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THE COMING-OF-AGE OF THE PUBLIC TRANSPORT HELICOPTER

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Stimulated largely but not wholly by the North Sea activity, there has been a dramatic growth of helicopter operation in the UK over the last two decades. This trend has affected similarly many other countries, particularly those in Europe and elsewhere that are engaged in oil exploration.

Taking the UK twin-engined fleet for example, 20 years ago we had just 21 on the Register, 10 years ago, in 1975, there were 92 and today 190. Hours flown have increased during the same period from 10,000 to 53,000 in 1975 and for the full year in 1985 I would estimate 150,000 hours.

Single-engine helicopters have, of course, increased during the same period but not so spectacularly. Over 20 years the number on the Register has increased by a factor of $3\frac{1}{2}$ and is now 350. Utilisation has increased by a factor of 2.

This expansion in operation has been the cause (and also the effect) of the development of helicopter capability - enhanced performance through advanced technology. It has been accompanied by a change in the distribution of the civil helicopter manufacturing industry: whereas in the 60s and early 70s the large majority of the western world civil fleet was of US manufacture, currently the European Manufacturers contribute some 45% of the production. This, I believe, has stimulated helicopter development in new designs and it is perhaps indicative of this, that the CAA has certificated 15 new types or major variants in the last ten years.

The CAA applauds these developments and the healthy growth of helicopter technology and operation. With the benefit of the conclusions of a study by a group under Dr Wilkinson's leadership, we are also happy to go along with the idea that, given the right circumstances and encouragement, helicopters will make a significant impact on the public transport system of this and other countries in the future. However, the CAA's main task, in collaboration with our own Industry and with colleagues in other countries, is to respond to this situation by setting and ensuring the achievement of suitable safety objectives. I cannot emphasise too strongly the CAA's belief in seeking a convergence of objectives among the manufacturers, operators and authorities of the various countries confronted by this common problem. In particular, we shall continue to work toward common certification standards whenever this is consistent with what we believe to be our responsibliities and our particular circumstances in the UK.

Helicopter Safety Record

Two distinct points of view can be taken, when looking at the safety record of helicopters so far in their history. One is that we have come a very long way: compared with fixed-wing aircraft at a comparable stage in their development, the record is commendable and even in absolute terms the record of helicopter operation on the North Sea - where conditions are as far from being favourable as it is possible to get - has been excellent. On the other hand, it has been established that helicopters presently operating do not offer a level of safety equal to that of comparable aeroplanes of similar capacity. More importantly and constructively, it has been established that further very substantial development is needed if on safety terms helicopters are to take their place alongside transport aeroplanes at the turn of the century. It is this belief that has led the CAA, in company with some other Authorities, to press on with setting the future objectives in detail terms. I shall also be explaining that in looking to the future we are finding it impossible to ignore the present and steps are being taken in several areas to do all that current technology can offer to enhance the safety of existing equipment and operations.

HARP

I believe that the work of the Helicopter Airworthiness Review Panel, that came to be known as HARP, was a very significant step in the history of helicopter development. The Panel's Report was published in June 1984 as CAP 491. What matters now is that some progress should have been made in responding to the recommendations of that Report. I think it has:

accepting that short-term changes cannot be achieved by design requirement action alone, we are particularly pleased with the response of Operators and those they serve and of manufacturers of helicopters and equipment in introducing safety-oriented modifications on the present fleet. Among the areas in which notable progress has been made I would mention:

- the Report of the Condition Monitoring Working Group (the subject of a paper by B L Perry and D Astridge later in this Forum);

- substantial progress in the study of human factors as a primary or secondary cause of accidents;

- advances in the control of fatigue-related problems in design, certification and operation (the subject of a paper by J Bristow and C Van Santen presented at last year's Forum);

- progress in a programme of operational data recording in order to explore further the actual operating environment for helicopter components;

- very substantial progress toward improving the capability of helicopters and their survival equipment in the event of ditching or accident.

I shall return to some of these subjects in more detail.

Ditching and the Present Work

There are times in every field of activity when the need to take some positive action becomes obvious to all concerned. In relation to helicopter ditching capability in North Sea operations, the following factors arose:

- the Operators were becoming increasingly conscious that the ditchings, though infrequent, were in fact occurring periodically and that sooner or later a ditching would occur in adverse conditions;

- the Authorities were conscious that a substantial reduction in ditching rate would not be obtained until the next generation of helicopters were in service (although this is not to say that some health monitoring techniques which improve reliability could not be introduced into current types); we were also conscious that the certificated ditching capability of current helicopters was not appropriate to adverse North Sea conditions and that in these circumstances the chances of successful ditching and survival of all occupants should be maximised by whatever means are available.

I am pleased to say that much progress has been made during the year due to the energetic response of the Operators and Equipment Manufacturers to the need that they and the CAA identified. I am also pleased that the companies using these services on the North Sea have been sympathetic toward the consequences in financial terms of this work and of further research in the area. The CAA for its part is ready to support with appropriate regulation the actions that have been agreed as desirable. The revision of life-raft equipment is a major feature of this programme. Research on the stability of helicopters on water is proceeding and there are some promising indications.

Achieving the best possible ditching performance from each type of helicopter operating in the North Sea has involved something of a departure from normal practice for both ourselves, the CAA, and the North Sea Operators. Jointly we have determined what could be achieved retrospectively for each type and those modifications have been, and are being, made mandatory for North Sea Operators. This does mean that the characteristics achievable can differ between types and the penalties in both initial and continuing operating costs also vary. I am extremely grateful to the Industry, both Operators and the Oil Company Users for their co-operation and support in this programme of retrospective improvement. It does mean that, before use in the North Sea, special modification standards will be required as compared with less onerous operating areas in the UK.

Helicopter Safety Research

The Authority is very conscious that research aimed at improving the breed is the business of the Industry. This is as true of safety as of performance or economics or reliability. Nevertheless, the Authority is legitimately concerned in encouraging research, sponsoring it, or in some cases actually doing it, where it is necessary to establish the safety standards that are from time to time appropriate in their objectives and realistic in their implementation. It is these items of research on whcih I shall comment. HARP and related studies have pointed the way in some of them:

- Flight data recording to establish real mission profiles and operating practices;

- Health monitoring: investigation of technology and certification techniques;

- Fatigue and damage tolerance: development of applicability of existing design and certification techniques;

- Ditching: continued search for improvement in the ditching and survival capability of present and future helicopters:

- Flight deck: pilot information and flight deck ergonomics and environment;

- Vibration suppression: reduction of crew fatigue and structural loads;

- Crashworthiness: review of appropriate standards and realistic objectives;

- Icing: definition of standards and certification techniques.

Before looking at a few of these aspects of R&D in more detail, I should like to take this opportunity to express my deep concern about the inadequacy of the R&D resources of both people and money. We need more resources to work on the programmes aimed at increasing airworthiness standards in the next generations of civil helicopters. This is not just a UK problem: it applies to a greater or lesser extent to all the manufacturing countries. I cannot help contrasting the massive private and governmental resources which were available and applied to the large fixed-wing passenger aircraft at the time in the 50s and 60s when they were going through the same phase of their development through which civil passenger helicopters are passing now. In both cases there is a contribution from defence development which, while welcome, does not solve the civil problems. To illustrate this, the Chinook had 17 years of military experience before entering civil operation. It then took only two years before the civil version had accumulated more hours than any military aircraft of the type. One might add that if the Chinook were to follow the life cycle of the S61, there will be aircraft which will achieve 30,000 hours in their operating lives. On the other hand, the S76 showed the formidable task confronting the Designer and Manufacturer of an ab initio civil helicopter. I hope this serves to put into perspective the relevance of military experience. Furthermore, the limited scale of the total size of the civil helicopter market makes it difficult to believe that adequate funding can be generated within the Industry. In my view the way forward is going to be slow and difficult unless more resources can be brought to bear.

Health Monitoring

Among all the aspects of helicopter safety that were covered by the HARP study, the subject of health monitoring received perhaps more attention than any other. The logic was simple: if helicopters in the foreseeable future are to continue to incorporate features (principally in the transmission system) that are not amenable to fail-safe design through redundancy, then other means must be found of protecting these features against uncontrolled failure. Health monitoring was seen to offer a means of providing this protection and techniques appeared to be available that could achieve this on most, if not all, of the vulnerable components.

Subsequent investigation of work in hand and of potential further development has tended to confirm the view expressed by HARP. We shall be hearing more on this subject in the course of this Seminar.

I feel there must be a word of caution in this area. I see health monitoring as a permanent feature of the total helicopter airworthiness package. Given the right design and certification techniques and the right approach to the use of health monitoring in continued airworthiness, there appears to be no reason why this should not provide a means of ensuring the very high levels of integrity that is associated with effective damage tolerance/fail-safety. I see a very special need at this time for the effective communication of philosophies among the Manufacturers, Operators and Authorities. I believe the CAA is playing its part in this dialogue.

Health monitoring can at best only provide the equivalent of a continuous inspection process. There will always be a threshold below which incipient damage is not detectable; there will always be a minimum time for reaction to the signals that the health monitoring system may give. Within these limits the philosophy of fail-safety must be achieved.

At last year's forum in the Hague, the paper by Bristow and Van Santen gave in detail recent UK experience of a significant number of fatigue failures that had occurred before declared lives had been reached. This reminded us that the setting of safe fatigue lives is by no means an absolute science. It was also seen to justify the emphasis being placed by Authorities and Designers on the damage tolerance approach. Recognising that the new approach will take time for Designers to put into practice, the approach is to move the balance in emerging airworthiness requirements toward damage tolerance, while requiring a more rigorous fatigue substantiation for components that remain on a declared safe life basis.

Crashworthiness

For all sorts of reasons, not all contacts with the ground are immaculate: some are far from being so, to the point where further protection of the occupants becomes impracticable. The regulatory authorities have to choose minimum standards of crashworthiness for certification. Designers may choose to go further if they believe the market presents a demand. The market is very conscious of the cost of increasing crashworthiness.

It would be possible to argue that the present minimum certification standards for crashworthiness contain all the necessary ingredients and that further safety investment should be directed more toward preventing crashes than toward making them survivable. However,

it is a fact that although the retention of heavy masses and seats is defined in numerical terms, they are set at a level that is substantially exceeded by most Designers. We believe and intend that in respect of general robustness and fire prevention, the requirements should result in all reasonable and available means being adopted to raise the standards of survivability in terms of:

- protection of the 'living space' for occupants; retention of heavy items;

- absorption of energy (including seats where protection is at its most efficient);

- protection of fuel system.

This is a matter in which consultations on an international basis with Industry, including Users, is particularly important: it is one in which the correlation between cost and safety is clear and some available techniques have not been welcomed for this reason. The question of applicability of enhanced crashworthiness standards to existing aircraft is probably contentious.

The relationship between crashworthiness and ditching capabilities is important where a large proportion of public transport operation is over water. As we see it, crashworthiness applies equally on land or water. Successful ditching can only be expected following a controlled descent that does not critically damage the aircraft's buoyancy nor compromise the occupants' ability to escape.

Human Factors

HARP observed that many helicopter accidents contained a significant degree of human factor. However, it was very careful to point out that most human factor accidents could be attributable to the fact that a pilot is confronted by the machine in circumstances that, to say the least, compromise his effectiveness in preventing an event escalating into an accident.

Flight deck environments are far less than ideal (vibration, poor air conditioning and uncomfortable seats are undoubtedly conducive to inefficiency), the information (internal and external) presented to the pilot is not ideal; the handling qualities of the vehicle are not ideal; its capabilities in adverse conditions, including icing, are limited. All these matters deserve attention and the first step being taken by the CAA (quite apart from the efforts of Industry in these areas) is to examine and analyse the accidents on record, in order to identify the human element. The results of this study appear promising and will be available shortly. We must not forget, by the way, that the study of human factors in relation to safety does not apply only to flight crews: engineers are also susceptible to the circumstances in which their work is done.

Monitoring Safety

Continued airworthiness is an expression that has gained popularity in recent years. Maintenance is one facet of this. However, apart from activity that is planned at the time of launching a type (and perhaps modified in the light of experience) there is another category that is unplanned but equally essential. Type certification is a statement that, so far as it is possible to ascertain, a design meets the intended airworthiness standards. Experience will inevitably show that this has not in fact been the case and action has to be taken to retrieve the intended standard. This is relatively a simple system of control when design, manufacture and operation are under one national system. Where they are each conducted under a number of systems the problem is very much more complicated.

National laws place different responsibilities and the scope and pace of international agreement is regrettably small and slow. The complexity of helicopter engineering emphasises the imperfection of the international system, and the CAA is active in seeking progress. However, one thing can be said with confidence and that is that without there being between Operators, Manufacturers and Authorities a rapid and comprehensive flow of information from service experience, no system can be effective.

Operational Aspects of Safety

In view of the focus of interest of this Symposium, I have concentrated on helicopter airworthiness and allied safety matters but, before concluding, I should like to touch on some aspects of performance and - operational regulation of civil helicopters which are not without their implications for the vehicle and the engineering of it. Consideration of these matters is worthy of a paper in its own right.

It is apparent from some of the matters which I have already mentioned - ditching and human factors are particular examples - that no scenario for helicopter safety can be completely drawn without consideration of the operational aspects. It is one of these, the helicopter's unique capability to land on the surface at any time, which has over the years been probably the most effective counter to the helicopter's inherent reduced standards of mechanical reliability and this has helped to keep the overall safety standards at an acceptable level. As helicopter operations have become more sophisticated, so this special ability has become a less effective contributor to safety. For example, flight in instrument meteorological conditions over the often hostile North Sea means that the helicopter pilot cannot solve all his problems by carrying out an immediate landing.

In the United Kingdom we have countered this in a number of ways. Some are fundamental; our Operator Certification Scheme, with direct supervision of all public transport operations, and the Helicopter Pilot Licensing System ensure acceptable standards of competence of both Operators and Crews. More specific areas cover measures to control weather limits, flight crew fatigue and to introduce a requirement for aircraft performance standards.

In other areas our involvement in operational aspects reflects more directly on the airworthiness 'state of the art'. I have spoken already of ditching; the requirements to carry special flotation equipment, life rafts, quick-donning life-jackets are all part of the ditching problem. We are also studying the need for constraint on helicopter overwater operations to require that the helicopter should always have the ability to return to a land base should malfunctions occur which would preclude a landing on a small offshore helideck. Similarly, we see the need to look closely at the routeing of helicopters flying over built-up areas; there must be some ability to land quickly. All of this, of course, reflects the present state of the art.

There is, however, another aspect of the operational side of the helicopter business. Because of the unique flight capabilities of the machine, throughout the relatively short history of the civil helicopter operation the companies involved have had to operate outside the relatively settled, controlled infrastructure of conventional air operations, largely dependent on their own resources and often in true pioneering conditions. There has been to some extent a quasi-military approach to the whole job.

This has resulted in a tendency in the Industry to do its own thing, to resist the introduction of new regulations and practices which are intended to raise the safety standards of the Industry. It is, of course, difficult for any individual operator, in the particularly competitive atmosphere of the offshore section of the Industry, to take a softer line and to adopt standards which, while achieving significantly improved standards of safety, also significantly and adversely affect the company's competitive position. However, the step must be taken and there are now signs of groups of Operators in concert working with the Authority to introduce new measures. This must surely be the way to go.

The pragmatic approach to safety regulation which we have adopted to meet the special needs of the North Sea and which, let me repeat, has served the Industry well, cannot be the solution for scheduled passenger transport operations. To oversimplify, making the helicopter seaworthy cannot be a substitute for making it airworthy. If the helicopter section of Industry is

to take its proper place alongside its fixed-wing counterpart and we are to see helicopters with engineering integrity on a par with current aeroplanes operating side-by-side in controlled airspace from city centre to city centre, there must be acceptance of the operating standards and practices which have long been adopted by the fixed-wing sector. The target is there; it has been there for a long time but now, with new technology and a new spirit, it can become positively attainable. It is a very worthwhile objective.

The Future

In conclusion, I will try to summarise, from the point of view of the Authority, how I see the future of helicopters in this country:

- The future growth of helicopter operation will depend on the extent and nature of future energy exploration. It would also depend on the development of public transport operation for which the helicopter is suitable. I cannot forecast either of these developments, although the question appears to be how quickly, rather than whether or not, these developments will take place.

- Present helicopters will need to be phased out as they are overtaken by the need to make retrospective changes that may not be economical or even practicable (there are about 50 S61s in North Sea operation - a type which was certificated more than 20 years ago).

- The safety level of transport helicopters will need to be improved substantially for public transport operation. For scheduled, passenger transport, such improvement must be in airworthiness terms: ditching qualities and operational restrictions will not be acceptable as means of achieving overall safety.

- So far as the North Sea is concerned, the effective safety should be increased, but it may be that this can be achieved by methods (such as improving ditching performance) or operational restrictions that would not be acceptable in scheduled public transport operation.

- We are almost certain to see what has been called a 'North Sea package' that converts a conventional helicopter into one that meets safety targets in extreme North Sea operations.

- Unconventional helicopters may emerge for faster long range operation if the demand is created by remote offshore destinations or other fields of operation. However, it will not be possible confidently to demonstrate compliance with civil certification standards until substantial experience has been gained on novel features.

- Techniques are at various stages of development that are capable of overcoming what have been obstacles to increased helicopter airworthiness levels.

- Until recently, the helicopter has been regarded as a vehicle with unique capabilities, the price for which has been the acceptance that certain safety problems are intrinsic to it. Now the helicopter is capable of maturity. The problems are not insurmountable because techniques exist for overcoming them. The means by which these techniques will be handled, in the processes of design, manufacture, certification and operation, will emerge much more quickly and effectively with international collaboration between all those concerned.
