more suitable for the operational helicopter, but most of the existing equipment was unsuitable for other reasons. For example, the desire to have sets working on these frequencies had been expressed strongly by the Army, but the spectacle of the Army attempting to get this sort of equipment into the tiny cockpit of the Skeeter had to be seen to be believed.

He knew that there were many difficulties with H F and L F, but he would be very sorry if some work were not taking place to deal with those difficulties because helicopters in general—and by “in general” he meant that the helicopters which carried passengers for profit were the exceptions—required communications over much longer ranges than V H F could give at low altitudes.

Mr Griffiths, in reply, said he had been surprised by Squadron Leader DOWLING's sharp pin. Presumably he had been referring to Mr GRIFFITHS' own statement that at the moment V H F was the most suitable aid. Mr GRIFFITHS stuck to the point, it was the most suitable aid at the moment. The future, of course, was unpredictable. As they knew radio communications today—and he was not referring to navigation—there was no communication more suitable for the helicopter than V H F on account of its size, ease of operation and aerial problems.

He had also been very surprised to hear that it was necessary to carry A A keys when ten minutes away from base. His own Company had had much experience in everyday operation of all types of aircraft with radio, and he would not like to sit in his present position if ten minutes away from base the V H F could not give a better indication than Squadron Leader DOWLING had suggested. If the Squadron Leader did not get better results than that, there must be something wrong. A ten minute flight did not take one very far in a helicopter. Certainly the B E A Helicopter Unit would not like to be told that their range was no more than ten minutes. He often heard them from London Airport when he was at Gatwick, which was 29 miles away. Similarly, he often heard helicopters at Booker working over Tangmere, which was over 70 miles distant.

Squadron Leader Dowling said he withdrew “ten minutes” and substituted “thirty minutes”.

Mr Griffiths commented that there was a good deal of difference between the two times.

Captain G Jacques (*Autair Ltd*) (*Member*), supported the comments made by Squadron Leader DOWLING. Last year he had had to operate helicopters over Greenland. Everyone present seemed to think that helicopters operated only in England from airfield to airfield and over flat country. They seemed to think that helicopters did not operate in the bush. He had operated helicopters in the Arctic and the Antarctic, as well as in Malaya.

When operating in Greenland he found that when he was ten minutes from base, often having climbed over 7,000 ft and down the other side of a mountain, the V H F was unsatisfactory. In such circumstances they needed H F, there was no doubt about that. On the other hand, it had been said that they could not get

H F to work because of aerial difficulties. He wanted to see the problems of H F much more closely investigated. Indeed, he had even used it with trailing aerials, although that was a particularly dangerous type of aerial for a helicopter. If possible, he wanted the problems of aerials and H F thoroughly investigated so that H F could be used. There was no doubt that it was needed by the helicopter.

It had been said that Helicopter Services Limited had wanted to fit Standard Telephones and Cables STR9X into their Bell 47G machines. He had flown those aircraft and had found that the V H F worked very well. He had also flown Swedish Bells, which had the LEAR V H F. It was a nice little pack which sat on top of the instrument panel, everything was complete in front of the pilot. It worked just as well as the other system, but it did not involve long leads and waterproof boxes, everything was placed in the cabin with the pilot. Could British manufacturers produce something like that?

The helicopter needed a pack radio which could be moved in and out easily. When operating in the bush, sometimes they needed one type of radio and sometimes they needed another. It was therefore important that the set could be removed easily. Sometimes they did not need radio at all. In fact, last year he had to operate without radio because he was operating at 5,000 ft and they had to try to reduce the weight they were being asked to carry. When they threw the radio out, however, the S B A C Racking system remained, with all the cabling, which involved unnecessary weight. He wanted to see a small, pack radio put in with the pilot and easily accessible to him. Would some of the experts comment on this?

Mr Kitson, in reply, said that manufacturers would undoubtedly be interested in manufacturing what Captain JACQUES wanted if the demand existed for production. That was the biggest difficulty in most of these problems. Electronics was sufficiently expensive in any event and the smaller the production the more expensive it was. The A R B did not very much like the LEAR system and it was not fitted in this country. There was no comparable British set on the market.

As speakers had said, V H F had its limitations and H F would probably provide an answer. Work was being done on H F aerials. He had been told that trailing aerials were used on whaling aircraft in the Antarctic, but he did not know whether they had been successful.

The Authors were very pleased to hear these comments from Squadron Leader DOWLING and Captain JACQUES. At the moment, V H F was the most common form of communications equipment for which they were asked. At the moment the demand was not sufficient to justify any Company going into production of H F, although that might change in time. In any event, he welcomed the comments which had been made.

Mr P A Hearne (B E A), said that after Squadron Leader DOWLING's remarks, he spoke with some trepidation from the civil operator's point of view and preferred to deal with navigation rather than communications. B E A were looking forward to using radio in navigation for three main purposes. The first was as an en-route navigational aid, the second was as a terminal area aid, and the third was as an approach and landing system. It was worth considering the sort of limits involved and the limits of accuracy which radio would have to meet.

Dealing, first, with en-route uses, he said they wanted to maintain track to within plus or minus one mile, which was considerably higher accuracy than was achieved by aircraft flying the airways in Great Britain. The airways were 10 miles wide and within those 10 miles the aircraft were liberally distributed.

Secondly, dealing with terminal area navigational problems, he said that the present International Air Transport Association's proposals were for flying in corridors no wider than 500 yards. At present this was considered unrealistic by operators, but the width of the corridor was unlikely in certain cases to be more than 1,000 yards, which meant that the accuracy must be plus or minus 500 yards.

In the landing system they wanted an accuracy which would put the aircraft within plus or minus 100 ft on 100 per cent occasions, which meant a considerably greater accuracy than had been achieved. When they considered availability of such an aid the situation perhaps looked a little bleak.

In the en-route problem they hoped to find a solution by using Decca. Decca as an area coverage aid gave greater flexibility of operation and had considerably higher accuracy in most stages of flight than point source aids such as V O R. It was, however, subject to precipitation. They had not had very much trouble with this but, on the other hand, they had not flown many times in conditions when it was most likely to occur, i.e., in cumulus and cumulus nimbus clouds. They used Decca as an approach aid in certain conditions too and here it was noticeable that the resolution accuracy of the equipment must be improved. It was found that although Decca would function perfectly adequately as a navigational aid, when used in approach conditions even though the accuracy of the information going into the equipment was adequate the accuracy with which the equipment reproduced the information was not high enough.

For the terminal aid, as yet they had no ideas. They might use the short base Decca or they might consider putting V O R in the aircraft or some similar equipment, using that aid as a secondary navigation system in case the primary navigation system failed. There were, however, many problems in fitting these V H F navigational aids to aircraft. They had been tried some time ago in America where errors of plus or minus 15 deg had been obtained regularly. Very little work had so far been done in this country, but it was hoped to start in January in an aircraft at Gatwick. There were also difficulties in using the A D F equipment as a secondary aid because if there were precipitation static conditions and the Decca failed, the A D F would give rather peculiar answers at the same time.

On the approach and landing system they were hoping to use the microwave system, which they had tried in experimental form at Gatwick, this aid would work in a band somewhere between 3,000 and 9,000 megacycles. This posed very difficult problems of aerial location on the aircraft. So far they had used horn aerials which had been extremely sensitive directionally, with a low entry angle. The aircraft generally had to be pointed towards the beam or pretty well on the beam before a useful signal could be obtained. This was obviously quite impracticable for a system in which the aircraft had to approach the beam at right angles and turn on to the beam. Considerable work must be done on microwave aerials before that type of system could be used as an approach aid.

Finally, the question of presentation had occupied their minds a great deal. Most of the existing equipment had been designed for presentation in fixed wing aircraft and when used in helicopters there was often room for improvement in the presentation.

Speaking on behalf of Captain R W DIBB, he wanted to make some additional comments. Captain DIBB complained that the cockpit installations of radio generally had sharp corners and were difficult to use. He wanted these smoothed so that he did not cut his knees or tear his trousers on the equipment. Secondly, he wanted some standardisation in the radio controls in his cockpit—similar controls for similar equipment preferably in similar positions. Thirdly, he believed—and Mr HEARNE agreed with him—that there was a need for more anti-vibration measures. Indeed, to a large extent he thought this was the answer to many problems. B E A had had an aircraft flying since the middle of September which still had an unserviceable V H F set arising from vibration problems which they could not trace.

Mr Hinchliffe, in reply, said Mr HEARNE had made several interesting points and it would take too long to try to discuss them in detail. He and Mr HEARNE had taken part in many discussions on these matters, and they lasted for a long time!

The question of much narrower corridors for air navigation raised an important point as an advantage of the Decca type of area navigation system in that if they had an area navigation system and all the aircraft in a given area were using that system, then errors of propagation did not enter into the collision risk error. The only collision risk arose from maladjustment of the receiver controls. It was an important point that there was a better chance of getting much narrower corridors when using an area type navigational system.

The approach aid narrow beam with U H F was another important point. Since Mr HEARNE had said that they intended to use Decca for their primary navigational aid, he suggested that the problems mentioned about approaching the descent path at right angles and turning on to it were considerably eased if they integrated

the approach aid and the en-route navigational aid during the transition from en-route to the approach phase. One could use Decca to approach and then could turn through 90 deg and be on the beam for the final approach.

Mr Creek, in reply, said he did not want to start a battle between A D F, Decca and all the other navigational aids. He emphasised that A D F had been used since 1931 and he would not like to suggest that it would be thrown out as a primary navigational aid. He thought that the ultimate accuracy of A D F would depend more on the installation than on anything else. Although the equipment and the techniques used by the Americans and ourselves differed somewhat, we both turned out a fairly high quality equipment and providing that they had full co-operation from the aircraft manufacturer and full co-operation from the user—the man who was paying the money—in the very early stages they would achieve much more accuracy and perhaps achieve what Mr HEARNE had in the back of his mind.

Mr J Chandler (*Smith's Aircraft Instruments*), said that a paper had reached his desk that morning, issued by the Wright Air Force Base, on the Doppler navigator for a helicopter. Probably some of those present had not seen it. It had been on trial since December, 1956. He wondered whether this answered some of the problems which had been put before the Symposium such as those raised by operators who operated in uninhabited parts of the world.

This equipment had a drift angle of 180 deg either side of its azimuth. It had a speed range of minus 50 to plus 300 knots and it measured the vertical speed of up to 3,000 ft/min. It weighed 72 lbs. It had the three-horn configuration.

Was this the type of navigational aid which would be considered by people operating in uninhabited areas? It appeared to be reasonably simple to fit, but it was still under development.

Mr Hinchliffe said a considerable amount of development was taking place in this country at the moment on Doppler navigation aids. During recent years most of it had been done under Government contract, with security specifications, but in the last few months a considerable amount of the security specifications had been relaxed and information was gradually being released about what these navigational systems were likely to do and which were likely to be available in the near future.

If anyone was interested, he knew of a British Doppler navigational aid. Enquiries would show that at least two Companies were developing them. He was not sure, however, whether in their present form they would be suitable for the helicopter.

Mr Court (*Marcom's Wireless Telegraph Co Ltd*), said it would be most unwise at this point to say very much about it. It would be easy to plead security as the reason. He would not like to go much further, however, because his ignorance would become more apparent!

He did not think that any such system would have any practical application to the general problem as it stood at present. The equipment which Mr CHANDLER had mentioned had more use in American circles, but for operational reasons which he was sure his colleagues would agree should not be disclosed, he did not think it was of much value to civil aircraft at the moment. The weight of such equipment at this stage would make many of his friends shudder, even those in the Charter Companies who carried such things as bags of cement to remote places. Mr CHANDLER had spoken of a weight of 72 lbs. This would be quite an achievement for equipment of that type! Mr HINCHLIFFE knew all about the problems of getting down to a weight of 40 lbs and he would not like to carry equipment of the weight mentioned by Mr CHANDLER in a commercial helicopter at the moment.

Mr CHANDLER had made a point which would be for future development but they must not be too hopeful about seeing such equipment as a commercial proposition in the next five years. In some ways he was not permitted to say much more, but he hoped that his remarks had helped a little.

Mr A R V Fouweather (*ARB*), replied to Mr KITSON's comment that the ARB did not like the Lear equipment. He wanted to correct that point of view. The Board had no responsibility for the type approval of radio equipment, their responsibility was to interpret the Regulations, and the Regulations laid down

that all radio equipment installed in aircraft must be of a type approved. The Lear was neither a type approved in America nor validated in this country. Indeed, it could not be validated in this country because it was not American approved.

Replying to Captain JACQUES, he said that there were helicopters operating in this country of which 50 per cent of the installed equipment was unapproved. Operators who had been in touch with the Board had been told that if they were in special circumstances they could get a dispensation to carry unapproved equipment for special uses.

Turning to the loop installations, he said they had had a lot of trouble about this and in the end had had to reach a compromise. In many cases in respect of helicopter installations the Board had tried to reach a certain standard but had had to bend the rules a little and forget the book because they had reached the best standard possible.

Mr Griffiths pointed out that he had explained how much he had been helped by the Board, particularly in installations for Air Service Training and Fison Airwork. He would also like to record the great help they had had from the Board over the years.

Captain Jacques, commenting on the use of navigational aids in the bush, said he had found that the A D F system was the best system, even if it gave an accuracy of only plus or minus 11 deg, it was first class for its job. He had flown aircraft with A D F, A R B approved, and although it had not given an accuracy of plus or minus 2 deg, it had been the best navigational aid which could be used on helicopters away from the civilised world.

Mr J White (*Westland Aircraft Ltd*) (Associate Member), replying to the comments which had been made about installing radio, said it seemed inevitable that the available space in the helicopter never conformed to the rectangular shape to which the black boxes were built. That comment applied also, but to a lesser degree to the control units, these came in varying shapes and sizes.

He asked for the views of the Authors on the possibility of splitting down the boxes into, on the one hand, vulnerable parts which needed A V mounting and, on the other hand, other parts which, literally, could be put into a box and screwed on to a wall. If this could be done it would assist the installation problem considerably.

The A V mountings provided a problem because they always appeared at the bottom of the black boxes. He often felt that they would like them on the top or at the side, because of the restricted space which was available. The helicopter was a peculiar device in that it had to carry all the equipment—engines, cabin space, and everything else—in one small fuselage, without wings on which to mount these devices.

He asked whether it was necessary to persist with the present practice with control units which had a flexible drive attached. These were very difficult to install. Usually the black boxes to which they were connected were remotely situated, very often on the side of the engines or bulkheads. Was it not possible to have electrical probes to replace the mechanical drives?

Another problem concerned lighting. Some control units were self-lit and others had no lighting. Inevitably lighting had to be provided. This was a point which appeared to have been neglected in some cases. If there were an explanation for it, he would like to hear it.

Mr B Moore (*Bristol Aircraft Ltd*), said he would like to support what Mr WHITE had said about A V mountings and lighting.

Mr. Kitson, replying to Mr WHITE, thought that we already had enough boxes without chopping them up and putting them all over the place. What was required was to make them smaller so that they could be distributed in a smaller space. That could be done quite easily, but it would cost more, and it would increase the weight a little, too.

Units were already split into as many as were feasible for servicing facilities.

There was certainly a case for standardised control units, which at the moment

were all shapes and sizes. There was a case, however, only if all the aircraft manufacturers could be persuaded to provide the same sized hole to put in the control unit when it had been built. If they were trying to cover a large range of aircraft, some of them larger than helicopters, they would need different sizes of combined control units by comparison with those needed for a small aircraft. This problem could probably be overcome.

He agreed with the comments about sharp units. These stuck into the pilot all over the place.

Mr R W Washer (*B E A*) (Member), commented on the variation in aircraft cables, plugs and sockets. He said that they were getting a hybrid set of plugs provided by various manufacturers and thought that it was time that the plugs and sockets were standardised. At the moment they were very complicated. It was time that this was stopped and that manufacturers began to manufacture a standard type of plug and socket for military and civil use, otherwise they would reach the stage where they were now with screw-threads.

Mr Griffiths replied that he agreed 100 per cent.

Mr Hinchliffe agreed that it must be a serious embarrassment to a man trying to put all these pieces of equipment on to an aircraft, but, speaking more as a designer of equipment than as a man responsible for installing it, he explained that it could be a serious embarrassment to a designer of new equipment to have to look up a book and to say, "I must use this particular plug or this particular socket." Sometimes he had to design the black box around the plugs and sockets and it was desirable to have a large range of plugs and sockets and not to be restricted. It was very useful, with a mixture of equipment, to say that you could have a mixture of plugs and sockets—a round one for one unit and a rectangular one for another unit. Standardisation was all very well in certain respects but it could lead one into serious trouble and it had to be tempered with a certain amount of intelligence.

Mr Eastwood (*Marcom's Wireless Telegraph Co Ltd*), said he hoped that they would have an opportunity of another meeting later. There was a long way to go in work on plugs and sockets. There must be flexibility in size and shape. They needed standardisation to a certain extent but they should not choose a large number of different basic types by different manufacturers.

The **Chairman**, concluding the discussion, said they had had a long and interesting evening. One could be left with the impression that pilots had the greatest difficulty in finding their way because equipment could not be put into the aircraft or, when it was in, did not work, but on the whole radio behaved fairly satisfactorily and certainly had behaved well in the Helicopter Unit, one field of helicopter operations with which he had had a close connection over the last ten years. Perhaps they had performed miracles because they had been single-track minded and had not permitted themselves to be frustrated by obstacles. He was referring particularly to the time when they had operated the first scheduled night mail service from Peterborough to Norwich, a distance of 67 miles. Because it was the first time it had been done and because not much was known about it, they had used elementary equipment, but they had never had a breakdown. This had been due either to the good basic engineering of the sets which they had used or to good maintenance. Certainly there had been teamwork.

If more meetings could be held between designers of helicopters, designers of the radio equipment, the users and those who had to keep the equipment going, nothing but good would be achieved.

He expressed the Association's appreciative thanks to the five Authors who had given much time and thought to their Papers and who had expressed their point of view so admirably. They could feel justified in having a certain amount of self-satisfaction in the work which they had done.

The discussion had been lively. It could have continued, but the time was already late, and if anyone had time they should see the equipment outside and discuss it with the Authors. They would find that well worth while.

The vote of thanks to the Authors was carried by acclamation.