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AIR MINISTRY

Report of
the Committee of Inquiry into
CIVIL AVIATION
and the observations of
H.M. Government
thereon

*Presented by the Prime Minister to Parliament
by Command of His Majesty
March, 1938*

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COMMITTEE OF INQUIRY INTO CIVIL AVIATION

THE RIGHT HONOURABLE LORD CADMAN, G.C.M.G. (*Chairman*).

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OBSERVATIONS OF HIS MAJESTY'S
GOVERNMENT

ON

THE REPORT OF THE COMMITTEE
OF INQUIRY INTO CIVIL AVIATION

PART I

1. It is desirable that the report of the Committee of Inquiry into Civil Aviation should be accompanied by the observations of His Majesty's Government on the recommendations contained in the report, and their decisions on these recommendations.

2. The report of the Committee deals, as the Government intended that it should, fully and comprehensively with the problems of civil aviation. The Committee recognise, however, and the Government agree, that "the problem of the air is one—two sides of a single coin—and the military aspect of aviation cannot fundamentally be separated from the civil aspect." The Committee also recognise that from the operational aspect the association of military and civil flying in one Department of State is necessary to ensure the closest co-operation on questions of control, and to secure the maximum co-ordination of the requirements of British military and civil flying at home and abroad.

3. The unprecedented effort which the Air Ministry and the aircraft industry have recently had to make in the military sphere has necessarily created the impression, and to some extent produced the result, that civil aviation has received less attention than is right. Nothing could have been allowed to come in front of the prime duty of the Ministry to carry out the re-armament programme as fully and rapidly as possible. But the Government feel that it is now possible to make further efforts to assist civil aviation and substantially to improve its organisation.

4. It will be convenient in the first place to offer some general observations on the policy in regard to civil aviation which has been pursued by successive Governments.

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5. Following the Report of the Hambling Committee (Cmd. 1811) in 1923 the Government decided to promote the amalgamation of a number of companies into a single unit (Imperial Airways), to entrust to the company so formed the development of British air transport overseas and to give that company substantial financial assistance.

6. The aim was to help civil aviation to become self-supporting, so that in the course of time it might "fly by itself." Subsidies were therefore given for the routes which afforded the best prospects of economic development from the point of view of passenger and mail traffic.

7. Survey flights opened up the prospect of Empire routes ; and the possibility of developing air transport throughout the Empire offered new opportunities of linking the countries of the Empire in the common interest of all.

8. The Government therefore deliberately adopted a policy of concentrating on the development of Empire routes, and decided that the major part of the money available should be devoted to this purpose. Empire Governments and companies became associated with this development. This exploitation of Empire air routes led to the conception of the Empire Air Mail scheme, a development which was unique in the air services of the world.

9. The policy of Empire development has been consistently followed by successive Governments, and this concentration has meant that relatively little money was available to assist other services. As a result the Empire services to South Africa, India, and the Far East, with their subsidiary services, constitute approximately 90 per cent. of the route mileage operated by Imperial Airways ; these routes are served by "Empire" flying boats which are in the van of flying boat construction. All first-class mail is being carried to South Africa, India, and to the East without surcharge, and the system will be extended to Australia during the present year. All this has been accomplished, as the report shows, at rates of subsidy which compare favourably with the rates paid in other countries.

10. The Government are convinced that, from every point of view, the policy of concentrating on the Empire routes was right ; and they are of opinion that the maintenance and development of Empire routes must remain a first charge on the financial assistance which the Government are able to devote to civil aviation.

11. Concurrently with the development of Empire air routes, the Air Ministry has consistently followed the policy of developing new and experimental types of civil aircraft for transport purposes, and a number of successful types have been developed in this way.

12. It is now the intention of the Government to invite Parliament to approve still larger expenditure on civil aviation; and the extent and objects of such expenditure are stated later. It is right, however, that certain principles, to which the Government attach first importance, should be plainly stated.

First, financial considerations make it impossible to incur an unlimited liability on civil aviation, and the limits within which expenditure can be incurred must be clearly envisaged.

Secondly, in order that the available money may be spent to the best advantage, the Government consider that the decision between competing projects should be governed by two main considerations: first, the importance of maintaining and developing air communications within the Empire, and secondly, the importance of selecting at the appropriate time routes which afford the opportunity of substantial traffic and postal revenue and where important British commercial interests are concerned.

Thirdly, in deciding upon the ways in which the Government can best encourage the development and production of civil aircraft, the Government will seek the co-operation of the air operating companies and act in close consultation with Sir Charles Bruce-Gardner, the independent Chairman of the Society of British Aircraft Constructors, who has been appointed by the aircraft industry to represent the interests of the industry as a whole, and one of whose duties it is to promote the development of civil aviation.

PART II

Organisation of the Air Ministry

13. The Committee have made recommendations for strengthening the Department of Civil Aviation and for ensuring that the development of civil aviation is adequately planned and carried out. With this general intention the Government are in full accord, and they propose to make the following improvements in the organisation.

14. The Government accept the recommendation of the Committee that a post of Permanent Under-Secretary of State should be created. The holder of this post will, in addition to his other functions, exercise general administrative direction in civil aviation matters and will be charged with the duty of ensuring the full and constant correlation of the policies of civil and military aviation. In these duties he will, as recommended, have the assistance of the Director-General of Civil Aviation who, while retaining his right of direct access to Ministers and his responsibility for the executive measures necessary to carry into effect the policies decided upon by Ministers, will be thus fortified in the exercise of higher control and in the planning and initiation of policy.

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15. It is further proposed to add a Deputy Director-General of Civil Aviation who will relieve the Director-General of much of the day to day supervision of the working of the Department and will be charged particularly with the important function of finance. Under the present organisation financial negotiations are conducted through a separate finance division of the Secretary's Department, but the proposed correlation of duties under a Permanent Under-Secretary of State will enable a greater measure of financial and executive autonomy to be exercised within the Department of Civil Aviation.

16. The Government accept the view of the Committee that the technical staff concerned with research, development and production of civil aircraft should be strengthened, and it is proposed to create a post of Director of Civil Research and Production. The officer chosen for this appointment will be carefully selected for his technical and general qualifications; and he will be responsible to the Director-General of Civil Aviation for ensuring that the civil aspects of research, development and production are given full consideration. He will be provided with the necessary staff to enable him to carry out these duties, and he will work in the closest contact with the research organisation and establishments of the Air Ministry. He will also keep in constant touch with the aircraft industry.

17. Other additions to the staff will be made as may be necessary to enable the less important matters to be devolved, thus freeing the higher officers from the comparatively routine matters which inevitably occupy much of their time at the present stage of development. Any further assistance needed to enable the Permanent Under-Secretary to devolve work at present performed by the Secretary will also be provided.

18. The general effect of these proposals will be to carry into effect the Committee's intention to provide for closer co-ordination both within the Air Ministry as a whole and within the Department of Civil Aviation. In the higher direction and control the practice of regular progress meetings conducted by Ministers and attended by the principal departmental chiefs concerned will ensure a business-like review of outstanding matters from all aspects. Administrative direction and co-ordination in matters concerning civil aviation will be effected through the Permanent Under-Secretary of State who, both by the continuity of his appointment and his status within the Ministry, as well as through the functions he exercises on the financial and contractual side of the present production organisation, will be in a position to secure the necessary degree of correlation between civil and military requirements. The additions of a Deputy Director-General of Civil Aviation, and of a Director of Civil Research and Production should afford an effective measure of reinforcement.

19. The Government have noted the proposal that a second Parliamentary Under-Secretary should be created. They are still considering whether the purpose aimed at will be best achieved in this particular way, but have not yet come to a final decision.

20. The recommendations include one proposal affecting the duties of Members of the Air Council. It is suggested that the functions of the Air Member for Research and Development and also that part of the Department administered by the Air Member for Supply and Organisation which deals with the production of aircraft should be transferred to the Permanent Under-Secretary of State. The Committee approaching the matter from the point of view of civil aviation considered that such a change was desirable in order to secure continuity in directing the policy of aircraft research, development and production. The Government are satisfied not only that these changes would seriously interrupt the work of the Service side of the Air Ministry, but that they are not necessary for the purpose of giving the requisite help to civil aviation. So far as the interruption of the work of the Service side is concerned, the whole organisation is now working at the highest pressure on re-armament, and the far-reaching changes proposed in the allocation of duties among Members of the Air Council would prevent concentration on the most urgent tasks in hand. The Government are, moreover, satisfied that there is already a high degree of continuity in the existing organisation as the following examination of the structure of the Departments in question will show.

21. Taking first the Department of Research and Development, there is an extensive organisation which is largely civilian and permanent. The Director of Scientific Research is a permanent officer and a scientist of high repute. The scientific and technical establishments of the Air Ministry are staffed preponderantly by permanent civilian scientists and technicians. Furthermore, working closely with the Air Member for Research and Development and his Department are the Aeronautical Research Committee and other advisory committees of Scientists. There is also a close working relationship with other Government Research Establishments, with Universities and with private firms. Continuity of policy is, therefore, fully assured.

22. The chief function of the Department's research and experimental organisation is to provide the industry with fundamental data upon which the design of aircraft and equipment can be based. The research and experimental establishments, with which the design staffs of all great aircraft firms are in the closest touch, provide testing stations and a central laboratory for theoretical research.

23. Research and development cover a wide field of equipment of every kind besides aircraft and engines. Here again, it has always been the policy of the Air Ministry and its research establishments to

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work in the closest touch with manufacturers. Much of the work done by the Department is of a highly confidential character, and a number of secret inventions of the highest importance, put into production for use in the Air Force to-day, originated with members of the research staff. For obvious reasons of secrecy many of the most recent and important inventions and developments cannot be stated. But examples which can properly be cited include such inventions as the wireless-controlled aeroplane (the Queen Bee); remote control mechanism; automatic pilots; various discoveries in the treatment of metals; a number of developments in bombs; and wireless equipment of great lightness and efficiency. In all cases where an invention or development is made by the Department, the practice is to secure that the invention is put into production by a competent firm in the simplest possible form, the widest latitude being left to the firm on the production side.

24. The Government are, therefore, satisfied that research and development are in fact continuous and progressive. It is axiomatic that a very great part of research and development on the Service side is of immediate value and available to makers of civil aircraft whether it be in airframes, engines or equipment.

25. Turning now to the Department of Supply and Organisation, the production of aircraft is primarily the function of industry, the Ministry's part being to place the necessary orders and facilitate their execution. The Government take the view that the proposed transfer to the Permanent Under-Secretary of that part of the Department of the Air Member for Supply and Organisation which deals with the production of aircraft is not likely to produce a more efficient organisation. Although it is true to say that the supply organisation of the Air Ministry which concerns service aircraft, has met with difficulties, it has, on the whole, surmounted them. The original policy of the Air Ministry in placing orders for wholly new types without prototypes has been fully justified. The plan of the shadow factories has not only secured a reinforcement in production for the expansion programme, but has also provided capacity for war production.

26. The wide range of equipment required in addition to aircraft has been provided. In armament, instruments, power-operated turrets, variable pitch propellers, and many other items, arrangements, which have been in no way lacking in foresight, have been made. Generally speaking, the equipment position is satisfactory, is in line with the main programme, and arrears are being rapidly overtaken.

27. Having regard to the importance of not interrupting the rearmament programme at the stage which it has now reached, and in view of the Government's conclusion that it is not necessary in

the interests either of military or civil aviation to run any such risk, the Government do not propose to accept the Committee's proposal concerning the duties of Service Members of the Air Council.

28. There is another consideration of great importance which weighs with the Government. Not only does the existence of senior Air Force officers at the head of these Departments ensure the fullest Service experience and collaboration, but these officers are continually required to take decisions as regards the safety and operational use of aircraft which would be impossible, for anyone but a serving officer to take. These decisions require not only a knowledge of aircraft and the operational use to which they are put, but also of the effect such decisions are likely to have on the morale of the personnel; and a Service, where morale counts for much, has confidence in these decisions because they are taken by serving officers in whom they have confidence. It is right, therefore, that distinguished and experienced officers of the Royal Air Force should be at the head of these Departments—indeed, it is the reputation and authority of such officers which gives confidence and promotes morale in the Services, just as in the Admiralty distinguished and experienced Admirals are charged with corresponding duties for the Navy.

PART III

Other recommendations of the Committee

29. *Air Services and Operating Companies.*—The Government are in general agreement with the conclusion of the Committee (paras. 34-5), that steps should be taken to secure an expansion of civil air lines and for the purposes of such expansion the Government are prepared to recommend to Parliament that the statutory limit on the aggregate annual amount of subsidies payable to air transport companies should be increased from £1,500,000, as fixed by section 1 of the Air Navigation Act, 1936, to £3,000,000. The Committee have made a number of specific recommendations for the establishment of services on particular routes with additional help by way of subsidies. These will be considered in due course, but acceptance by the Government of the Committee's recommendation that increased subsidies should be paid is not to be taken as committing the Government to the grant of a subsidy to services on any particular route. In selecting routes the Government will be guided by the remarks set out in the opening paragraphs of this statement.

30. The conclusions and recommendations of the Committee with reference to the number of operating companies and the allotment of routes are accepted (paras. 36-42). In particular the Government

agree that the same external route should not be operated by more than one British company subject, however, to exceptions with a view to conducting services for special purposes (para. 37). Imperial Airways should, in the opinion of the Government, first and foremost be concerned with the development of the Empire Air Routes specified by the Committee (paras. 38 and 39). The Government agree that British Airways should in general develop the British air services in Europe and should operate experimentally to West Africa with a view to establishing ultimately a service to South America (para. 40). With regard to the London-Paris route, the suggestion of the Committee that the services of Imperial Airways and British Airways should be amalgamated under a single company is approved (para. 41). The title of Imperial Airways to be associated with "short-haul" services to France and Italy and with flying-boat services via Italy to Greece should in general be recognised, as recommended by the Committee (para. 42). The Government have ascertained that both Imperial Airways and British Airways are willing to accept the above conclusions and recommendations so far as they respectively are concerned.

31. The Government share the view taken by the Committee that the conveyance of air passengers in safety and comfort and of mail and freight has been achieved by Imperial Airways with considerable efficiency (para. 46), and they agree that the Company's record with regard to the safety of its services, as set out by the Committee (paras. 113-115), is an exceptionally good one. The Committee findings on the allegations of defects in equipment are all favourable to Imperial Airways (paras. 110-112). Nevertheless the Committee make certain recommendations (paras. 46-7) concerning the organisation and internal management of the Company with which the Government find themselves in agreement. One of these recommendations is that the responsibilities of Imperial Airways require a Chairman able to devote the whole of his time to the Company's business. The present Chairman is not free to give his whole time to the task. The Government have consulted the Company and have been informed that the Company welcome this suggestion, which is in accord with the views which they have held for some time, and that the appointment of a whole-time Chairman will in due course be made by the Board in agreement with the Government. The Government likewise agree that one or two full-time Directors should be associated with the Chairman. They accept the observations of the Committee concerning the duties of the Managing Director and they are informed that these observations will receive the attention of the Company's Board after its reconstitution.

32. The Government agree generally with the recommendation (para. 48) that British Airways should be organised in capital, direction, personnel and equipment on a scale appropriate to the increased responsibility which the Government agree that this Company should

assume. The Company have accepted this recommendation. As in the case of Imperial Airways the Government have approached British Airways regarding the appointment of a whole-time Chairman, and have obtained an assurance that this proposal also is acceptable to the Company. The Government are likewise in sympathy with the conception that British Airways should be a counterpart to Imperial Airways in carrying out British civil aviation policy overseas and that there should therefore be close co-operation between the two Companies.

33. *Dividends of Subsidized Companies.*—The Committee refer (para. 107) to the fact that Imperial Airways increased its dividend last year from 8 per cent to 9 per cent. The Committee point out, however, that during the early years of the Company's operation no dividends were paid and that over a period of 13 years (1924–1937) shareholders received, on an average, $4\frac{1}{2}$ per cent on their capital. In paragraph 118 of their report the Committee observe that it is incorrect to state that the dividend of 9 per cent in respect of the year ended 31st March, 1937, was paid out of an increased subsidy. There was, in fact, a reduction in subsidy for that year. During the last three years dividends have increased, while the subsidies have decreased, a result indicative of improved trading.

34. The proposal of the Committee (para. 108) to limit the dividends of subsidized air transport companies on the lines of public utility companies is associated with the acceptance of their other recommendations. The Government are in agreement with the principle underlying the proposal, namely, that public money should not be used for raising dividends to undue levels. This principle has, in fact, always been borne in mind by the Government, and in particular in their negotiations with Imperial Airways for the Empire Air Mail Agreement, but in doing so they have necessarily had regard to the Company's need to raise large additional sums of money from the public, and to the risks involved in an enterprise of this novelty and magnitude which may be held to justify the possibility of dividends at a higher rate than those customary in public utility companies as ordinarily understood. The Government will, however, consider in the light of the Committee's suggestion whether arrangements can be made, in connection with further assistance by way of subsidy, to give effect to this principle, without violation of existing contracts.

35. *Aircraft Industry.*—The Government accept the view of the Committee that British aircraft constructors should play a vigorous and creative part in the development of civil aviation (para. 49).

36. The Committee recommend State assistance to encourage the production of suitable types of air liners (paras. 52–57); that subsidised Companies should be given special grants to keep their

fleets equipped with new British aircraft (para. 60); that a programme of development for large aircraft for Empire and other long distance routes should be formulated (para. 61).

37. As previously stated, the Government propose to invite Parliament to increase the annual amount available for subsidy payments to operating companies, and in determining the allocation of the increased subsidy payments, special consideration will be given to the question of obsolescence and replacement.

38. The Government are also fully in agreement with the Committee as to the desirability of stimulating the development and production by the aircraft industry of suitable types of civil aircraft. It has in fact been the policy of the Air Ministry from the earliest days to encourage the development of new civil types, either by direct financial assistance or by their subsidy agreements with the operators. Provision has been made every year in the Air Estimates for the construction of experimental civil types or for research on such types, and it was in pursuance of this policy that the Air Ministry placed development orders for types such as the Argosy and the Calcutta, which subsequently went into commercial civil production. Following the report of the May Committee in 1931, it was necessary to reduce the financial provision taken for civil development, but substantial increases have been made in the provision taken latterly. In pursuance of this policy the Air Ministry have, for example, been able by placing direct orders to secure the development of the Albatross aircraft which is designed for work on the Trans-Atlantic service, and is also being purchased by Imperial Airways for their landplane services. The long-term programme which has already been announced, includes proposals for the development of two medium-sized civil types; for prototype aircraft for long-range flying for the development of express services; and for a design contract for a very much larger long-range aircraft of a type which will probably be required some years hence.

39. In addition to giving development orders of this kind, the Air Ministry have, by their subsidy policy, stood behind the development of such types as the Empire flying boat as they are now standing behind the new long-range flying boats which are being built for the North Atlantic service.

40. These facts show that the Air Ministry are in fact carrying out a long-range development programme on the lines contemplated by the Committee. The dual policy of direct development expenditure and of encouragement through the subsidised companies will be steadily pursued in future years.

41. The Government favour the suggestion (para. 62) that operational data of subsidised companies should be made available to constructors and consider that arrangements to this end might

best be made between the operating companies and the independent Chairman of the Society of British Aircraft Constructors. The Government understand that both Imperial Airways and British Airways will be prepared to co-operate on this basis.

42. *Compression-ignition Engines.*—The State has already contributed large sums of money in assisting the development of compression-ignition engines in this country. The Government agree with the Committee (para. 64) that assistance should continue to be given for this development.

43. *Research.*—The Government fully accept the view of the Committee that the technical staff and equipment connected with research and development should be maintained at the highest level (paras. 30 and 66). The technical and scientific personnel of the Air Ministry and of its technical establishments has been very greatly increased in the last few years, notwithstanding the difficulty of finding suitable staff at a time of great expansion of the aircraft and aero-engine industries. The Government agree with the Committee (para. 68) that research on icing problems is of the utmost importance, both from the point of view of the Service and Civil Aviation, and this research is being pressed forward as rapidly as the circumstances and conditions render possible.

44. *Maybury Committee Recommendations.*—Action has been, or is being, taken to give effect to these recommendations of the Maybury Committee on the Development of Civil Aviation in the United Kingdom which require Government action (para. 72).

45. *Petrol Tax.*—The Committee suggest (para. 77) that further consideration should be given to the question of the incidence of the petrol tax on internal air lines. This is a question which has often been considered in the past, but it has always been held, and the objection still holds good, that it would be impossible to grant a concession of this kind to the air transport companies without its giving rise to almost irresistible claims for similar concessions from other bodies which have from time to time pressed for relief from the tax. In effect, the concession would be a form of cash subsidy to the operating companies, but the Committee themselves, in paragraph 76, have agreed with the conclusions of the Maybury Committee that internal lines should not be subsidised. In the circumstances the Government feel that no useful purpose would be served by reviewing the question further.

46. *Aerodromes.*—The Committee suggest (para. 80) that the aerodrome position in this country should be reviewed in detail and a co-ordinated scheme prepared. A survey of requirements was prepared in the Air Ministry and used by the Maybury Committee. The Government accept this recommendation in broad principle on

the understanding that it is to be a basis of advice given to the local authorities, who must remain responsible for the provision of aerodromes, and not an implication that financial assistance from the Exchequer will be forthcoming for such provision.

47. The Government think it important that the rule that State grants should not be given for the construction or enlargement of aerodromes should be maintained. On this understanding the Government are prepared to make grants from the Exchequer, as recommended in paragraph 80, towards the capital expenditure necessary for the provision of full night-lighting equipment at certain main aerodromes, to be selected by the Air Ministry, which are large enough and otherwise suitable for night operations.

48. The Government agree with the remarks of the Committee (para. 86), that an adequate plan for the location and utilisation of London aerodromes as a whole is desirable, and they will continue to give all possible advice and encouragement to authorities wishing to establish aerodromes in the London area.

49. The Government accept the Committee's recommendation (para. 86) that a London Airport Committee representing the various interests concerned in the London airports should in due course be formed.

50. The Government agree with the view of the Committee (para. 86), that effect should be given as soon as practicable to the proposals of the Air Ministry for the improvement of the Croydon Airport. It will, however, be appreciated that major improvements, which would necessitate the temporary closing of the aerodrome, could not be carried out until sufficient other aerodrome accommodation is available.

51. The Committee comment (para. 88) on the lack of progress made in providing a suitable base for the Empire flying boat services. A site at Langstone Harbour was approved as suitable for development as an Empire Air Base; and a scheme was provisionally agreed between the Air Ministry and the Portsmouth City authorities on the basis that Portsmouth would develop the base assisted by a Government contribution. Last November, however, the Portsmouth City Council decided not to proceed with the promotion of the necessary Bill in Parliament. The Air Ministry in conjunction with other Government Departments concerned are actively engaged in considering alternative sites, including both Portsmouth and Southampton. A decision will be reached as soon as possible.

52. The Government take note of the representations with regard to customs facilities which have been made to the Committee (para. 92), and in accordance with the Committee's recommendation

they have given instructions that the arrangements for customs clearance at aerodromes should be reviewed by the Departments concerned.

53. *Operating Personnel.*—Imperial Airways have been informed of the opinion of the Government that the reforms recommended (paras. 103–105) by the Committee concerning the staff organisation and the relations between the Company and the employees should be taken in hand, and have notified the Government that they are in full accord with the reforms in question.

54. Imperial Airways have informed the Government that it is their express intention to review the rates of flying pay in consultation with their pilots or their representatives, and that they have already so informed their pilots (para. 121).

55. Allusion is made in paragraph 115 of the report to the question of the carriage of a sufficiency of petrol for particular journeys. The Government attach extreme importance to the strict observance of the statutory regulation on this subject. They are informed by Imperial Airways that the Company's instructions to its Captains of Aircraft provide that in addition to seeing that the loading of their aircraft is correct they are responsible that the aircraft have sufficient fuel, oil and water for the flight to be undertaken. The Government have received assurances from Imperial Airways that in this matter the discretion given to their Captains is never interfered with.

56. The Government agree with the view of the Committee (para. 122) that the interests of safety clearly require that pilots should not fly for a period which imposes undue strain upon them. The Government have been informed by the Company that their practice does ensure against excessive flying and have received from the Company particulars of the steps taken to ensure that the practice is fully observed.

TERMS OF REFERENCE

The Under-Secretary of State for Air made the following statement in the House of Commons on 24th November, 1937 :—

“ . . . No formal terms of reference have been given to the Committee, but my Noble Friend has written to the Chairman as follows :—

‘ I am most grateful to you for accepting the Chairmanship of the Committee which I have set up to inquire into matters raised in the recent Debate in the House of Commons. I do not think it is necessary to give the Committee formal terms of reference, as the scope of the inquiry was clearly stated by the Under Secretary of State in the course of the Debate. While broad question of principle on which the policy of the Government has been fully explained to Parliament would not fall to be reviewed by the Committee, I should wish the Committee to exercise the fullest freedom in examining any matters raised in the Debate whether affecting the Air Ministry or Imperial Airways ; and I think the Debate itself affords the most convenient terms of reference. The Under Secretary stated that I should discuss with the Government Directors of Imperial Airways the system employed by the Company in dealing with its staff, including the methods by which pilots and others are enabled to have their grievances or representations fairly considered. It is my intention to discuss this with the Government Directors. At the same time I should very much value the opinion of your Committee on this matter, and I should therefore be much obliged if you would treat this question also as included in your inquiry.’

My Noble Friend wishes me to add this : He realises that there were possibly several hon. Members who desired to raise certain points during the Debate, but could not do so in the short time available. He would, therefore, welcome the Committee dealing with questions not specifically raised in the Debate, provided that they have not already been settled by existing Cabinet decisions. The Committee have been informed that they are at liberty to discuss such questions.”

NOTE

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To : THE RIGHT HONOURABLE VISCOUNT SWINTON, G.B.E., M.C.,
Secretary of State for Air.

MY LORD,

You appointed us on 30th November, 1937, to inquire into the matters raised in the course of the debate on British civil aviation in the House of Commons on 17th November.

2. You did not give us formal terms of reference, because the scope of the inquiry had already been clearly stated by the Under-Secretary of State for Air in the course of the debate. Your wishes were amplified in a letter dated 22nd November to our Chairman and in a reply by the Under-Secretary of State in the House of Commons on 24th November.

In sum, our reference required us to investigate :—

(A) Charges of inefficiency in the Air Ministry and Imperial Airways, Ltd. ;

(B) The present state of British civil aviation, particularly in Europe ;

(C) The system employed by Imperial Airways for dealing with its staff (in supplement to the discussions between the Secretary of State and Government Directors of Imperial Airways) ;

(D) Other questions not specifically raised during the debate.

The following were excluded from our consideration :—

(a) Broad questions of principle on which the policy of the Government has been fully explained to Parliament ;

(b) Matters dealt with by the Committee under the chairmanship of Sir Henry Maybury on the Development of Civil Aviation in the United Kingdom ;

(c) As regards Imperial Airways—specific grievances of the staff and of individual pilots.

3. We have, between 2nd December, 1937, and 4th February, 1938, held 30 meetings. We have received oral and written evidence from a considerable number of witnesses, whose names are shown in Appendix A.

We are grateful to all who have assisted us in this manner, and should like, in particular, to express our indebtedness to the Air Ministry for the immense amount of detailed information which has been put at our disposal, and to Imperial Airways for their readiness to facilitate our inquiry in every way.

4. We have also had the advantage of studying the speech made on 20th December, 1918, by the then Secretary of State for Air, Lord Weir.

5. In the course of our investigation we have covered all the points of substance raised in the debate and certain others subsequently put forward to us. In the belief that a settlement of large issues will automatically cure many matters of less importance, we have not reported on all of the latter which have been brought before us.

6. Our report falls into two parts. In the first part we have considered the major (and closely associated) problems of the policy and organisation of the Air Ministry, the development of air services and the production of civil aircraft. These transcend in importance the other points raised in the debate.

In the second part we have reviewed certain related questions of air operation, organisation and administration.

PART I

MAIN PROBLEMS

The position to-day

7. The debate in Parliament revealed a genuine apprehension that, except on the Empire routes, this country is backward in civil air transport.

We consider that there is reason for more than apprehension. Indeed, we view with extreme disquiet the position disclosed by our inquiry.

If, as we assume, the Government desire this country to take a leading place in civil aviation, much reorganisation and additional expenditure of public money will be necessary.

Internal Air Transport

8. The Maybury Committee on internal air transport reported just over a year ago and, although some progress has been made towards the reorganisation which they envisaged, the picture, as disclosed to us, remains virtually as black as they then painted it.

European Services

9. In Europe the mileage of the routes flown all the year round by the premier British subsidised company is, for reasons given in paragraph 13, less than it was before that company was formed fourteen years ago. Moreover, the company is now operating with obsolete aircraft.

On the new subsidised lines to Scandinavia and Germany, operated by British Airways, it was found necessary to employ foreign aircraft, a course which has been damaging to our manufacturing prestige.

British mails to Switzerland are being carried entirely in foreign machines, and the assistance of the Belgian air-line company has been invoked for the conveyance of air mails to Belgium.

Other Services

10. Further afield severe foreign competition is developing on the North Atlantic air route ; air services to the West Indies and across the Pacific are the uncontested monopoly of an American company ; there is no British air line to South America—a route which has been operated for several years by French and German companies, to which heavy payments (amounting in 1937 to some £100,000) are made by the Postmaster-General for carrying British mails.

National prestige and trading considerations alike call for British air services on all these routes.

Aircraft

11. There is not to-day a medium-sized air liner of British construction comparable to the leading foreign types. The fears expressed to the Air Ministry by the Society of British Aircraft Constructors in 1923—that an operating policy which disregarded aircraft development and production would adversely affect British design—have, unfortunately, proved to be well founded. In consequence, foreign manufacturers—American in particular—not only dominate the European market, but have gained a firm footing in the Dominions, a position which national and Imperial reasons alike make it important to retrieve.

Past Policy

12. Responsibility for the defects to which we call attention in the course of this Report cannot be attributed solely to the present Administration.

13. A brief historical review of British air services to the Continent, furnished to us by the Air Ministry (Appendix B), enables the circumstances of the origin and development of these services to be seen in proper perspective.

The original purpose of the creation of Imperial Airways in 1924, and of the endowment of that Company with a monopoly of subsidy, was to secure the establishment and progressive development of British air services in Europe.

Three years later, however, a fundamental change of policy followed the successful inauguration of the Cairo-Basra service as the first step towards an Empire air service. The Government decided in 1927 to concentrate upon developing the great Imperial routes, in particular those from England to India and South Africa, and to restrict operations in Europe to the more remunerative routes.

14. The restrictive policy of 1927 was apparently not reviewed for eight years—until, in fact, an Inter-Departmental Committee to advise on International Air Communication was appointed in 1935, under the chairmanship of Sir Warren Fisher.

During this period, which witnessed great progress in aeronautics, foreign companies, with liberal financial assistance from their governments and without great regard for economy, were creating an elaborate network of air services throughout Europe. In the meantime, although subsidies for British services were concentrated on Imperial Airways, the Air Ministry's contracts with that Company provided solely for the operation of specified services. They neither supported nor encouraged the development of new routes. The essential stimulus to expansion was, therefore, entirely lacking. Moreover, a state of inertia was perpetuated by the fact that the total amount made available for all civil aviation purposes in the Air Votes was for a number of years restricted to £500,000, from which a wholly insufficient balance was left after the requirements of the expanding Empire Service had been met.

15. In 1935, the Inter-Departmental Committee, mentioned above, recommended that action in Europe was imperative. A British subsidised service to Scandinavia was in consequence improvised. As, however, there had been no planning by the Air Ministry during the previous period, the selected company had to press into service the best type of British aircraft immediately available. In addition to being inferior to machines employed by competing foreign lines, this type of aircraft proved to be unsuitable for that work. It was, therefore, withdrawn from use, and, since no other British aircraft were available, foreign machines were purchased and are still in service.

We are surprised to learn that, although the relevant contract with Imperial Airways is due to expire in little more than a year's time, there is as yet no decision by the Air Ministry on future policy concerning British air services in Europe.

16. Aircraft operation and construction seem in the past to have been treated as separate and distinct questions, not as related elements of a single problem.

There has been no consistent and progressive policy directed to encourage manufacturers to produce civil aircraft of types likely to secure a prominent position for the British industry in European and Dominion markets.

The subsidies paid to Imperial Airways were not conceived with any regard to civil aircraft construction, and the operations of that Company, which has viewed itself as an ordinary commercial company trading in transport, have not encouraged the development of types other than those designed for its own special needs.

The present demand for modern high-speed all-metal air liners of medium size has laid bare the defects of past policy.

The Remedy

17. How can the position be remedied ?

It seems to us that four elements in civil air transport must now be closely associated and co-ordinated if successful development is to be assured. They are :—

(a) The machinery of government—initiating policy, taking a forward view, considering the international implications of civil aviation, promoting the establishment of air lines and civil flying, stimulating the development and production of aircraft, conducting the necessary international and inter-Imperial negotiations, and exercising such control as will safeguard the public ;

(b) The aircraft operator—giving practical effect to the governmental policy by developing air transport with energy and foresight in a manner which will uphold the national prestige and national interests in all parts of the world ;

(c) The aircraft constructor—producing aircraft and equipment which will satisfy the requirements of the British operator, outrival competitors in the world markets, and enhance our reputation as a manufacturing nation ; and

(d) The provision of essential ground organisation—to which some reference is made in the second part of this Report.

The Air Ministry

18. On behalf of the Government, the Secretary of State for Air is directly responsible for the development of both military and civil aviation ; it rests with him to ensure the form of departmental organisation and the selection of men best equipped to fulfil this purpose.

19. We are convinced that far-reaching changes in organisation and outlook are required if the Minister's extremely heavy task is to be effectively discharged, and we recommend re-organisation on the lines described below.

In our view the problem of the air is one—two sides of a single coin—and the military aspect of aviation cannot fundamentally be separated from the civil aspect.

20. The Department of Civil Aviation is now constituted as an administrative and regulative body, and the higher staff is too much taken up with routine matters. Numerous schemes of development at home and abroad, consequent upon the recent adoption of a more liberal financial policy towards civil aviation, are severely taxing the Department, and it is finding it difficult suddenly to recruit new staff adequately trained to deal with so specialised a subject.

21. There must be much more virility in the initiation of policy and in forward planning. Operators and constructors alike stress the necessity for longer views and for speedier decisions on Governmental policy. The higher control of the Department must be strengthened.

22. We think that the Minister should be assisted by a second Parliamentary Under-Secretary of State, whose sole concern would be civil aviation. (We understand that statutory authority would be required to give effect to this recommendation.)

Under the direction of the Secretary of State and in close association with the Civil Aviation branch of the Air Ministry, the new Under-Secretary should define Governmental policy and constantly review its application. His personal contact with the Secretary of State would ensure that military exigencies did not relegate civil aviation to the background. In the House of Commons he could answer for his subject from first-hand knowledge, and thus afford relief to the present Under-Secretary of State, who must in existing circumstances be so engrossed in the ever-changing details of military and civil aviation that he can find little time to participate in the promotion of either.

23. It devolves upon the Secretary of State to stimulate the development of research and design and the production of civil aircraft, to encourage suitable organisation of the aircraft industry, and to settle a far-reaching Governmental policy which will secure our pre-eminence in this new industry.

This responsibility appears to have been neglected in many respects; although shortage of funds may have contributed to this result, we regard the defects in the Air Ministry organisation as the primary cause.

24. Under the present organisation it is the responsibility of a military Member of the Air Council, a Royal Air Force officer of high rank, to advise on all problems of research and development in aviation. This officer is appointed generally from a Royal Air Force Command, and, after serving in the post for a short regulation period, is in due course transferred to another Command or some other employment of a military character. A military officer temporarily occupying this post would doubtless be the last to claim any special technical knowledge qualifying him to advise on research and development problems, and he must obviously rely in his turn upon the advice given by his subordinates. There can, of course, be neither the continuity nor the experience required for an efficient policy of aviation development and research under such a system.

25. Likewise in the case of production, the Member of Council responsible under the existing organisation is a military officer also appointed for a short period. Here again, however distinguished an individual officer may be, the problems of aircraft production on a

large scale are, with modern processes, so specialised that it is contrary to all sense to expect a military officer without previous knowledge and experience of such matters, and holding office for a limited term, to deal effectively with the situation. Parenthetically we would remark that, unlike his colleague for research and development, the Member for Supply is apparently not concerned with the civil problem which is regarded as entirely outside his purview and that of the Directorate of Aeronautical Production. The supply of civil aircraft would, therefore, seem to be nobody's baby.

26. Such a system is quite unsuited to the rapidly developing technique of the problems of aeronautics, which is still in its infancy. It may, indeed, account for many of the difficulties in meeting the present demands for equipment for the Royal Air Force, and it cannot be adapted with any prospect of success to the promotion of civil aviation.

27. If civil aviation is to remain a charge of the Air Ministry and, for reasons explained below, we think that for the present it should, there must be continuity in directing the policy of aircraft research, development and production.

This continuity can only be achieved by transferring the task from transitory military Members of Council to a permanent officer of the Air Ministry, of Council rank, not necessarily a technician, but possessing high ability, energy and proved capacity for organisation. Such a change is essential for the efficiency of both military and civil production.

28. For this purpose we recommend the creation of a post of Permanent Under-Secretary of State for Air, who (in addition to the present duties of the permanent Secretary) should assume control of the Department at present administered by the Air Member for Research and Development, and also of that part of the Department administered by the Air Member for Supply and Organisation which deals with the production of aircraft.

This would involve the delegation of many of the Secretary's existing duties.

29. The Permanent Under-Secretary of State, who would thus be entrusted with defined and continuing responsibility to the Secretary of State in connection with aircraft production as a whole, would further be charged to see that the policies of civil and military aviation were constantly correlated, in which duty he would on the civil side have the assistance of the Director-General of Civil Aviation.

30. In connection with the production of civil aircraft it would be necessary for the Permanent Under-Secretary of State to ensure that the Directorate of Aeronautical Production (which would be under his immediate control) dealt with the civil, as well as with the military, aspect, and for this purpose an additional Director would probably be needed. Considerable strengthening of the technical staff concerned with research and development is also essential.

31. It will be convenient if we bring together into a single paragraph the practical suggestions we have just made for reforming the Air Ministry. These are :—

(1) The creation of a second post of Parliamentary Under-Secretary of State who will devote his whole time to the problems of civil aviation (paragraph 22).

(2) The creation, in place of the permanent Secretaryship of the Air Ministry, of a post of Permanent Under-Secretary of State and the transfer to this permanent Member of the Air Council of the duties in connection with aircraft research, development and production hitherto allotted to the third and fourth military Members of the Council (paragraphs 27 and 28).

(3) The reinforcement, under this Officer, of the Directorate of Aeronautical Production, as also of the Directorates of Scientific Research and Technical Development (paragraph 30).

(4) The correlation by this Officer of the policy of civil with that of military aviation, and the strengthening of the Department of the Director-General of Civil Aviation (paragraphs 29 and 21).

(5) The relief of this Officer by substantial delegation of the duties hitherto allotted to the Permanent Secretary of the Air Ministry (paragraph 28).

32. With the organisation of the Air Ministry thus reformed, we are satisfied that the question of transferring civil aviation to another Department of State need not arise for so long ahead as we can see.

Moreover, until aeronautical technique has emerged from its present embryonic stage, knowledge and experience gained in the development of military and civil equipment must be pooled to solve the problems of each, and the services of research and experimental establishments must be made equally available.

From the operational aspect, the association of military and civil flying in one Department of State is necessary to ensure the closest co-operation on questions of control, particularly in view of the increase of air activity within the United Kingdom. That association is also necessary to secure a maximum co-ordination of the requirements of British military and civil flying at home and abroad.

Internal Air Services

33. The question of the development of internal air transport in this country was considered by the Committee under the chairmanship of Sir Henry Maybury, which reported to you in December, 1936.

We have not, therefore, inquired into this important aspect of civil aviation, but have later (paragraph 72) referred to the steps taken to give effect to that Committee's recommendations.

International Air Services

34. In international civil aviation, considerable effort and expenditure will be required if our position is to be fully secured. We consider that national prestige and the interests of British civil aviation require that first-class air services, financially assisted by the State as necessary, should be established between London and all the principal capitals of Europe, and that, in particular, a day service to Berlin should be inaugurated with British aircraft as soon as possible. For the same reasons every effort should also be made to expedite to the utmost the inauguration of the proposed service to South America. In addition, plans should be prepared for the development of other routes for air services, including the West Indies and the Pacific. The dictum that "trade follows the flag" will be found to hold good in this new form of transport, as it has in older forms.

Subsidy Limit

35. We understand that under the Air Navigation Act, 1936, a limit of £1½ million has been imposed on the aggregate amount of subsidies which may be paid in any financial year, and that actual and prospective commitments leave little or no margin for the developments which we suggest. In our view the position does not brook delay, and Parliamentary sanction for the further sums necessary should be promptly sought.

We emphasise that British civil aviation cannot compete with subsidised foreign aviation unless it is comparably subsidised.

Operating Companies

36. We feel that, if our national prestige is to be maintained, our external air services must be concentrated in a small number of well-founded and substantial organisations, rather than dissipated among a large number of competing companies of indifferent stability. Subsidised foreign lines will provide all the competition necessary to stimulate improvement in services and equipment.

37. We consider that the same external route should not be operated by more than one British company, and that, as recommended by the Maybury Committee in the case of internal air services, some measure of restriction should be applied to avoid indiscriminate competition. We except services conducted for special purposes (such as services for goods only), which the company selected for the operation of a particular route may not be in a position fully to develop.

38. By virtue of a fifteen-year agreement recently concluded with the Air Ministry, Imperial Airways have been entrusted with the operation of the Empire air routes to Africa, India and Australia

and of various branch lines, as, for instance, to Hong Kong. They have also been selected to participate in the development of the North Atlantic service in association with Dominion partners, and they will presumably play an important role in connection with proposed services in the Tasman Sea and eventually the Pacific, likewise in conjunction with Dominion enterprise.

39. It seems to us that this Company should first and foremost concern itself with the development of these services, the efficient conduct of which imposes on its shoulders such a heavy responsibility to the State, and that, in order to avoid overburdening it, the operation of routes elsewhere should, in general, be entrusted to another organisation.

40. We think, therefore, that, subject to our remarks below, the British air services in Europe should be developed by British Airways, which since 1936 has been the second chosen instrument of the Government for air transport. This Company is already, under subsidised arrangements, running a day service to Scandinavia and a night mail service to Berlin, and it has been selected to operate experimentally to West Africa with a view to establishing ultimately a service to South America. It also runs an unsubsidised service to Paris.

41. We think, however, that the large traffic potentialities of the London-Paris route, on which both companies now have well-established services (Imperial Airways carrying approximately four-fifths of the total passenger traffic of the two companies), single it out for special treatment. We suggest, therefore, that the services of each company on this route should be amalgamated under a single company with pro-rata shareholding, to which such subsidy as may be appropriate would be paid.

This course would recognise the interests of each company in the service, and yet avoid the position which invoked justifiable comment in the debate, that two subsidised companies were operating the same route.

42. As Imperial Airways are required on the Empire service to traverse France and Italy, its title to be associated with "short-haul" services to those two countries should in general be recognised, and this should also be the case with flying-boat services via Italy to Greece.

Imperial Airways

43. The debate in the House directed our special attention to Imperial Airways' relations with the Air Ministry, its dealings with its staff and its internal management. We have given very close consideration to these matters, and are profoundly dissatisfied in regard to them.

44. The relations between the Air Ministry and Imperial Airways were defined by the Hambling Committee in 1923 in the following terms :—

“ In the first place, we desire to make it clear that we do not recommend the creation of a Corporation or Company administered under Government control, but of a commercial organisation run entirely on business lines with a privileged position with regard to air transport subsidies, on terms and conditions to be defined later. . . . The Government should not exercise any direct control over the activities of the Company, other than by the appointment of Directors, except for the purpose of such checking as may be necessary to determine the amount of subsidy payable and except for such control as may from time to time be exercised by the Government through the Civil Aviation Department over all civil flying in the country.”

These recommendations were adopted, and have, we understand, governed the relations between the Department and the Company since its inception.

45. This policy can be maintained only on the clear understanding that, in view of the international and Imperial problems involved, there shall be the closest liaison between the Company and the Air Ministry. As a chosen instrument of the policy of the Government, the Company must be fully and promptly informed of all proposals which concern it. On its part the Company must continually be ready with information, advice and suggestions on the best means of giving effect to these proposals, and must frankly disclose its own plans and projects and the means contemplated for their execution.

46. Although the carriage of air passengers in safety and comfort, and the conveyance of mails and freight, have been achieved by Imperial Airways with considerable efficiency, we cannot avoid the conclusion that the management of Imperial Airways has been defective in other respects. In particular, not only has it failed to co-operate fully with the Air Ministry, but it has been intolerant of suggestion and unyielding in negotiation. Internally its attitude in staff matters has left much to be desired.

It appears to us that the Managing Director of the Company—presumably with the acquiescence of the Board—has taken a commercial view of his responsibilities that was too narrow, and has failed to give to the Government Departments with which he has been concerned the co-operation we should have expected from a Company heavily subsidised and having such important international and Imperial contacts.

There should, in our opinion, be an immediate improvement in these respects, and this may well involve some change in directing personnel.

47. We further consider that the responsibilities which now confront the Company have increased to the point that they can no longer be borne for practical purposes by a Managing Director.

In our view, the Chairman of the Company should be in a position to give his whole time to the direction of the business, and should do so. We think the Chairman should personally control the management of the Company, and he should be aided by the services of one or more other whole-time Directors.

We particularly stress the appointment of a whole-time Chairman, because, apart from the many directorial duties which will fall to him, close personal intervention on his part is immediately necessary to restore the mutual confidence and goodwill which have been seriously prejudiced but are essential in the relations of the management to Government Departments, the Company's staff and outside organisations.

48. As regards British Airways, the extension of its activities would necessitate its being organised in the matter of capital, personnel and equipment on a scale appropriate to the large responsibility which we recommend should be given to it. We conceive this Company as a counterpart to Imperial Airways in carrying out British civil aviation policy, and there must be close co-operation between the two companies.

As in the case of Imperial Airways, we think that British Airways should also have the services of a whole-time Chairman and one or more whole-time Directors.

Aircraft Industry

49. Reorganisation of the Air Ministry and development of air services will be of no avail in the promotion of the British civil aircraft industry unless British constructors themselves play a vigorous and creative part in the common effort.

50. Other countries have gained the initiative in civil aircraft construction, and British constructors, with lucrative military orders ready at their doors, have shown little disposition to embark upon the costly venture of producing modern civil machines in a speculative attempt to re-enter the lists. Without prospective orders, they cannot in particular bear the heavy initial expense which must be incurred before manufacture can commence. Construction thus waits upon demand, which it must itself create—a vicious circle.

51. The dimensions to which the world's aircraft construction industry may develop cannot be foreseen to-day. We consider it most important in the public interest that British constructors should take a leading part in it. We are convinced that in the long run their ultimate prosperity will rest less upon demands for military, than for civil, types. In this connection, we note with interest that

the recently appointed Executive Chairman of the Society of British Aircraft Constructors, is, *inter alia*, to concern himself with the well-being of the industry in the development of civil aviation and the export trade. We commend, in particular, to his attention the desirability of bringing about a considerable measure of reorganisation in the industry.

52. We believe that this country is fully abreast of others in the technique of military design. By similar concentration upon the design and production of civil aircraft, it should be possible in a relatively short time to put things right in that sphere also. But, as it takes two years or more to produce a new type, there is no time to be lost.

We consider that at the present juncture some form of State assistance would be justified as a stimulus.

53. We have received suggestions that the offer by the Air Ministry of a prize for the design of new types would be a suitable form of encouragement to constructors. We do not favour this proposal, which would immobilise the design activities of the competing firms, and cause fruitless expense to all but the prize-winner.

54. Without desiring to be dogmatic on this difficult question, possibly involving technical factors which none but experts are able to assess, we offer for consideration the following suggestions.

55. The Air Ministry should form an advisory panel comprising representatives of operators, constructors and the Ministry itself. With the collaboration of this panel and in the light of information regarding the probable requirements, two years ahead, of aircraft in Europe and the Dominions, the Air Ministry should specify broadly the requirements of a limited range of types of suitable air transport aircraft, and should ascertain which constructors would be interested in the production of these types.

From among the interested constructors, the Air Ministry should select a limited number, who would be requested to submit detailed designs, the reasonable costs of which would be reimbursed. The most suitable design for each type would then be selected by the Air Ministry in consultation with the panel; and account would be taken also of the manufacturing capacity of the designing firm and the price at which it would sell the aircraft. The Ministry would undertake to bear the cost of the jigs and tools necessary for the production of the aircraft of each design.

We do not contemplate that either the panel or the selected constructors should necessarily be restricted to the Air Ministry's list of "approved" firms.

56. In order that the prototypes should be thoroughly tested before being put into production, the subsidised operating companies should, with due regard to their business, be required to test them

under normal conditions of service. In addition to enabling final improvements to be made, these tests would demonstrate the products of the British construction industry in places overseas. When machines representing a definite advance in operating technique had thus been produced and shown, the sales organisations of the constructing companies would doubtless do their part by securing orders for them.

57. In the event of the aircraft being commercially successful, the State should obviously be entitled to recover the whole or part of its contribution to design and manufacture. We suggest, therefore, that in this event a proportion of the sums paid should be refunded by the constructor in respect of each aircraft sold in excess of a pre-determined number.

58. The State assistance to the construction industry, which we have suggested in the previous paragraphs, should be a reasonable supplement to commercial enterprise, and should enable aircraft of an advanced design to be offered at prices competitive with those of foreign makes.

59. Although the foregoing procedure applies particularly to the stimulation of British aircraft construction to meet present requirements, we consider that the necessity for timely development of future types must continuously be borne in mind, and it may well be essential to continue, for some time to come, the State assistance we have recommended.

60. The restoration of British prestige in civil aviation and the promotion of the aircraft industry are among the prime reasons for subsidising air services in Europe. We consider that, to assist in demonstrating in that area the quality of up-to-date British products, special grants should be made, where necessary, to the operating companies, to enable them to replace their fleet with new aircraft before its normal obsolescence period has expired.

61. The replacement of the large aircraft designed specially for the main overseas services and long distance routes presents a similar problem. It is essential to formulate a specific programme of development for these aircraft, which will ensure that the operating companies are at all times using aircraft that are in the van of aeronautical progress. This will, in particular, secure progressive development of large type flying boats.

62. The need for exchange of information between manufacturing and operating companies has been stressed by the former, who state that lack of operational data handicaps them in producing aircraft to meet the requirements of air transport.

With the object of advancing the design and performance of British aircraft, close co-operation between constructors and operators is highly desirable in the interests of each, and steps should be taken

to ensure that as much technical information as possible concerning the operations of the subsidised companies is put at the disposal of the British aircraft industry.

Engines

63. So far as the petrol engine is concerned, the position of the British industry appears to be fairly satisfactory, and no difficulty should be experienced in keeping pace with aeronautical design. Here again, however, it is important that, if British civil engines are to hold their own with foreign makes, constructors shall see to it that the requirements peculiar to civil aviation (such as high power at "take-off") are studied and met.

64. Although recent advances in petrol engine design and the use of high octane fuel have given this type a very definite lead over the compression-ignition engine for military purposes, we feel that the development of the latter type should be actively pursued with a view to its eventual use in the large civil flying boats and landplanes intended for operations over long distances. Development grants from the Air Ministry could usefully be made with the object of producing within the next five years a compression-ignition engine representing a considerable advance in design and power on any engine of foreign make now in the market. The time is ripe for this action.

Research

65. Progress in design and construction is essentially dependent upon research.

It has been suggested to us that in the past most of the research undertaken by the Air Ministry has had a military bias. The re-organisation which we have recommended should ensure that civil research work is given due prominence in future.

66. Commercial competition among constructors will always be an incentive to them to prosecute research to the greatest extent possible, particularly for the solution of practical difficulties. But the industry must be able to rely upon State institutions for assistance in matters beyond the compass of individual firms and in the solution of general aeronautical problems. The equipment and staff of State experimental and research establishments must, therefore, be maintained at the highest level.

67. We think that sufficient funds should always be made available in Air Votes to enable the investigation of important problems to be speedily carried to a conclusion.

68. A case in point is the icing problem, to which considerable prominence has rightly been given, in view of the peril which ice accretion presents to all-weather flying.

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We have paid particular attention to the available evidence on this subject, and reproduce, as Appendices C and D, memoranda which the Air Ministry have prepared for us. The prevention of ice formation presents, we understand, not one problem, but a large number, affecting respectively the engines, airscrews, instruments, wireless equipment and the air frame itself. Research into this problem must be prosecuted with the utmost vigour.

69. We have been informed in evidence that this country is not keeping pace with the United States of America in developments of importance to civil aviation, such as pressure cabins, automatic blind-landing equipment, anti-static electricity devices, aircraft instruments and research into problems concerning the application of wireless to aviation purposes.

The Air Ministry should, therefore, make every effort to emulate the progress being made elsewhere in such matters, and should also in this connection consider whether the present conditions under which instruments are manufactured are best calculated to encourage development.

70. Special attention should, we think, continually be paid to lines of research which will make flying safer. For instance, it would be beneficial if the landing speed of air liners could be reduced without impairing performance in other respects. Indeed, unless a limit can soon be put to the size of aerodromes, considerations of cost may prove a serious handicap to further progress.

PART II

OTHER QUESTIONS

71. The questions considered in this second part of our Report, although subsidiary to the problems discussed above, are in many cases of considerable intrinsic importance. They do not lend themselves to arrangement in a logical sequence.

Internal Air Operations

72. It was announced on 1st March, 1937, that the recommendations of the Maybury Committee on the development of civil aviation in the United Kingdom had been fully considered by His Majesty's Government, and that those which involved action by the Air Ministry had been approved in principle.

As the result of our inquiry into the position resulting from this announcement, we would urge that the Air Ministry should use every endeavour to speed up its action on the recommendations of that Committee.

73. The internal air line companies are gradually coalescing into a number of groups, to the benefit both of their prospects and services to the public. Railway interests have participated in some of these mergers, a fact which gave rise to adverse comment in the debate.

Railway Air Lines

74. We consider that the railway companies are making a useful contribution to civil air development. While they are no doubt influenced by consideration of their own interests, the evidence is that they have provided capital and experience in a proper and constructive manner under the authority of powers conferred on them by the several Railway (Air Transport) Acts of 1929.

Fears have been expressed that the railway companies may crush smaller air operators, and then proceed to stifle internal air transport. Section 10 of the Acts, however, seems to us to afford adequate safeguards :—

“ 10. If the Secretary of State for Air is at any time of opinion that the interests of the public as regards the development of air transport or otherwise are prejudicially affected by the exercise of the powers of this Act he may give to the Company notice in writing thereof and of the reasons upon which that opinion is founded and may direct a public inquiry to be held at which all parties whom he considers entitled to be heard shall be given an opportunity of being heard. If after such inquiry the said Secretary of State shall still be of the said opinion and the Company shall not within such period as he may direct make provision to his satisfaction for the protection of the interests of the public then the said Secretary of State shall report to both Houses of Parliament.”

Booking Facilities

75. We have taken evidence on cases of refusal by the Railway Clearing House to afford booking facilities to certain air transport companies. We have ascertained that, with one important exception, this matter is being satisfactorily solved. The case now outstanding involves certain political aspects which, we understand, you have under consideration at present.

Assistance to Internal Air Lines

76. We cannot support proposals put before us that internal air lines should be subsidised. The reasons which necessitate subsidies to British air services competing with foreign subsidised undertakings do not apply here.

77. The suggestion that internal air lines should receive relief from the petrol tax has been put to us. This suggestion, which is not a new one, involves fiscal considerations which have previously led

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His Majesty's Government to reject it. In view of the fact, however, that this tax bears far more heavily on aviation than on motor transport, owing to the much higher powered engines necessarily employed, with correspondingly increased fuel consumption, there is, in our opinion, justification for re-examination of the matter.

78. We have received representations from two sources concerning British air services to Eire. It is clearly not in the public interest that the institution of a London-Liverpool-Dublin service and other air connections between the two countries should be unreasonably prevented or delayed, and we think that every effort should be made to find a satisfactory solution of the difficulties as soon as possible.

Aerodromes

79. The whole subject of the provision of aerodromes in this country was fully examined by the Maybury Committee. Our consideration of the question is limited to the Air Ministry share of the responsibility for the present position of aerodrome owners.

80. We are in entire agreement with the wisdom of the policy urged on municipalities of reserving suitable sites for aerodromes, with an eye to possible future developments of air transport.

We find, however, that sites have been approved by the Air Ministry, and aerodromes have been fully developed by municipalities, in a completely haphazard manner. Our attention was directed to one case in which four municipal aerodromes have been created in an area which, it was said, could be adequately served by one. The licensing of aerodromes has, in fact, been regarded as an administrative act unrelated to the probable requirements of air services.

We suggest that the position should be reviewed in detail and a co-ordinated scheme prepared in readiness for development of the plan proposed by the Maybury Committee.

81. We think that, until internal air transport has assumed larger proportions, it would be reasonable for the State to make a development grant towards the capital expenditure necessary for fully equipping to a standard scale the main aerodromes, selected by the Air Ministry, to be regularly used for day and night flying by internal air services.

Use of Municipal Aerodromes by R.A.F.

82. We have been advised that it would be impracticable from the point of view alike of the Royal Air Force and of civil flying, for major military training activities to be undertaken at aerodromes which are in regular civil use, and that military reasons, moreover, preclude the present use of civil aerodromes for aircraft storage units.

Civil aerodromes are, however, being used to a considerable extent for the Royal Air Force Volunteer Reserve, Auxiliary Air Force squadrons, and as elementary flying training schools.

We feel that it should have been possible for the Royal Air Force to have taken more advantage of the facilities for elementary training at light aeroplane clubs, but we consider that the extent to which aerodromes can be simultaneously used for civil and military purposes is a matter on which the judgment of the Air Council must prevail.

Rating of Aerodromes

83. It has been represented to us that the present rating system acts as a deterrent to the conversion of suitable agricultural sites into aerodromes. We suggest that the Air Ministry should examine this question in conjunction with the other Departments concerned.

London Airports

84. From several quarters it has been urged that an "Airport of London Authority," composed of representatives of Government Departments and unofficial bodies, should be created to manage and co-ordinate the development of all airports in the London area and also the Empire Services permanent base, when established, and be vested with full powers of control and expenditure.

85. It will be recalled that the Maybury Committee considered the question of unifying the ownership of aerodromes serving London, but reached the conclusion that it would be premature to make recommendations on the subject. There has, in the meantime, been no material change in the position, and we agree with the view expressed by the Maybury Committee.

86. Nevertheless, the London area is a special case. It is probable that at all future times air traffic to and from London will be greater than at any other centre. Moreover, the convergence of aircraft upon London from various points of the compass (and vice versa), together with the great area of London itself, make it eminently desirable that aerodromes should be so located around London that normal traffic routes do not intersect: for example, traffic from the south should land at a southern aerodrome, and that from the west on the west of London.

We think, therefore, that in addition to devising an adequate scheme for the location of London aerodromes, it will be found desirable to appoint an Airport Committee, representing the various interests concerned with London airports, to ensure that facilities are co-ordinated in the best manner possible.

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Croydon Airport

87. The adequacy of the Croydon Airport has been questioned. It will be recalled that Croydon was in 1923 selected as the terminal aerodrome for London after an exhaustive review had been made of the possibilities of other sites by a Committee fully representative of air interests.

We find that the Air Ministry are alive to the defects of Croydon Airport and have plans for mitigating them. The plans include the fullest possible extension of the landing area, the levelling of the surface, and the reconstruction of administrative buildings and hangars. We recommend that these proposals should be carried out as soon as possible, but we understand that their execution is to some extent dependent on the development of the aerodrome site at Fairlop by the City of London Corporation, and on the decision of the Southern Railway regarding an aerodrome at Lullingstone.

Proposed Empire Air Bases

88. Attention was called in the debate to the delay in providing a suitable air base for the Empire flying boat services.

We are astonished at the lack of progress made in this matter, and we regard the present position as highly unsatisfactory. A decision on the site to be developed ought to be made without further delay and should be followed by speedy construction of the base.

In this connection, our Chairman has transmitted to you proposals submitted to us with regard to sites at Langstone and Southampton, the investigation of which would be beyond our scope.

Gatwick and Gravesend Airports

89. We have ascertained that the desirability of arranging for an aerodrome to be available on the south side of the North Downs in the vicinity of Redhill for use by aircraft coming from the Continent, when conditions of bad visibility prevail at Croydon, induced the Air Ministry to conclude in October, 1935, an agreement with Airports, Ltd., in respect of Gatwick Airport, under which that Company, in consideration for certain annual payments to be made by the Department for a period of 15 years, undertook, *inter alia*, to purchase land for the enlargement of the aerodrome, to prepare the surface and maintain it in a good condition fit for use by all types of aircraft, and to provide certain equipment and housing accommodation. A similar agreement was entered into with the same Company in respect of Gravesend Airport, so that there might also be available in emergency on the south-east side of London a relief aerodrome to Croydon.

90. Objection was raised during the debate to the reference in the prospectus of Airports, Ltd. to these contracts between the Company and the Air Ministry. It is, however, a statutory requirement that a prospectus should state the dates of, and parties to, every material contract, and a reasonable time and place at which such contract may be inspected. The Company was, therefore, legally obliged to supply this information.

91. The availability of Gatwick and Gravesend aerodromes has enabled the Department to establish essential Volunteer Reserve centres there without incurring any capital costs on land or buildings. The circumstances in which arrangements were made with Airports, Ltd. for these centres do not seem to present any unusual features.

Customs arrangements at Airports

92. Representations have been made to us that the arrangements for Customs clearance at airports, and in particular those concerning the attendance of Customs Officers, do not meet the requirements of air transport.

We recommend that the position should be reviewed by the Air Ministry and the Department of Customs and Excise.

Ground Organisation

93. On the question of wireless and meteorological facilities, the responsibility for the provision of which devolves upon the Air Ministry, we have been furnished by the Department with memoranda which are attached as Appendix E.

Wireless Facilities

94. There are in this country 27 direction-finding installations and 10 radio beacons, but there are only 188 aircraft on the Air Ministry Register equipped with wireless apparatus. Although the provision of ground wireless installation may seem liberal from this comparison, it must be remembered that all-weather air services are conditional upon ground organisation which should, therefore, be in advance of requirements.

95. We understand that the inadequacy of the wave bands allocated to the aeronautical wireless services is a cause of congestion, and that a remedy will be sought at the forthcoming International Telecommunication Conference.

We are informed that the regulations governing the use of wireless in aircraft are being revised and that some improvement may result. Apparently, however, the available facilities cannot be fully utilised unless the use of radio-telephony is abandoned and a wireless operator is carried on aircraft in addition to the pilot.

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Meteorological Services

96. General satisfaction has been expressed with the meteorological service at stations where it exists, but representations have been made to us that there should be a much more complete service and that, in particular, the number of stations reporting on upper air temperature and humidity should be increased.

We bring these representations to your notice ; but appreciate the difficulties of the Director of the Meteorological Office in producing at short notice trained staff in adequate numbers to cope with all the heavy demands on him for new stations.

Control

97. The position regarding air traffic control in this country appears to be causing serious apprehension. Flying in conditions of bad visibility is becoming more general, and greatly increased flying by the Royal Air Force adds to the risk of collision, particularly when military machines operate in the vicinity of the civil routes.

98. We understand that the Air Ministry has the whole problem under active investigation, but we call special attention to the question of control in the Southampton area, in view of the fact that the Empire flying boat base at Hythe is situated directly on the course of aircraft flying between Jersey and Southampton.

99. It has been represented to us that the difficulties of pilots cannot be appreciated by control officers unless, in addition to other qualifications, the latter have had practical experience as pilots of air liners in conditions of bad visibility.

If, as is probable, there is an insufficiency of pilots willing to become control officers, and fitted for their duties, the training of a control officer should include a number of flights in air liners in conditions of bad visibility, preferably in the area which he is to control.

100. We also suggest that the present policy of leaving complete discretion to pilots should be reconsidered in comparison with the possible advantages of specifying minimum conditions of visibility at aerodromes, below which the departure and arrival of aircraft should be prohibited by control officers.

101. We are not prepared to make positive recommendations in these matters of air traffic control which seem to us to require further examination by experts.

102. On a closely related subject our attention was called to the inadequacy of present arrangements for safeguarding the passage of aircraft engaged on air services across the Irish Sea. We suggest that this question also should be examined.

Operating Personnel

103. It is clear that the considerable increase during the last two or three years in the numbers of pilots and other operating personnel, coupled with amalgamations of air transport undertakings, is rendering personal contact between employer and employee ineffective for the adjustment of grievances or for representations on other matters.

104. In our view personal contact must now be supplemented by collective representation of employees. The desire for such a change has been expressed to us by representatives of pilots. Imperial Airways, the Company employing the largest number of such officers, has stated that it has no objection to "collective bargaining."

105. The approach to collective representation and bargaining is, therefore, clear. It is essential, however, that any organisation formed with those objects should be in a position to negotiate authoritatively on behalf of a substantial proportion of the class it claims to represent.

If, as an extension of the separate representation by individual organisations, the formation of a council on the "Whitley" method should be thought desirable (and we think it would have advantages), information and advice based on the experience gained in the Civil Service would readily be forthcoming from the Treasury.

Questions particular to Imperial Airways, Ltd.

106. In the first part of this report we have made recommendations concerning the management of Imperial Airways, which, if adopted, should obviate further cause for criticism on many of the matters raised in the debate. It now remains to deal with certain specific complaints.

107. It was objected in the debate that in the same year Imperial Airways not only cut the salaries of its pilots, but increased its dividend from 8 per cent. to 9 per cent., and more or less doubled its Directors' fees.

The original prospectus of the Company, issued with the concurrence of the Government, provided for:—

"the balance of profits after the payment of 10 per cent. dividend on the paid up capital to be divided as follows:—
 one-third to Government for repayment of the above subsidy;
 one-third to reserve for development;
 one-third to be available for additional dividend to shareholders."

There is little doubt that capital was attracted to the enterprise by the prospect of substantial dividends. During the early years of the Company's operation, however, no dividends were paid; and over a period of 13 years (1924–1937) shareholders received, on an average, 4½ per cent. on their capital.

108. If our recommendations are put into effect, the position of Imperial Airways and other subsidised air transport companies will be more secure than that of companies trading on a normal commercial footing.

We think that it would be proper for the dividends of all such companies to be restricted to the limits usually associated with public utility companies.

109. The increase in the fees of Directors of Imperial Airways was voted at the Annual General Meeting of the Company held on 10th November, 1936. The grant of such an increase is solely within the powers of the shareholders.

Equipment

110. The circumstances in which a contract for the purchase of certain motor boats was placed by Imperial Airways with the British Power Boat Company have been called in question.

These motor boats are used in connection with the Empire Air Mail Scheme, and the Air Ministry is responsible for providing them, or arranging for their provision, at certain stopping places. Arrangements were made with the Company to purchase, maintain and operate these boats which, however, remain the property of the Government.

We have satisfied ourselves that the ultimate decision to place the contract with the Power Boat Company was taken by the Air Ministry.

111. On the subject of de-icing equipment, the statement was made in the debate that :—“ It is utterly wrong that, because of rivalry between these two rubber companies (i.e. Dunlop and Goodrich) the Goodrich de-icer, even though it is . . . far from perfect, should have been barred from Imperial Airways' machines during the last few years.”

Our inquiries have made it clear that there is not the slightest ground whatever for the suggestion that Imperial Airways barred the use of the Goodrich de-icer for any such reason. We consider that the aspersions on Imperial Airways in this connection were unwarrantable.

112. Imperial Airways have been criticised for not having equipped their aircraft engaged on the London–Budapest service with Lorenz wireless apparatus to facilitate landings in bad visibility.

We are informed that Lorenz equipment could not have been effectively used by aircraft during the relevant period (the winter of 1936/7) because it was only at aerodromes in Germany that the essential ground installation was then fully available. It did not exist at Prague, Budapest or Croydon, and was only in partial

operation at Vienna. Heston, although equipped with Lorenz, could not, we are advised, have been safely used by air liners for landings in bad visibility by means of this apparatus.

All the Company's major aircraft on their European routes are, however, now being fitted with this equipment. Arrangements are also being made on certain aircraft to duplicate the power plant for the wireless equipment, even though the reliability of wireless during the last twelve months reached 99·35 per cent.

Accidents

113. It was stated in the debate that on the London–Budapest service there had over a period of years been many accidents, more or less serious in character, and one or two deaths. It was also said that “ the course is strewn with crashes.” We have received evidence that the only accidents, major or minor, which occurred on this service were :—

- 14th April, 1935 .. at Budapest—Aircraft G–ACWO was damaged taking off ; no personal injuries occurred.
- 22nd October, 1935 .. at Zwettl—Aircraft G–ADCM made a forced landing owing to ice accretion. There were no personal injuries, but the aircraft was seriously damaged.
- 15th March, 1937 .. at Elsdorf—Aircraft G–ACVZ was wrecked and three of the staff of the Company were killed.

No passengers and no other staff have, in fact, been killed on the European services of the Company during the years 1935–1937, a fact which, we think, merits emphasis.

114. On the general question of the safety of the Company's services, statements which have been prepared for us by the Air Ministry are attached showing :—

- Appendix F .. Particulars of fatal accidents to the aircraft of Imperial Airways and of the other principal European air transport companies from 1934 to 1937.
- Appendix G .. Passenger-mileages of these companies and the percentage of that mileage flown outside the European system.
- Appendix H .. Accidents to aircraft of Imperial Airways since 1st January, 1934.

115. Experience suggests that accidents occur in cycles. A fair comparison of the safety of operating companies can, therefore, only be obtained from records covering a number of years.

We find no evidence to support the suggestion that Imperial Airways' services are less safe than those of any foreign company. We have no reason to think that the Company puts traffic considerations before prudence in the matter of the quantity of petrol carried on board their aircraft. We are informed that the sufficiency of fuel for a particular journey is, by statutory regulation, a matter in the discretion of the Captain.

Traffic

116. Comparative figures of the cross-Channel traffic from Croydon of Imperial Airways and other companies are given in Appendix I.

We see no reason for dissatisfaction with the proportion of the traffic carried by Imperial Airways. During the last few years several British companies have shared the traffic, new foreign services, such as "Swiss-air," have been admitted to Croydon, and routes not served by Imperial Airways have been developed. In 1937, moreover, Croydon gained the cross-Channel service of British Airways, but lost the Empire service of Imperial Airways.

Subsidies

117. The subsidies paid to Imperial Airways have always been on a contractual basis for specific services, and normally on a descending scale ; any increase of subsidy has been in payment for additional services.

The amounts actually credited in the Company's accounts in respect of subsidies are shown in Appendix J.

A comparison on a ton-mileage basis of the subsidies paid to various companies in Europe is given in Appendix K. The figures in this Appendix show that a lower amount was paid to Imperial Airways for work done than to any of the other companies.

Since 1934 subsidies to Imperial Airways, expressed as a percentage of the Company's total revenue, have been reduced, in the case of European services, from 32·4 per cent. to 20·2 per cent., and for all services, from 45·4 per cent. to 23·8 per cent. As will be seen from Appendix L none of the four large foreign companies can approach these figures.

118. It is incorrect to state that the dividend of 9 per cent. in respect of the year ended 31st March, 1937, was paid out of an increased subsidy. There was, in fact, a reduction in subsidy for that year. During the last three years dividends have increased, while the subsidies have decreased, a result indicative of improved trading.

Operating Personnel

119. It was alleged in the debate that the Company had victimised certain pilots who were prominent members of the British Air Line Pilots' Association, or who had complained of the unsuitability of the aircraft used on the London-Budapest service, or who had objected to cuts in salary.

120. We have reviewed these cases and others which have been brought to our notice. We desire to make it clear that we did so, not with the object of rectifying specific grievances, which is beyond our province, but to assist us in forming an opinion on the Company's methods of dealing with its staff, and in assessing the need for collective representation in future.

121. We understand that Imperial Airways has recently introduced a new scale of remuneration for pilots employed on the Empire Services. Under the new scale, fixed amounts of "service pay" replace "flying pay" based on time worked or mileage flown.

We are informed that the new agreements will expressly provide that both sides shall have a square deal as understood by fair-minded men. The Company has also promised to review the rates after one year—in consultation, we assume, with pilots or their representatives.

122. The suggestion has been made that the pilots of Imperial Airways are employed too long on continuous duty, and that eighteen hours' flying is a normal requirement for pilots east of Cairo.

Whilst we think that the case has been overstated, the interests of safety clearly require that pilots shall not fly for periods which impose an undue strain on them. The question should, therefore, be kept under constant review.

We have been advised by the Air Ministry that limitation of the daily amount of flying would not be a practical subject for regulation, but the statutory provision which requires a commercial pilot to undergo a medical examination, if he exceeds 125 hours' flying in 30 days, seems to be a suitable precaution for ensuring that physical efficiency is maintained.

PART III

SUMMARY OF MAIN RECOMMENDATIONS

Air Ministry

123. (i) An additional Parliamentary Under-Secretary of State solely concerned with civil aviation should be appointed (paragraph 22).

(ii) The higher control of the Department of Civil Aviation must be strengthened; there must be more vigour in initiating policy and foresight in planning (paragraph 21).

(iii) A post of Permanent Under-Secretary of State for Air should be created. He should take over responsibility for aircraft research, development and production, hitherto exercised by transitory Members of the Air Council (paragraphs 27 and 28).

(iv) The Permanent Under-Secretary of State should see that the policies of civil and military aviation are constantly correlated (paragraph 29).

(v) A Director of Aeronautical Production is needed for civil aircraft (paragraph 30).

(vi) The technical staff concerned with research and development in aviation should be considerably strengthened (paragraph 30).

Air Services and Operating Companies

(vii) It is also a matter of national importance to establish first-class air services between London and all the principal capitals of Europe with British aircraft as soon as possible. The inauguration of the proposed service to South America should be expedited. Plans for the development of other air routes including the West Indies and the Pacific should be prepared (paragraph 34).

(viii) Parliamentary sanction for the necessary additional subsidies should be promptly sought (paragraph 35).

(ix) British external air transport should be concentrated in a small number of well-founded and substantial organisations (paragraph 36).

(x) The same external route should not be operated by more than one British company, so as to avoid indiscriminate competition (paragraph 37).

(xi) Imperial Airways should concern themselves primarily with the development of the Empire air services and certain other long distance air services (paragraph 39), but their title to be associated with "short-haul" services to France and Italy, and flying boat services to Greece via Italy, should be recognised (paragraph 42).

(xii) The London-Paris terminal service should be operated by a single company formed with pro-rata shareholding by an amalgamation of the services of Imperial Airways and British Airways on this route (paragraph 41).

(xiii) British Airways, suitably organised, should develop the other air services in Europe, subject to the foregoing limitations (paragraph 40).

(xiv) British Airways should be organised in capital, direction, personnel and equipment appropriately to its increased responsibility (paragraph 48).

(xv) There should be close working liaison between Imperial Airways and British Airways (paragraph 48).

(xvi) Serious defects in the management of Imperial Airways call for immediate reform ; and some change in the directing personnel may well be involved (paragraphs 46 and 47).

Dividends of Subsidised Companies

(xvii) It would be proper in the case of subsidised air transport companies for dividends to be restricted to the limits usually associated with public utility companies (paragraph 108).

Aircraft Industry

(xviii) British aircraft constructors should play a large part in the civil aircraft industry of the world (paragraph 49).

(xix) State assistance should be afforded to encourage the production of suitable types of air liners (paragraphs 52-57).

(xx) Subsidised companies should, with the aid of special grants, keep their fleet equipped with new aircraft (paragraph 60).

(xxi) A specific programme of development for the large aircraft required for the main Empire mail services and long distance routes should be formulated (paragraph 61).

(xxii) The operational data of subsidised companies must be made available to constructors (paragraph 62).

Diesel Engines

(xxiii) A compression-ignition engine representing an advance in design and power on foreign engines should, with the assistance of a development grant, be produced within the next five years (paragraph 64).

Research

(xxiv) Equipment and staff of the State experimental and research establishments should be maintained at the highest level (paragraph 66).

(xxv) Research into the icing problem must be pressed forward (paragraph 68).

Maybury Committee Recommendations

(xxvi) The Air Ministry should speed up its action on the recommendations of the Maybury Committee (paragraph 72).

Petrol Tax

(xxvii) There is justification for reconsideration of the incidence of the petrol tax on internal air lines (paragraph 77).

Aerodromes

(xxviii) The aerodrome position in this country should be reviewed in detail and a co-ordinated scheme prepared (paragraph 80).

(xxix) Development grants should be made towards the capital expenditure necessary for fully equipping to a standard scale selected main aerodromes (paragraph 81).

(xxx) An adequate plan for the location and utilisation of London aerodromes as a whole is desirable (paragraph 86).

(xxxii) A London Airport Committee representing the various interests concerned in the London airports should, in due course, be formed (paragraph 86).

(xxxiii) Effect should be given as soon as possible to the proposals for improving Croydon Airport (paragraph 87).

(xxxiv) A site for the Empire flying boat base should be selected and developed without further delay (paragraph 88).

(xxxv) Arrangements for customs clearance at aerodromes should be reviewed by the Air Ministry and the Department of Customs and Excise (paragraph 92).

Collective Representation

(xxxvi) Personal contact between employer and employee in air transport should be supplemented by collective representation (paragraph 104).

124. We wish to place on record a special tribute to our Secretary, Mr. W. W. Burkett. His great capacity has been freely placed at our disposal, and the fact that such a large volume of evidence has been taken and dealt with in two months has meant work by night and day for the Secretary.

His position, as an official of the Air Ministry, has been one of some delicacy, and we have purposely dissociated him from our consideration of matters affecting the Air Ministry and its organisation.

(Signed) CADMAN, *Chairman.*

J. W. BOWEN

T. HARRISON HUGHES

FREDERICK J. MARQUIS.

8th February, 1938.

APPENDICES

- A. List of Witnesses.
 - B. Historical Review of British Air Services to the Continent.
 - C. Ice and Civil Aircraft.
 - D. Progress Report on Ice Formation on Aircraft and its Prevention.
 - E. Meteorological and Direction-finding Facilities.
 - F. Fatal Accidents to Aircraft of certain European Air Transport Companies, 1934–1937.
 - G. Passenger-mileages flown by certain European Air Transport Companies, 1934–1936.
 - H. Accidents to Imperial Airways' Aircraft since 1st January, 1934.
 - I. Cross-Channel Air Traffic Statistics.
 - J. Subsidies paid to Imperial Airways, 1925–1937.
 - K. Comparison of Subsidies per Traffic Ton-mile paid to certain European Air Transport Companies in 1936.
 - L. Subsidies paid to certain European Air Transport Companies, expressed as Percentages of Total Receipts.
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APPENDIX A

EVIDENCE RECEIVED BY THE COMMITTEE

(a) The following witnesses have appeared before the Committee :—

The Earl Amherst, M.C.
 Sir Donald Banks, K.C.B., D.S.O., M.C.
 Sir George Beharrell, D.S.O.
 Flight Lieutenant G. Birkett.
 Major H. G. Brackley, D.S.O.
 Hon. Mrs. Victor Bruce.
 Major J. S. Buchanan, C.B.E.
 Colonel H. Burchall, D.S.O.
 Flight Lieutenant P. W. S. Bulman, M.C., A.F.C., R.A.F.O.
 Captain S. L. Collins.
 Mr. J. W. S. Comber.
 Sir Hugo Cunliffe-Owen, Bart.
 Mr. W. F. Davison.
 Mr. A. M. Desoutter.
 Captain F. Dismore.
 Lieutenant-Colonel H. A. P. Disney.
 Mr. P. D. Eckersley, M.P.
 Captain L. A. Egglesfield.
 Mr. E. C. Gordon England.
 Air Commodore W. Lindsay Everard, M.P.
 Mr. C. R. Fairey, M.B.E.
 Mr. A. H. Fedden.
 Mr. St. John Field, K.C.
 Sir N. F. Warren Fisher, G.C.B., G.C.V.O.
 Air Marshal Sir W. R. Freeman, K.C.B., D.S.O., M.C.
 Admiral Sir Cyril Fuller, K.C.B.
 Mr. J. G. Gibson.
 Captain H. R. Gillman.
 Flying Officer R. G. Grant-Ferris, M.P.
 Mr. L. T. H. Greig.
 The Lord Grimthorpe.
 Mr. F. W. Hancock.
 Sir Harold Hartley, C.B.E., M.C., F.R.S.
 Mr. L. M. Haybittle.
 Mr. A. E. Hewitt.
 Mr. Gordon Hill.
 Mr. G. E. Woods Humphery, C.B.E.
 Mr. F. C. R. Jaques.
 Captain A. C. Lamplugh.
 Captain E. Lane-Burslem.
 Mr. H. R. Latreille.
 Mr. R. M. Marshall.
 Major R. H. Mayo, O.B.E.
 Major J. R. McCrindle, O.B.E., M.C.
 Wing Commander A. H. Measures, O.B.E.
 Captain R. P. Mollard.
 Mr. F. Montague, M.P.
 Lieutenant-Colonel J. T. C. Moore-Brabazon, M.C., M.P.
 Mr. C. M. Newton.

Mr. G. P. Olley, M.M., R.A.F.O.
 Mr. T. J. Owen.
 Mr. F. Handley Page, C.B.E.
 Hon. Clive Pearson.
 Mr. W. R. D. Perkins, M.P.
 Captain H. H. Perry.
 Mr. J. V. Primrose.
 Mr. T. Regan.
 Captain W. Rogers.
 Mr. H. C. Rose.
 Alderman A. A. Sennington.
 Lieutenant-Colonel Sir Francis Shelmerdine, C.I.E., O.B.E.
 Mr. O. E. Simmonds, M.P.
 Captain R. H. Stocken, R.A.F.O.
 Rear-Admiral Sir Murray Sueter, C.B., M.P.
 Captain A. S. Wilcockson.
 Mr. Lawrence A. Wingfield, M.C., D.F.C.
 Sir William V. Wood.
 Wing Commander J. A. C. Wright, M.P.

(b) The foregoing list includes representatives of :—

The Aerodrome Owners' Association.
 Air Dispatch, Limited.
 The Air Ministry.
 Airports, Limited.
 The Air Transport Section of the Society of British Aircraft Constructors, Limited.
 The Association of Aeronautical Ground Engineers.
 The British Air Line Pilots' Association.
 British Airways, Limited.
 The Guild of Air Pilots and Air Navigators of the British Empire.
 Imperial Airways, Limited.
 Imperial Airways Pilots' Committee (Croydon).
 Imperial Airways Pilots' Committee (Hythe).
 Jersey Airways, Limited.
 North Eastern Airways, Limited.
 Olley Air Service, Limited.
 The Parliamentary Air Committee.
 Railway Air Services.
 The Railway Clearing House.

(c) Written communications and memoranda have been received from, or on behalf of, the following, who did not give oral evidence :—

Lord Apsley, D.S.O., M.C., M.P.
 Mr. J. R. Bryans.
 Mr. William Courtenay.
 Mr. Roderick Denman.
 Mr. Leo d'Erlanger.
 Mr. Alan Goodfellow.
 Mr. C. G. Grey.
 Mr. W. D. Macpherson.
 Major R. H. S. Mealing.
 Flight Lieutenant G. Rose, R.A.F.O.
 Mrs. A. Sinclair.
 Mrs. H. B. Tate, M.P.
 Air Vice-Marshal Sir T. I. Webb-Bowen, K.C.B., C.M.G.
 Mr. H. E. Wimperis, C.B.E.

Allied Airways (Gandar Dower) Limited.
Armstrong Siddeley Development Company, Limited.
Association of Wireless and Cable Telegraphists, Aircraft Section.
The Commercial Aviation Committee.
The De Havilland Aircraft Company, Limited.
The General Council of Associated Light Aeroplane Clubs.
Isle of Man Air Services, Limited.
Messrs. William Muirhead and Partners.
Messrs. Primrose and Tangye.
The Purley Air Vigilance Committee.
Scottish Airways, Limited.
The Society of British Aircraft Constructors, Limited.
The Southampton Harbour Board.
The Southern Railway Company.
The Straight Corporation, Limited.
Utility Airways, Limited, and Merseyside Air Park Company.
Western Isles Airways, Limited.
The Willoughby Delta Company, Limited.

APPENDIX B

**GOVERNMENT POLICY IN RELATION TO BRITISH AIR SERVICES
IN EUROPE****(Memorandum furnished by the Air Ministry.)**

The purpose of this memorandum is to trace the development of British air lines on the continent of Europe, starting from the competitive and unsubsidised services which operated across the Channel in 1919, and showing how it became necessary for the Government to provide subsidies, and to abandon the principle of competition, in favour of a State-assisted monopoly company; how about 1927, three years after the adoption of this new policy, the Government decided that the centre of interest had shifted from the European field to the much wider task of providing air communications throughout the Empire; how thereafter, owing to the stringency of its financial resources (particularly during the crisis of 1931 and after) the Air Ministry was unable to provide assistance adequate for the proper exploitation of Europe, and how the burden of Imperial communications continued to grow until within the last year or two it evidently became sufficient of itself to absorb the energies of one commercial organisation, so that policy had to be directed towards the encouragement of a second national company capable under subsidy of providing virile British air services in the north of Europe.

2. The years since the war may be divided for the study of policy into three periods:—

(1) **1919–1923. Period of Competition.**

(2) **1923–1935. Period of Monopoly.**—This period begins with the recommendations of the Hambling Committee.

(3) **1935—onwards. Period of Partition** with the encouragement of a second subsidised company. This period begins with the establishment of the Inter-Departmental Committee on International Air Communications (Warren Fisher Committee) and its study of the European situation.

1919–1923. Period of Competition

3. On 26th August, 1919, Air Transport and Travel, Ltd., began regular operation between London and Paris, and later between London and Amsterdam. Shortly afterwards Handley Page Transport, Ltd., embarked on the London-Paris route and later established regular services between London and Brussels and London and Amsterdam. In the summer of 1920 Instone Air Line began a service between London and Paris, as also did the Air Post of Banks.

These companies ran without subsidy, in spite of a recommendation by an Advisory Committee set up by Mr. Winston Churchill that Government assistance to the maximum amount of £250,000 should be given for the years 1920/1921 and 1921/1922. The recommendations of this Committee were never adopted by the Government.

As a result of inadequate finance the position became serious in 1920. Air Transport and Travel, Ltd., went into liquidation at the end of the year, and in February, 1921, British civil air transport ceased altogether.

4. In March, 1921, this state of affairs was examined by a Committee under Lord Londonderry which evolved a temporary scheme involving subsidy for the first time, as a result of which Handley Page Transport and the Instone Air Line were able to revive the services between London and Paris for another year.

In April, 1922, Daimler Hire, Ltd., entered the field, and new subsidy agreements were made for the three companies to fly the London-Paris route, as well as with British Marine Air Navigation to maintain the services which they had opened to the Channel Islands and Cherbourg.

5. It became clear, however, that competition between these services was entirely uneconomical from the standpoint of earning Government subsidy, and arrangements were made whereby Handley Page Transport took over the London-Paris route; Instone Air Line ran from London to Brussels and Cologne; Daimler Hire, Ltd., from Manchester to London and thence to Amsterdam, Hamburg and Berlin, and British Marine Air Navigation from Southampton to Cherbourg, Havre and the Channel Islands.

This division did not work satisfactorily, and in January, 1923, the Secretary of State for Air appointed the Civil Air Transport Subsidies Committee, under Sir Herbert Hambling, to consider the working of the cross-Channel subsidy scheme and advise as to the best method of subsidising air transport in the future.

As a result of this Committee's recommendations the four interests mentioned above became merged into Imperial Airways, thus terminating the period of competitive development.

1923-1935. Period of Monopoly

6. The Hambling Committee found that the principle of competition, which had previously been considered an essential feature of development, had in fact been dropped by the revised scheme of 1922 under which definite routes were allocated to the four participants in the subsidy. They felt that all schemes hitherto adopted suffered from the defect of securing to each firm an assured income in return for the maintenance of an agreed minimum service, and offered no encouragement whatever to an operating company to extend its activities beyond what was settled in the agreement. The exception to this criticism was the "Permanent Scheme" endorsed by Lord Londonderry's Committee, which did, in fact, secure a large increase in the proportion of traffic carried by British companies, but which failed owing to over-optimism as to the probable increase in traffic in relation to the needs of three separate companies.

The Hambling Committee, therefore, recommended the creation of a single commercial organisation with a privileged position in regard to air transport subsidies, and this recommendation was adopted by the Government.

7. The first Agreement between the Air Ministry and the new organisation, Imperial Airways, was made in 1924, and based originally on a straightforward requirement of a million miles to be flown per annum, which was subsequently modified into a formula of mileage multiplied by horse-power. The Company was required to maintain an efficient air service on his basis between London-Paris, London-Brussels, London-Amsterdam and Southampton-Channel Islands, or such other places approved by the Air Ministry, as in the opinion of the Company might be commercially desirable. The requirement of a service to the Channel Islands was subsequently dropped.

The subsidy payable to the Company was £137,000 per annum for the first four years, dropping to £32,000 in the tenth year.

8. The general increase of air lines in Europe between 1920-1926 was phenomenal. In the former year, there were 6,000 miles of route, in the latter over 18,000 miles. The example of this country was followed shortly afterwards by Germany, who instituted a similar merger resulting in the highly efficient organisation "Deutsche Luft Hansa." France adopted the same policy at a later stage, resulting in "Air France."

In 1927, Imperial Airways were operating the following services in Europe :—

Service.	Frequency.	
	Summer.	Winter.
London-Paris .. .. .	.. 3 times daily	Daily
London-Paris-Basle-Zurich .. .. .	.. Daily	Closed
London-Ostend .. .. .	.. .. .	.. .. .
London-Brussels-Cologne .. .. .	.. Twice daily	Daily
Southampton-Channel Islands .. .. .	.. Weekly	Weekly

1927—Government decision to give priority to Empire Routes

9. In 1926, however, a second Agreement had been concluded with Imperial Airways for the establishment of a service between Egypt and India. This Agreement was to last for five years, the maximum annual subsidy payable being £93,600.

One of the results of this experiment was that the Secretary of State for Air (Sir Samuel Hoare) brought to the notice of the Government the great importance of making practical use of civil aviation as a means of Imperial communication. This had been strongly urged at the Imperial Conference of the previous year. The considerations before the Government were that we were committed under existing contracts to a considerable expenditure on subsidies over a period of years, and it was important to ensure that this money was, so far as possible, *productively* spent. The degree of success which had attended the service in the Middle East, intended to connect Egypt with India, but so far (owing to difficulties with Persia) only opened between Cairo and Basra, made it clear that long distance Imperial services were likely to prove less unprofitable than short distance services to the Continent on which there was necessarily very keen competition with existing means of transport. It was consequently decided to adopt a policy of closing down the less remunerative of these latter services and concentrating on the great Imperial routes, in particular from England to India and South Africa.

It was also decided that the Civil Aviation Vote should be stabilised over a ten-year period at £500,000 per annum, and that the policy of concentrating air transport in the hands of a single company—Imperial Airways, Ltd.—should be continued.

10. The effect was to orientate the principal effort of the Air Ministry and Imperial Airways in a new direction. Nevertheless, although the vastness of the project thus opened out was bound to claim the major part of their attention, it cannot fairly be said that the European field was neglected.

The following figures show—

- (a) the intensity of service provided by Imperial Airways under the European subsidy; and
 (b) the degree in which these services were effective in attracting passengers through this period.

Year.	(a)		(b)	
	Aircraft Miles.		Passengers carried.	
1925	805,300	13,160		
1926	732,980	18,197		
1927	614,655	19,762		
1928	793,365	28,724		
1929	778,260	30,547		

The drop in intensity of service in 1927 is to be related to the closing of the London-Amsterdam service, but it will be observed that intensity recovered in the following year to very nearly the peak established in 1925. On the other hand, the passenger traffic shows a continuous increase throughout the period and most notably a leap of 45 per cent. immediately after 1927.

11. These figures do not perhaps tell the full story. The history of the services on the routes during the three years of recovery is as follows :—

<i>Route.</i>		<i>1927</i>	<i>1928</i>	<i>1929</i>
London-Paris ..	Summer	Thrice daily	Thrice daily	Four times daily
	Winter	Daily	Twice daily	Twice daily
London-Paris- Basle-Zurich	Summer	Daily	Daily	Daily
	Winter	Nil	Twice weekly	Twice weekly as far as Basle only
London-Ostend ..	Summer	Daily	Daily	Discontinued
	Winter	Nil	Nil	
London-Brussels- Cologne	Summer	Twice daily	Daily	Daily
	Winter	Daily	Daily	Daily
Southampton- Channel Islands	Summer	Weekly	Weekly	Discontinued
	Winter	Weekly	Weekly	

It will be seen from the above that Imperial Airways tended to concentrate their European services on the lucrative routes.

12. In 1930 there was a serious falling off in all the major European services, both our own and those of other countries. The number of passengers carried by Imperial Airways dropped from 30,547 to 24,077, a decrease which was continued in the subsequent year. This general condition is attributable to the widespread financial crises. The service to Cologne was maintained in the winter only on alternate days by arrangement with the Belgian Sabena Company. In 1931 the London-Paris service was reduced to thrice daily during the summer, but increased to twice daily during the winter.

13. These important variations in what was otherwise a steady growth of effort up to 1929 correspond in time with the conclusion of a new Agreement in that year between Imperial Airways and the Air Ministry, which remains in force, as far as Europe is concerned, until 1939.

Under this Agreement the subsidy for European services, which would under the old Agreement have been £100,000 for the year 1929-30, decreasing to £32,000 for the year 1933-34, was increased to £125,000 for the years 1929-30 and 1930-31, decreasing to £110,000 for the next four years, and thence to £30,000 in 1938-39.

This Agreement, although representing a reasonable adjustment of the position to meet the conditions in prospect in 1929, and certainly contributing to the increased activity of the Company in its recovery after the slump, and in succeeding years, has become quite inappropriate to conditions now prevailing towards the end of the subsidy period.

14. It is right to say that from 1931 onwards, the services began to pick up again as regards traffic. An interesting report presented to the Air Transport Co-operation Committee of the League of Nations in 1933 by M. Henri Bouché shows that in the years 1930, 1931 and 1932 Imperial Airways progressed more rapidly towards financial autonomy (i.e., independence of State subsidy) than any of their European competitors. The principal figures are :

		<i>1930</i>	<i>1931</i>	<i>1932</i>	
		%	%	%	
United Kingdom ..	..	69	49	36·7	Revenue from State subsidy.
Germany ..	..	63	69	70	ditto.
France ..	..	80	82	80	ditto.
Netherlands ..	..	51	40	41	ditto.

In 1933 the number of aircraft miles flown rose to 762,300 or very nearly the figure for 1929, whereas the number of passengers carried increased steadily up to that year. There was a slight set back in 1934, but in 1935 the total of aircraft miles rose to 1,256,700 and the figures for passengers were twice those in 1929.

In 1935 two new services were opened :—

- (a) London-Paris-Marseilles-Rome-Brindisi. (Mail only twice weekly.)
 (b) London-Cologne-Leipzig-Prague-Vienna-Budapest.

The first service was treated as a preliminary element of the Empire Mail Scheme and, therefore, did not come within the existing subsidy scheme, although the Company were, in fact, assisted to maintain it.

The second was instituted by the Company on their own initiative, and did not come explicitly under the subsidy arrangements. It was a natural consequence of the expectations arising under the Agreement of 1929, namely, that without further subsidy the Company's operations would be capable of expansion as economic conditions improved and the better established services came more nearly to being self-supporting.

15. It will be appreciated that with the limitation from 1927 onwards of the Civil Aviation Vote to £500,000, coupled with the Government's publicly expressed intention of developing as a primary care its air communications throughout the Empire, there was very little which could be spent on the development of the European services.

The following tables show the consequences of this policy. Taking 1926 as a datum, the rise of expenditure on Empire services from 1927 onwards quite outweighs the other resources of the Vote. When it is appreciated that Column (e)—which represents the money available for all purposes after subsidies had been met—covers the cost of Croydon and Lympne, technical equipment and works at home and abroad, subsidies to light aeroplane clubs, and miscellaneous expenditure on other activities, there is clearly no margin for the allocation of more State funds to the work in Europe.

	Subsidies to Imperial Airways.			Gross Total of Civil Aviation Vote.	Remainder available for other purposes.
	Europe.	Empire.	Total.		
	(a) £	(b) £	(c) £	(d)* £	(e) £
1926	137,000	30,000	167,000	473,000	306,000
1927	137,000	94,000	231,000	474,000	243,000
1928	137,000	113,000	250,000	427,000	177,000
1929	125,000	216,000	341,000	441,000	100,000
1930	125,000	303,000	428,000	547,000	119,000
1931	110,000	410,000	520,000	651,000	131,000
1932	110,000	441,000	551,000	666,000	115,000
1933	110,000	436,000	546,000	663,000	117,000
1934	110,000	451,000	561,000	673,000	112,000
1935	80,000	350,000	430,000	585,000	155,000

* The gross total of the Vote is reduced by receipt in the form of Appropriations-in-Aid: it was the resultant *net* total which was limited to an average £500,000 per annum. This explains the apparent excesses over this amount in column (d). The gross total is, of course, the measure of the Department's spending power.

16. In 1931 the Committee on National Expenditure (May Committee) left its mark on civil aviation, as will be seen from the figures in column (e) for 1932, 1933 and 1934. The amounts allocated by agreement to Imperial Airways for European services could not be reduced, and the pressure of Imperial communications was steadily growing. As a result, the scope of the Civil Aviation Department for entering into any further commitments was restricted to the barest minimum. This process was repeated in another part of Air Ministry Votes in which provision is made for research and development of civil aircraft; here provision was not only limited to an annual total, but the Air Ministry were compelled to relinquish the whole of their proposed programme of development for 1931, and subsequently had to abandon a large experimental flying boat, the cost of which would have mortgaged their spending power under this head for some years.

In their recommendations the May Committee suggested an independent inquiry on the question whether it was expedient to enter into any fresh agreements with Imperial Airways, and whether any such agreement should not be confined to fast mail transport only, so that a revision of existing agreements might take place. Furthermore, they suggested that air mail service contracts should be vested in the Post Office rather than the Air Ministry, in which event the burden of subsidy would have been shifted to the postal revenue. The Air Ministry and Post Office have, however, always been alive to the possibility of Government contracts with operating companies becoming purely postal if and when the cost of the service can be covered by the available postal revenue.

17. Generally speaking, the effect of the limitation of finance in 1931 and the years immediately following was to preclude the Air Ministry from carrying out the policy which it would undoubtedly have wished to adopt in securing for British activities a fair share of the Continental air system in face of the heavily subsidised national companies of other countries.

18. The situation changed towards the end of the monopoly period, owing to a further attempt on the part of certain companies to restore unsubsidised cross-Channel services. This modified to some extent the traffic position enjoyed by Imperial Airways. Air Dispatch began to operate a daily morning freight service between Croydon and Paris and a week-end service between Croydon and Le Touquet, and Wrightways started a daily early morning service between London and Paris for the carriage of newspapers.

19. By 1935, however, there were other and more ambitious services set on foot. For example, Hillman Airways had started and maintained a London-Paris service four times daily in the summer and twice daily in the winter; also a London-Brussels-Antwerp service thrice daily in the summer and twice daily in the winter, in addition to a daily summer service between London-Ramsgate and Le Zoute, with an extension to Brussels at week-ends, which developed into a winter daily service London-Lille-Brussels and London-Antwerp-Amsterdam.

All these services incurred heavy losses, even though a "second-class" service was offered instead of the "first-class" standard set by Imperial Airways.

1935-onwards. Period of Partition

20. By 1935 it was clear that development of services in the European field under the 1929 Agreement was not successful. On the one hand, unsubsidised services, such as Hillmans, incurred heavy losses, sufficient to deter them from business. On the other, although traffic was growing, Imperial Airways were finding difficulty owing to the magnitude of the task which they had undertaken throughout the rest of the Empire, for it was in

this year that the Company's preparations for the inception of the Empire Air Mail Scheme began to constitute a serious drain on the resources of their overhead organisation. A factor of significance emerged at this time in the discovery that it would be ultimately more economical and a greater incentive to air transport development to carry mails on the "all-up" principle rather than on a surcharge basis, and that the additional revenue thus made available from postal sources might be expected to provide an increasing support to the finances of operating companies.

It will be appreciated that all-up mail is now being sent from this country to nearly every other country in Europe, involving loads which considerably modify the previous relative importance of mail and passenger. Previously the small surcharge mail was a welcome addition of revenue to the operating company, but it did not absorb any important part of the carrying capacity of the aircraft. The all-up mails, however, are large enough to become an important factor in the service and an asset all the more valuable to the company, because by long experience the various national Post Offices can calculate the flow of mail traffic with sufficient accuracy to justify long-term contracts based on traffic-carrying capacity. The carriage of mails, therefore, in this case, owing to the comparatively small size of the vehicle employed, has made much more difference in the history of air companies than of shipping or railway companies.

21. In 1935 the Government set up a Standing Inter-Departmental Committee, under Sir Warren Fisher, to consider questions of International Air Communications, and one of the tasks which this Committee considered themselves bound to take up early and with vigour was the study and improvement of the situation as regards our European services. They came to the conclusion that if profit was to be taken from the experience of the last few years, and if the lessons of the 1929 Agreement had been learnt, the future policy of the Government in relation to operating companies must be based on three conditions:—

- (1) Government support to more than one company.
- (2) Each supported company to have its own de-limited sphere of operation.
- (3) Incentives to expansion and effort by restricted competition and effective Government control.

The Air Ministry determined, therefore, to encourage an independent concern to undertake the establishment of a first-class service to Scandinavia, and the amalgamation sponsored by United Airways, which embraced Hillman Airways, Spartan Air Lines and subsequently British Continental Airways, under a single management with effective financial backing, provided the opportunity. The new organisation, under the title of British Airways, contained within itself sufficient of the elements of air operating experience, coupled with business and financial experience, to justify its being accepted as a second "chosen instrument." Air operating experience is indeed one of the cardinal requirements for success, and its lack a fruitful cause of waste in life and money. In 1935 such experience could be claimed by few people outside Imperial Airways, so that it was the more imperative that this essential element should be carefully husbanded.

22. In order to provide this new organisation with its own scope and responsibilities, negotiations were opened with Imperial Airways, who under the 1929 Agreement were solely entitled to all subsidies paid in respect of the services in Europe, and with great public spirit Sir Eric Geddes agreed to relinquish that part of the Company's concession which related to Europe north of the line, London to Berlin. The way was thereby clear for the subsidy to British Airways for the service to Scandinavia, which might be regarded as the first leg of a British service penetrating eastward into Russia

when circumstances permitted. The ensuing agreement with this Company embodied not only day services, but also the operation of a night mail to Scandinavia which in fact never proceeded in that direction beyond Hanover, as it became apparent that there was greater practical advantage in making use of the international air mail clearing-house there.

Pressure was maintained on Imperial Airways, however, to put forward greater efforts in Europe, as for example in the carriage of the all-up mail to Switzerland, but their other preoccupations and the difficulty of obtaining a sufficiency of useful aircraft in time, prevented success.

As the Company were not in a position to give effect to a long prepared scheme for the night mail to Berlin, the Postmaster-General eventually entered into a contract with British Airways for the extension of the night mail to Hanover, as far as Berlin. This night mail is now run by British Airways, alternately with Deutsche Luft Hansa, who had been running a night mail from Berlin to London for some time.

23. There is limited competition between these two major subsidised companies in that they both run on the lucrative route, London-Paris. It will be appreciated, however, that British Airways' subsidy is calculated in respect of Scandinavia and Berlin services and contains no element whatever for the London-Paris route. Effective Government control is a principle which has been at the basis of the Empire Agreement, and is secured by periodical review; in the case of British Airways, such control has been secured by the operation of short-term agreements.

24. The European position has been closely studied by the Air Ministry in consultation with the Post Office within recent months. It is clear that under present arrangements the financial years 1940-42 (which are critical under the Parliamentary limitation of the total of annual subsidies) have no margin for subsidy to European services beyond about £60,000 per annum. In the current year (1937) Imperial Airways' subsidy amounts to £50,000, for which they are required to operate services between London-Brussels-Cologne, and London-Paris-Basle-Zurich, and between other places in Europe as may be from time to time agreed.

For the sum of £98,000 provided in 1938 (together with a postal payment to British Airways) the nation will obtain the following services :—

- | | | |
|---|-------------------|---------------------------------|
| (1) London-Paris | Imperial Airways | Four times daily. |
| (2) London - Basle - Zurich | Imperial Airways | Daily. (Suspended this winter.) |
| (3) London - Brussels - Cologne. | Imperial Airways | Daily. |
| (4) London - Hamburg - Copenhagen - Malmo - Stockholm. | British Airways | Daily. |
| (5) London - Scandinavia night mail. (Dropped at Hanover.) | } British Airways | Alternate nights with D.L.H. |
| (6) London - Berlin night mail. | | |
| And indirectly by activity of these Companies which is not actually included in subsidy agreements :— | | |
| (7) London - Cologne - Frankfurt - Leipzig - Prague - Vienna - Budapest. | Imperial Airways | Daily. (Suspended this winter.) |
| (8) London-Paris | British Airways | Daily. |

25. If British services are to secure an equal footing within the already closely knit Continental air system, the Government is still faced with the position resulting from the heavy subsidies which foreign Governments grant to their national companies.

Taking every mitigating factor into account, it seems unlikely that the remedy for this situation could be found without a substantial increase in Government subsidies, which, under our present statutory limitation, will be restricted to a maximum of £60,000 in 1940-1942 and may even be less.

AIR MINISTRY,

11.1.38.

APPENDIX C

ICE AND CIVIL AIRCRAFT

(Memorandum furnished by the Air Ministry.)

The problem of preventing the physical processes of ice formation from interfering with the safety of civil aircraft proceeding on their lawful occasions is a very complex one, to which there is no simple solution like the application of a muzzle to a ferocious dog. It is a problem which is being given anxious and intense study in all countries actively interested in flying, and which can best be considered under the following headings:—

1. **The Meteorological conditions which give rise to icing problems.**—The physics of ice accretion and the meteorological conditions in which ice accumulation is liable to become dangerous, together with notes for the guidance of pilots who find themselves in ice-forming layers, are given in a paper entitled—"Ice accretion on aircraft" prepared by Sir George C. Simpson, K.C.B., F.R.S., and published as a Meteorological Office pamphlet. M.O.420b. (Professional Notes No. 82.) This paper is on sale at H.M. Stationery Office, price 3d.

2. **The effect of ice accretion on the performance, manoeuvrability and navigation of aircraft.**—A "Progress Report on ice formation on aircraft and its prevention," prepared by the Royal Aircraft Establishment, Farnborough, Report H.1418, November, 1937, is attached as Appendix D, but for convenience the parts of an aircraft affected by icing, with brief explanatory notes, are mentioned below in order of decreasing seriousness, but it should be added that the order given is largely a matter of opinion and is subject to alteration as practical experience accumulates.

(i) *Engine.*—(a) Carburettor and induction system.

(b) Intake.—The air intake may choke with snow or ice, and ice accretion in the induction system or in the carburettor may interfere with the supply of the correct mixture to the cylinders. Any reduction in the power output of the engines will affect adversely the ability of the aircraft to climb above an ice-forming layer and so deprive the pilot of a common means of escape, or even in the worst cases leave the pilot with no alternative other than a forced descent.

(c) Petrol and oil tank vents.—Choking of the petrol and oil tank vents interrupts the free ingress of air to these tanks and so interferes with the gravity or suction fed supply of fuel and oil to the power plant.

(ii) *Blind Flying Instruments.*—Ice formation occurs in cloud and it is thus important that instruments commonly used for flying in these conditions should not be affected. Some of these instruments, such as the Airspeed Indicator, the Directional Gyro, the Artificial Horizon and the Turn Indicator rely for their functioning on air pressure differences which are picked up from fittings, i.e., pressure heads and venturis, supplied for that purpose in the airstream exterior to the aircraft. Such fittings must therefore be artificially heated, failing which it is necessary to supply the pressure difference from an engine driven pump. Where the pressure difference is supplied from an engine driven vacuum pump, trouble may also occur through ice formation in the air pipe connecting the pump with the dashboard instruments.

(iii) *Control Surfaces*.—The manoeuvrability of an aircraft can be seriously impaired by ice forming on the leading edges of the ailerons and the elevators, or on exposed control links, arms, operating members, hinges, etc., and so preventing actual movement of the controls, or (alternatively), ice broken off from the leading edges of the main planes may be carried back to lodge in the aileron gap, thus jamming the aileron.

(iv) *Airscrews*.—Ice formation on the airscrew occurs most readily on the boss and on the inner portions of the blades which not only reduces the effective thrust of the airscrew, but also causes loss of balance which necessitates throttling down the engine when its power may be needed most. Damage to the aircraft and injury to personnel may result from ice thrown off from the rotating blades. Wooden airscrews are more susceptible to ice accretion than metal airscrews, the probable explanation being that the greater thermal conductivity of the metal blade enables the heat generated at the blade tips to be transferred more readily to the blade roots.

(v) *Main Planes*.—Ice builds up very readily on the leading edges of the main planes which present a large surface to the airstream, and under severe conditions the amount of ice collected accumulates very rapidly, and not only increases the total weight of the aircraft but also deforms the aerofoil section of the wings, and so reduces their "lift" and increases their "drag."

(vi) *Windscreens*.—Ice or snow collecting on the outside of the windscreen reduces visibility for the pilot and at the same time prevents the operation of mechanical wipers.

(vii) *Wireless Aerials*.—Three types of aerial are commonly employed, viz. :—trailing aerial, fixed aerial and D.F. loop.

Ice forming on the wire of a trailing aerial increases its weight and renders it liable to breakage, but, where fracture does not occur, the presence of the ice on the wire reduces signal strength and frequently renders communication either very difficult or impossible. The aerial fair lead through which the wire is led into the aircraft may be choked with ice, thus rendering it impossible to wind in a trailing aerial and clean the wire or substitute another aerial.

(viii) *Miscellaneous*.—Erratic behaviour of the magnetic compass has been reported concurrently with ice forming conditions, but the cause of this erratic behaviour has not yet been definitely established. There is also the possibility of retractable undercarriages being jammed during flight, and so rendering it impossible for the undercarriage to be lowered when required for landing.

3. Research and development work being undertaken by the Air Ministry, with an appreciation of the relative value of various methods which at present hold the field for countering the ice hazard.—A general statement of the progress made in the development work undertaken at the Royal Aircraft Establishment, Farnborough, will be found in the report at Appendix D referred to above.

All reports issued in the technical press and elsewhere concerning development work undertaken in other countries on this subject receive careful consideration and, in addition, a personal interchange of information was made in June of this year at a conference held in Berlin between representatives of the British and German Air Ministries and of Imperial Airways, Ltd. and the Deutsche Luft Hansa. This interchange is to be renewed in 1938 probably on a wider basis, in order to take advantage of the experience accumulated during the present winter.

A general note on the present position is given below, with cross references to the Farnborough report :

(1) *Engine.*—(a) Carburettor Induction System, (b) Intake.—Satisfactory carburation is now ensured by heating the intake air or by keeping all internal surfaces to the carburettor and induction system at a temperature above 0° Centigrade, or by adding an inhibitor, such as alcohol, to the fuel. An ice accretion indicator fitted in the induction system shows when heated air or the use of alcohol is necessary. An ice detection instrument has been developed for use in engine induction systems which is responsive to ice formation and which is arranged to switch on a warning light on the dashboard while ice conditions persist. The situation with regard to the engine is now well in hand, and no serious troubles are anticipated from this source. (See Sections III and IV of Appendix D.)

(c) Petrol Tank Vents.—Blocking of the vent is cured by reversing the normal position of the vents so as to face aft instead of forward or by fitting auxiliary vents inside the cabin of an aircraft, in which latter case they should be protected by cocks which are normally kept closed to minimise the risk of fire from petrol vapour in the cabin. (See Section VIII of Appendix D.)

(2) *Blind Flying Instruments.*—Electrically heated venturis are available, but are not considered satisfactory for severe conditions. A system comprising a spray of de-icing fluid in front of the venturi is being tried with and without electrical heating. Engine-driven vacuum pumps are employed in lieu of venturis on the Short Empire boats, and have given satisfaction apart from icing troubles which have developed in the piping between the pump and the dashboard instrument. The latter trouble is being overcome by heating the air circuit. Duplicate engine-driven pumps are installed on the Lockheed Electras operated by British Airways, Ltd., and no troubles have so far been discovered. Electrically heated pressure heads for air speed indicators are available and appear to be functioning satisfactorily. (See Sections VI and VII of Appendix D.)

(3) *Control Surfaces.*—Ice formation on the leading edges of control surfaces can possibly be overcome by fitting a mechanical type de-icer, or by applying a fluid de-icer where the gap is wide enough. Considerable difficulties have been encountered in America in the fitting of the mechanical type of de-icer, particularly on balanced ailerons. Flight tests with pastes and with a liquid de-icer are to be carried out.

British Airways, Ltd. have been experimenting with "Kilfrost" on the Lockheed Electras, but they have not found the use of this paste to be effective in practice, and have, moreover, discovered that it has a corrosive action on the surface to which it is applied. The use of this particular paste has now been abandoned by this Company. Exposed control links, arms, operating members, etc., should be shielded as far as possible and hinges should be well greased with a non-freezing grease. (See Section II of Appendix D.)

(4) *Airscrews.*—It has been found that airscrews can be effectively protected by the application of a fluid anticicer, such as ethylene glycol, fed into a "U" section ring (known as a "slinger" ring) fixed behind the boss and discharged by centrifugal force through tubes which deliver it at appropriate points near the roots of the blades. A "Spinner" fitted in front of the airscrew boss has been found to give sufficient protection to the mechanism of a constant speed airscrew (which is utilised to alter the pitch of the blades in such a manner as to keep the engine revolutions constant). (See Section V of Appendix D.)

(5) *Main Planes.*—There are three methods in use: (a) the mechanical de-icer, (b) the fluid de-icer (or anticler), and (c) the application of anti-freezing pastes, and a fourth method (d), the thermal method, is under investigation.

(a) The mechanical method has been used extensively in America and has given a fair measure of satisfaction. There is no universal design which can be applied to any type of aircraft, and it is necessary to design special apparatus for each different type. The same method has been experimented with for several years in Germany, but it is not now employed on D.L.H. aircraft other than for experimental purposes.

(b) The fluid de-icer, or Dunlop system, utilises a mixture containing ethylene glycol which is discharged on the surface of the leading edge through a porous outer covering, such as leather and/or gauze or perforated rubber. The fluid is forced out under pressure and the rate of delivery can be regulated. An advantage of the fluid system is that it can be applied both to thin and to thick wing sections, whereas the mechanical Goodrich system is not so suitable for thin wing sections. Two aircraft, the Heyford and the Northrop, have been allocated exclusively for icing research at the Royal Aircraft Establishment. The Northrop has one wing fitted with the Goodrich system, and the other with the Dunlop de-icer (referred to above), and comparative tests are being made. The Heyford is fitted with the Dunlop de-icer. Twelve aeroplanes are being allocated for icing research at R.A.F. stations distributed over the United Kingdom, the intention being that these aeroplanes should be sent up whenever icing conditions are reported in their locality. The first six of these aircraft are being fitted now; the remaining six will be fitted as soon as the first six are finished.

(c) *Pastes.*—The principle underlying the use of pastes is the incorporation in a suitable adhesive medium of water-soluble substances which lower the freezing point of water at the surface to be protected. This tends to prevent the initial formation of ice or, failing complete prevention, to produce a liquid boundary layer between the surface of the leading edge and the ice, and thus facilitate the removal of the latter by the air stream. Various substances have been tried under ice-forming conditions, both in flight and in a wind tunnel. None of the preparations so far tested at Farnborough has been found to be wholly effective, and all were strongly corrosive to metals. The experience of British Airways, Ltd. with "Kilfrost" has been similar, but further tests will be undertaken by R.A.F. aircraft. Imperial Airways, Ltd. are understood to favour the use of "Kilfrost," as it is easy to apply, inexpensive to use and comparatively light in weight. No reports of corrosive effects have been received from Imperial Airways, Ltd., and instances have been quoted in which "Kilfrost" has withstood heavy rain on an Empire flying boat (Cambria).

(d) *The Thermal Method.*—This method aims at keeping the surfaces to be protected at a temperature in excess of 0° C.

It is favoured in Germany, where it is now undergoing extensive tests, and has been fitted on the new four-engined Junkers machine. It takes the form of a metal tube inside the leading edge of the wings, supplied with a current of warm exhaust gases, which are led by a system of shields along the top and bottom surfaces of the wing, and which, it is claimed, raise the temperature of these surfaces to an extent sufficient to prevent ice formation.

In France, an alternative system utilising an electrical source of heat has been tested in the laboratory under the auspices of a Commission on Ice Formation appointed last year by the French Air Ministry. It is

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claimed that an aircraft of about 800 H.P. would require, at minus 3° C., the equivalent of 8 H.P. for a period of 70 seconds to de-ice the estimated heating surface of 7 square metres. So far as is known, no tests have yet been carried out under practical flight conditions.

Investigations in this country up to the present have tended to show that to heat the wing electrically will cost too much in electrical power.

The thermal method has also been tried in the United States, where it is not considered to offer a practical solution. (See Section I of Appendix D.)

(6) *Windscreens*.—An anti-freezing liquid applied to the windscreen prevents external obscuration by ice, snow, etc., and enables a windscreen wiper to remove the resulting mush. Various forms of wipers and of rotating screens are under trial, but no satisfactory results have yet been obtained. Electrical heating of the screen is also the subject of experiment at the Royal Aircraft Establishment, as are also direct vision methods of providing a clear view. (See Sections IX and X of Appendix D.)

(7) *Wireless Aerials*.—No practical method has yet been evolved to prevent ice forming on aerial wires, but shielding of the fairlead has so far met with some success. British Airways, Ltd. have experimented with "Kilfrost" on D/F loops, but have not found this of any value, and in one instance ice had formed over the "Kilfrost" on the upper portion of the loop. Retractable D/F loops are now available and these should reduce, if wound down inside the fuselage when not actually being used, the icing trouble. (See Section XI of Appendix D.)

4. Dissemination of relevant information to pilots and operating companies including the steps taken to forecast meteorological conditions favourable to ice accretion, and the issue of regulations regarding de-icing requirements.—The attempt to make the aeroplane safe for extended flights in icing conditions is a poor substitute for avoidance of those icing conditions altogether.

Notes for pilots in the paper on ice accretion on aircraft, referred to in heading 1, have, therefore, as already stated, been placed on sale by H.M. Stationery Office, and this paper contains a very full account of all that is relevant to the meteorological aspect of the subject.

The practicability of forecasting conditions liable to give rise to ice formation is also dealt with in the concluding section of the same publication, and an appreciation on the part of civil pilots of the difficulties involved is assisted by the meteorological knowledge required of these pilots in connection with the issue of pilots' and navigators' licences. Further liaison between the forecaster on the ground and the pilot in the air is strengthened by the issue of Notice to Airmen No. 221 of 1937, in which pilots encountering icing conditions in actual flight are requested to report the essential details by wireless, in order that the information may be broadcast to other pilots through the medium of the Borough Hill radio-telephony station maintained by the Air Ministry for the issue at regular intervals of meteorological information and of navigational warnings.

In addition, a Notice to Airmen No. 205 of 1937, was issued in September last, drawing attention to the possibility of the lateral control of an aeroplane becoming temporarily jammed when severe icing conditions have been encountered.

Copies of the report at Appendix D, which gives an account of the progress of the work at the Royal Aircraft Establishment, are being circulated to all operating companies.

The issue of regulations regarding compulsory fitting of de-icing devices has been under continuous consideration for some time by the Civil Airworthiness Committee. This Committee was appointed "to advise the Secretary of State for Air upon questions affecting technical requirements for Certificates of Airworthiness and technical questions relating to the construction and operation of civil aircraft, to appoint sub-committees as may be requisite, not necessarily from among its own members, and to make recommendations." It is composed of representatives of the Air Ministry, aircraft constructors, engine manufacturers, aircraft operating companies and insurance interests. The Air Registration Board has accepted an invitation to appoint a representative. The Director-General of Civil Aviation is the permanent Chairman. A serious obstacle to the formulation of definite legislation has been the difficulty arising from the lack of conclusive evidence of the efficacy of the many devices which are still in an experimental stage of development, but Notice to Aircraft Owners and Ground Engineers No. 29/1937 gives advance warning of impending legislation concerning satisfactory means now actually available with respect to carburettor systems, intakes, air-driven flying instruments and fuel and oil tank vents.

The possibility of extending the requirements was examined in October last by a special De-Icing Sub-Committee appointed by the Civil Airworthiness Committee for that purpose. The recommendations of this Sub-Committee were approved in November, 1937, at the next meeting of the main Airworthiness Committee, as a result of which steps are now being taken to extend the requirements so as to provide for:—

- (i) protection of the air circuit between engine vacuum pumps and the dashboard instruments served by those pumps ;
- (ii) protection of the mechanism of variable pitch airscrews ;
- (iii) the satisfactory heating of the pressure head of an air speed indicator ;
- (iv) the screening of aerial fairleads ; and
- (v) the use of a satisfactory de-icing paste to prevent essential openable windows freezing up when shut.

It is not considered that the time has yet arrived when regulations can be introduced governing the application of a de-icing device to the wings, control surfaces or airscrews, but, as regards airscrews, the Committee decided that operating companies should be invited to try out one or other of the present known methods of protecting airscrew blades (e.g., de-icing fluid or paste) and to inform the Air Ministry of how the selected method works in practice.

5. Investigations conducted independently by civil air operating companies.
—Investigations by Imperial Airways, Ltd., have been carried out in close collaboration with the Royal Aircraft Establishment, and their technical manager has participated in the work of the Civil Airworthiness Committee in this respect.

The application of the Goodrich mechanical system to obsolescent aircraft, such as the Heracles and Hannibal class, is not practicable, nor is it suitable for the thin wing section of the D.H.86 class. Alternative methods tried by the Company are the fluid de-icing system for the main planes and control surfaces, and the application of "Kilfrost" paste. Of the two the Company favour the latter, and they are at present also trying out this paste on airscrews. It is understood to be the view of Imperial Airways, Ltd., that metal surfaces are less susceptible to icing than fabric surfaces, but this view is not corroborated from other sources.

British Airways, Ltd. have fitted all their Lockheed Electras with the Goodrich system, and have found it effective, but they realise the importance of avoiding ice regions as far as possible, and are collecting data this winter on all aspects of the problem. They have found the Goodrich system more

difficult to employ on their Junker aircraft used on freight services, and have been in close touch with Germany to secure an efficient system. So far they believe the measures adopted by them are more effective than those used in Germany. Horn balanced controls on these aircraft have presented difficulties not yet overcome, added to which rubber in Germany is of poor quality. The Company has also established contact with the Lockheed and the Goodrich Companies in America and, through the former, with the Department of Commerce. In consequence, they are aware of the trouble experienced through static discharges puncturing the rubber overshoe and (on Douglas aircraft only) of the fatigue to the wing surface caused by the pulsations of the bags. The former difficulty has now been circumvented by the insertion in the rubber covering of canvas strips, and British Airways, Ltd. have adopted the same remedy on their own aircraft.

As regards the use of ancillary equipment, hot air is supplied from an exhaust muff to the intake, which is led between the cylinders and inside the engine cowling. Slinger rings and spinners are employed on the airscrews. Air-driven instruments are operated from either one of two engine-driven pumps. The pitot tube of the air speed indicator is electrically heated, while the sensitive altimeter is provided with an alternative static pressure supply taken from inside the cabin through a selector cock, in case the outside static supply is blocked by ice. Rubber cups have been fitted to protect aerial fairleads.

The Company has experienced one case of ice on the control surface, caused by jamming of the elevator tab, after a Lockheed Electra had been climbing through cloud. On arrival at operating height the pilot was unable for some time to trim the aircraft fore and aft for level flight.

"Kilfrost" applied on the control surfaces gave rise to incipient corrosion, and the use of this paste has now been abandoned, the Company never having encountered any instance in which it has proved effective. On the contrary, they have found that it blew off even in dry air, and in one instance on a D.F. loop, ice was found to have formed over the "Kilfrost."

The severest icing conditions are encountered in Europe, where British Airways employ metal aircraft, and Imperial Airways aircraft with fabric covered wings, whereas the only metal aircraft used by Imperial Airways are the flying boats operated on the Empire Routes. These facts may explain to some extent the different experiences of the two companies, different experiences which illustrate the difficulties at present inherent in any attempt to make the use of any one device mandatory until more practical data have been accumulated.

In conclusion, it is emphasised that every possible step is being taken to collect all available data concerning the ice hazard, to co-ordinate the experiences being built up in this and other countries, and to improve the accuracy and scope of meteorological forecasts affecting icing conditions.

AIR MINISTRY,

9.12.37.

APPENDIX D

ROYAL AIRCRAFT ESTABLISHMENT, FARNBOROUGH
Progress Report on Ice Formation on Aircraft and its Prevention
Report No. H.1418—November, 1937

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Introduction—Conditions of ice formation

This subject is fully dealt with in M.O. Professional Note No. 82 by Sir George Simpson, K.C.B., F.R.S. :—" Ice Accretion on Aircraft—Notes for Pilots."

The meteorological conditions under which ice can form on aircraft are very varied, and the nature of the deposit and rate of accumulation vary greatly in consequence. Because of this great variety of ice-forming conditions it is difficult to assess the effectiveness of the different means which have been proposed for the prevention of ice formation on aircraft; this largely accounts for the many apparently contradictory reports which have been made. For rapid ice formation in large quantity it is a prime condition that the concentration of water in the atmosphere must be high. Information

as to the maximum possible concentration of precipitated moisture in the atmosphere appears to be lacking, but it is obvious that in order to accumulate ice at the rate of two inches per minute on a slow aircraft, which has been reported, the concentration must be very high. Such conditions occur in or below disturbed areas in which the fall of precipitated water is retarded by rapid upward currents, and large drops may result.

The most dangerous icing conditions are probably associated with supercooled water. Rain may be cooled many degrees below freezing point without solidifying. Contact with the leading edge of an aircraft will then cause the immediate freezing of a portion of the water to glassy ice, the amount depending upon the degree of supercooling; freezing of a further quantity of the water may then be induced by evaporative cooling which may proceed rapidly owing to the high speed and lowered pressure in the neighbourhood of the leading edge. Such conditions frequently occur at a "warm front," where warm moist air meets a wedge of cold air and is forced upwards, the resulting rain being supercooled in its descent through the top of the cold wedge. Similar conditions are frequent in mountainous regions. On other occasions the meteorological conditions favourable to rapid ice formation are vigorous vertical currents producing heavy precipitation at suitable altitudes with regard to temperature distribution; these conditions are identified with towering cumulo-nimbus clouds of thunderstorm type.

It is obviously desirable to avoid flying into ice-forming conditions if possible. To meet this requirement the Meteorological Office has issued details of an arrangement made to give suitable warning of ice-forming conditions.

Section I

Protection of leading edges of wings, etc.

(a) *Pastes*.—The principle underlying the use of all these materials is the incorporation in a suitable medium of water-soluble substances which will lower the freezing point of water at the surface to be protected; this tends to prevent water freezing on the surface, or if ice forms, tends to produce a liquid boundary layer between the surface and the ice which facilitates its removal by the air stream. These materials are usually applied with a brush or palette knife.

From first principles it would appear that any such material can be only a temporary expedient, for only a limited quantity of the active material can be applied to the surface, and loss of this material must proceed as the action takes place. Indeed, if warm rain has been encountered before ice forming conditions are entered, the active constituent may have been removed. In the absence of long continued rain the material may remain effective during short flights. In general these materials must be applied just before a flight is made owing to their deliquescent nature.

Various media and active substances including a number of proprietary preparations have been tried under ice-forming conditions both in flight and in a wind tunnel. Great difficulty was experienced in obtaining a preparation which combined the properties of good adhesion, suitable consistency and solubility and it was necessary to compromise. None of the preparations so far tested at this Establishment has been found to be wholly effective and all were strongly corrosive to metals. Further tests will be made.

(b) *Highly polished surfaces*.—Wind tunnel and flight tests have been carried out on a number of highly polished metal surfaces which are said to have been effective. In none of the tests so far carried out at R.A.E. has any of these surfaces been found to be effective in preventing ice accumulation, although the degree of adhesion of ice to these surfaces has not been determined.

(c) *The fluid de-icer.*—This method aims at maintaining on the surfaces on which ice may form, a layer of a fluid which lowers the freezing point of water and so tends to prevent ice formation. Alternatively, if ice forms on the surface, the fluid exuding from below melts the ice at the surface of contact, forming a liquid boundary layer which enables the ice to be detached by the airstream.

A system based on this method has been devised and is now provided by the Dunlop Rubber Company.

In this system the fluid is a mixture containing ethylene glycol and is discharged at the surface to be protected under a porous outer covering, such as leather and/or gauze, or perforated rubber. The fluid is forced out under pressure and the rate of delivery can be regulated.

Flight tests on struts and thin wing sections have been carried out on Gordon and Hart aircraft and on thick wing sections on the Courier. The system has been found to be effective in preventing the formation of ice under the ice-forming conditions encountered by these aircraft.

Further experiments will be carried out on a number of modern Service aircraft.

(d) *The mechanical de-icer.*—In this system compressed air is used to pulsate rubber tubes covered with a rubber "over-shoe" placed along the leading edge. An engine-driven pump maintains a cycle of alternate expansions and contractions, the deformations of the leading edge region tending to break up the ice which is then blown away by the slipstream. This system was developed by the Goodrich Company and is marketed in this country by the British Tyre and Rubber Company.

This equipment was fitted to the main planes and tail unit of a Northrop aircraft. The installation on the main planes consisted of three inflatable rubber tubes, one centrally along the leading edge, and one above and one below the leading edge. On the narrow section tail unit two bags separated by a "sine curve" division were used. With the engine running at cruising speed, the time of the complete cycle of pulsations was 1 minute; on the main planes the upper and lower bags were first simultaneously inflated, after which they collapsed and the centre bag was inflated. On the tail plane and fin the two bags were inflated simultaneously, producing a sinuous deformation. The weight of the installation on the Northrop is approximately 73 lbs.

The aircraft has been flown under very severe ice-forming conditions and the device has been found to be effective in clearing the ice from the tail unit and the main planes with the exception of a few feet near the tip and on some occasions of a portion of the ice nearer the root of the wing, which appeared to be attached below the leading edge. In general from the tests done at R.A.E. this system appears to be satisfactory.

A number of modern Service aircraft are about to be equipped for further tests.

(e) *Thermal de-icer.*—In this system the surfaces to be kept clear of ice are maintained at a temperature slightly above 0° C.

The surfaces could of course be heated electrically but the amount of electrical power required makes this method quite impracticable.

An alternative method is to lead hot air or the hot exhaust gases or vapours through the wings.

The method presents obvious constructional difficulties and has not been tried in this country, although considerable experimental work has been carried out in U.S.A., and an experimental installation with hot air is being tried in Germany. In the U.S.A. the thermal method is not considered to be a practical one. Detailed reports of the German experiments have not been received, but our representatives at a recent conference were told that good results had been obtained.

Section II

Protection of control surfaces

Ice may form on the leading edges of control surfaces, e.g., ailerons and elevator, and eventually prevent movement of the controls. One accident in the U.S.A. is attributed to this cause. It is also suspected that ice, broken off from the leading edges, may sometimes be carried back to lodge in the aileron gap, and so jam the aileron.

The first type—ice formation on the control leading edge—might be overcome by fitting a liquid or mechanical type de-icer where the gap is wide enough. Flight tests with pastes and with the liquid de-icer are proposed.

In the second type of trouble, pieces of ice that lodge in the aileron gap can frequently be dislodged by manipulation of the aileron controls. The controls should be moved to follow up the jamming action, and not to fight against it.

Exposed control links, arms, operating members, etc., should be shielded to prevent ice forming on them, and control hinges should be well greased with non-freezing grease.

Section III

Protection of engines

Various methods of preventing the building up of snow and ice in the intakes and induction systems of engines have been tested.

(a) *Intakes*.—The intake may either choke with snow, or it may be obstructed by the accretion of ice from the atmosphere. This may be prevented by :—

(i) Arranging the intake, or fitting an alternative intake, so that it cannot be blocked by snow and ice.

(ii) Spraying an inhibitor, such as alcohol, into the intake.

To ensure complete freedom from snow and ice, the amount of inhibitor to be sprayed would be considerable, as much of it would pass into the intake without making contact with the snow and ice on the internal walls. The application of the inhibitor in this way would also prevent ice accretion in the carburettor and induction system if no other means for this purpose were available.

(b) *Carburettor and induction systems*.—Ice formation in the carburettor and induction systems may be prevented by :—

(i) Keeping all internal surfaces of the carburettor and induction systems at a temperature above 0° C.

(ii) Heating the intake air.

The supply of heat should be sufficient to evaporate all entering water or ice, and reduce the relative humidity of this intake air to 50 per cent. This ensures that, when the air passes through the carburettor and is cooled by the evaporation of the petrol, the excess moisture deposited will, in the worst case, be negligible.

A fully sheltered intake can be used and the intake air heated 15° C. above the temperature of the outside atmospheric air. This will reduce the relative humidity below 50 per cent. A fully sheltered intake is one which cannot be blocked by snow and ice, and prevents ingress of snow, rain or water vapour evaporated from heated surfaces, and so limits the relative humidity of the intake air before it is heated to 100 per cent.

When the intake is not fully sheltered, more heat is necessary to reduce the relative humidity of the intake air to 50 per cent.

An ice accretion indicator should be fitted in the induction system to show when heated air is necessary.

(iii) Adding an inhibitor, such as alcohol, to the fuel. To economise in the use of the inhibitor, it is preferable to add it only when ice accretion is likely, and this can be done manually or automatically: If manual operation is employed, an ice accretion indicator should be fitted in the induction system to show when the use of the inhibitor is necessary.

Section IV

Instruments for ice detection

(a) *Engines.*—An instrument has been developed for use in engine induction systems, which is responsive to ice formation. It comprises a detector, a pressure sensitive diaphragm and a warning light.

The detector consists of two orifices, one small and one large, both exposed to the mixture stream after the carburettor in that part of the induction system which experience has shown to be most liable to ice formation. The orifices are in free communication with opposite sides of the diaphragm, and small air bleed holes are also provided from both sides of the diaphragm to some point on the aircraft which is approximately at static pressure.

The system is arranged for complete pressure balance at all throttle positions.

The formation of ice tends to block the orifices, but the smaller orifice is closed first. Air then flows in through the bleed hole and the pressure rises on that side of the diaphragm. The resultant movement of the diaphragm closes an electrical contact and switches on a warning light.

When ice is dispersed in the induction system, the pressure balance is restored and the lamp switched off.

The instrument is not necessary in conjunction with an induction system in which ice formation is prevented by the application of heat to the walls and to the carburettor throttle butterfly valve, as ice-forming conditions may prevail in the mixture stream without loss of power when the walls, etc., are adequately heated, and a warning by the detector has then no significance.

(b) *Aircraft.*—Owing to the evaporative cooling in the induction system, ice-forming conditions may be present in the engine when they are not present over the remainder of the aircraft. A separate ice indicator is, therefore, required for the aircraft.

An instrument employing the same principle of operation as that described above, is being developed to indicate when aircraft icing conditions are present.

It differs from the previous instrument in that means must be provided for quickly removing the ice from the detector after it has formed sufficiently to give a warning, in order that further signals may be given should the icing conditions continue. This is done by fitting electrical heaters to the detector orifices, and these are automatically switched on by the diaphragm movement at the same time as the warning lamps. Heating will then continue until the ice is melted and the pressure balance restored. While icing conditions prevail, this cycle will continue.

The instrument requires to be fitted in such a position that it is exposed to the free air stream, the diaphragm being then operated by the difference between the pitot and static pressures.

Section V

Protection of airscrews

Ice formation on the airscrew not only reduces its efficiency, but also, by causing loss of balance, may necessitate throttling down the engine when its power is needed most. Damage to aircraft and injury to personnel may result from ice thrown from airscrews.

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Ice formation occurs most readily on the boss and inner portions of the blades, the outer portion being maintained at a temperature considerably higher than that of the air, owing to heat generated in overcoming viscous drag. The fact that metal airscrews are less liable to ice accretion than wooden ones is probably due to their greater thermal conductivity.

The formation of ice on airscrews may be prevented, or alternatively accumulated ice may be removed, by an application of a fluid anticler. Ethylene glycol or other suitable liquid is fed into a U-section ring fixed behind the boss and discharged by centrifugal force through tubes which deliver it at appropriate points near the roots of the blades.

This device is available in commercial form.

A similar method has been developed for preventing ice formation on the spinner or nose-cap, which is a necessary protection for variable pitch mechanism, and flight tests are being arranged.

De-icing pastes have been applied to airscrews, but the results so far obtained have not been satisfactory. This may be partly due to the high centrifugal forces necessitating the use of a large proportion of adhesive medium compared with active de-icing material. The danger of corrosion must also be considered.

Section VI

Protection of pressure heads for airspeed indicators

Electrically heated pressure heads are now available, which so far appear to have functioned satisfactorily.

Section VII

Protection of venturis for driving blind-flying instruments

Repositioning of the venturi, to avoid ice formation, has been tried on a number of aircraft but was not satisfactory.

Electrically heated venturis are available, but are not considered satisfactory for severe conditions. A system comprising a spray of de-icing fluid in front of the venturi is being tried with, and without, electrical heating. It is desirable to fit engine-driven suction pumps wherever possible.

Section VIII

Protection of petrol tank vents

Petrol tank vents are frequently faced forward, so as to produce a pitot pressure, in which position they readily ice up. All vents should, therefore, be arranged to face to the rear. It should be noted, however, that the almost flush vents on the planes of the Northrop have never been observed to collect any ice.

Provision of emergency vents inside the fuselage is an additional and certain safeguard; such vents should be fitted with cocks, and normally kept closed.

Section IX

Methods of providing a clear view in bad weather

Possible ways of removing rain, ice, snow, etc., from the outside of the windscreen will be considered first and the elimination of internal misting later. Direct vision schemes, whereby the pilot is given an unobstructed view through an opening in the screen, are discussed in a separate paragraph.

(a) *External obscuration by rain, ice, etc.—Wipers.*—If ice and snow can be loosened by applying an anti-freezing liquid to the windscreen, then a windscreen wiper may be able to wipe clear the resulting mush. Rotating screens, reciprocating and double-arm rotating wipers are being tried in conjunction with anti-freezing liquid sprayed on to the screen, but no definite results have yet been obtained.

The closer the pilot is to the wiped window, the bigger the angle of view he has through a given wiped area; an important corollary of this is that, with the pilot close to the screen, the wiper blade can be kept short, and thus the driving torque reduced.

Experiments are also in hand to test whether a feed of anti-freezing liquid to the actual wiper blade is necessary, or whether the spray on the screen will deal with ice already formed and which is cementing the blade to the glass screen.

Another method of removing ice is electric heating, although this is costly in power. Heaters are obtainable commercially, wired for low wattage, and need rewiring for use on aircraft. A narrow metal frame carries a sheet of glass in front of which are the heater wires. The whole is attached to the inside of the windscreen, so that the heater wires are between the auxiliary screen and the screen proper. Experiments on these lines are in hand at the R.A.E. A wiper will probably be required in conjunction with the heater.

(b) *Prevention of internal fogging.*—Internal fogging results from moisture condensed at temperatures below the dew point. This often occurs when aircraft are brought out from the hangars, especially at night. It may also occur in flight in badly ventilated cabins. At low temperatures the condensed moisture may freeze, thus still further reducing transparency. A wide variety of preparations for preventing internal fogging have been examined. They are available in a number of forms, such as impregnated cloths, powders, waxes, pastes, liquids, jellies and solid films. Chemically they may be classified as soaps, wetting agents, organic acids, alcohols, sugars and impregnated colloids. Except in the case of a few liquids, all these preparations require to be applied in advance of the time of need, owing to the vigorous polishing required or the necessity for providing a grease-free surface, to enable the preparations to be effectively applied. In general, such preparations do not survive more than three repeated wettings, and none possess any anti-fogging properties after once frosting. They are not effective on surfaces which are at a temperature below -5° C. A chemical, known as Compound No. 28, for preventing internal fogging has been prepared and will shortly be issued to the R.A.F.

External fogging due to the deposition of very small drops of water may result from the same causes that are responsible for internal misting. Such fogging is usually more opaque on screens made of material other than glass, for the reason that water has a lower spreading power on these materials. This cannot be dealt with adequately by a single application of any preparation; either a continuous or an intermittent supply must be arranged, but any system of liquid feed with wiper, such as has already been described, will deal with such fogging. No suitable liquid has yet been found which can be used on synthetic resin screens.

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Section X*Direct vision methods of providing clear view**

If the pilot can open a window or part of a window in front of him and so obtain a view forward unobstructed by any glass which can become obscured the ideal solution of the problem is achieved. The difficulties are, of course, the draught which enters such an opening, and also the direct entry of rain, etc.; in addition, the increase of noise in the cabin must be considered.

(a) *Direct vision front openings.*—Wind tunnel tests at the R.A.E. show that it is possible to leave direct vision openings, in the form of horizontal gaps, in flat front screens, inclined at 45°, without causing draught near the pilot's head. To satisfy this condition the internal cabin pressure must be approximately $\frac{1}{2} \times \frac{1}{2} \rho V^2$ for the deeper openings with no deflectors, and maintenance of this positive pressure in the cabin would call for the elimination of all leaks in the fuselage. The no-draught condition can be satisfied even with negative cabin pressures if shallow openings are used with deflectors. Such openings will not prevent the direct entry of rain, snow, etc., and, when the atmospheric temperature is low, the circulation of air in the opening might lower the cabin temperature too much. To meet this difficulty a rear screen could be built in to form a "sealed compartment." Rain and ice that form on the rear screen could then be wiped clear with less powerful wipers and electric heaters than would be needed on the front screen, since the air in the "sealed compartment" will be moving comparatively slowly. Experiments are in hand on these openings.

(b) *Direct vision side panel openings.*—Many aeroplanes are fitted with a small window which can be slid forward to give the pilot a view ahead. If this opening is situated so that it is not in a region of high positive pressure, then the draught from the opening will not be great. This draught can be further reduced by hinging one window to act as a deflector panel.

If a panel is hinged forward and another is slid forward, leaving a direct vision opening, then, when all the glass panels are iced up, the pilot can still obtain some view straight ahead, and for the later stages of landing he can, by moving his head to the right, obtain a reasonable side view. A direct vision arrangement on these lines has proved successful on the aircraft used on some Continental air lines. In heavy rain, when the opening might admit rain, the front opening could be closed and the side panel slid back.

In any system of side panel opening or sliding cockpit hood, it will be necessary to keep the hinges and sliding rails free of ice, so that the necessary movement can be made. Experiments are being made to this end, principally by the application of anti-freeze liquid to those points.

Section XI**De-icing of wireless aerials**

(a) *Trailing aerials.*—The aerial fairlead, that is, the tube through which the aerial wire leaves the aircraft, should be protected from ice by means of a shield which deflects the air flow. Some fairleads are retractable, and therefore, may be withdrawn into the aircraft during ice conditions. No practicable method has yet been evolved to prevent ice forming on the aerial wire itself,

* Two diagrams issued with this Report have not been reproduced here, and slight consequential modifications of the original text of Section X have, therefore, been made.

which may be anything up to 300 feet in length. Spare trailing aerials should always be carried in case ice conditions are so severe that it becomes necessary to cut adrift an iced-up wire.

(b) *Fixed aerials*.—Shrouds should be fitted over the aerial insulators, to protect them from the direct air flow and keep them clear of ice. The point where the aerial downlead enters the aircraft, that is, the deck insulator, should also be protected by a shield. A large number of de-icing pastes and liquids have been tried on fixed aerials, but so far without success. Modern practice tends towards the increasing use of fore and aft aerials, and these do not appear to ice up to the same degree as aerial wires which run from the wing tips to the tail. The protection of insulated aerial masts which act as the aerial downlead is to be tried by both the Dunlop and Goodrich systems.

(c) *D.F. loops*.—Protection of loop aerials is still in the experimental stage. Two methods are being attempted :—

(i) The “Dunlop” system, which consists of anti-ice liquid being distributed over the loop surface.

Laboratory tests have given satisfactory results and arrangements are being made for flight tests.

(ii) The “Goodrich” system which consists of a pulsating envelope—air inflated—designed to break away the ice formed.

Three forms of loop are in use: the “Fixed” (exposed to air flow the whole time); the “Collapsible” (folding down into a recess on the top of the fuselage); and the “Retractable” (capable of being wound down into the fuselage).

The “Fixed” will require complete de-icing.

The “Collapsible” will require protection at its hinging mechanism and possibly at the loop itself.

Further experiments are needed to determine the proper procedure with the “Retractable” aerial. It may be possible to reduce the time occupied in taking a bearing, so that only a small amount of ice is collected and retraction is possible.

Section XII

Compass interference under ice-forming conditions

Ice-forming conditions usually occur when flying in cloud. Reports have been received from an R.A.E. pilot and from an Imperial Airways' pilot that on a number of occasions the magnetic compass has behaved erratically; errors of up to 90° have occurred and sometimes persisted for considerable periods, although finally disappearing.

Although this is known to be due to the presence of electrical disturbances within and around the cloud formation, the exact mechanism by which the compass is disturbed has not yet been ascertained.

**THE METEOROLOGICAL AND DIRECTION-FINDING FACILITIES WHICH
THE AIR MINISTRY HAVE CREATED IN THE LAST TWO YEARS,
INCLUDING SUCH MILITARY FACILITIES AS ARE AVAILABLE FOR
CIVIL AVIATION**

(Memorandum furnished by the Air Ministry.)

PART I.—**METEOROLOGICAL**
PART II.—**COMMUNICATIONS**

PART I

METEOROLOGICAL SERVICES FOR CIVIL AVIATION

A.—Home and Continental Air Services

Paras.

- 1 and 2 Methods of collection and distribution of information.
- 3 and 4 Outline of facilities provided by individual meteorological distributive stations and headquarters.
- 5 Summary of meteorological services provided for individual air services.

Charts

- 1 Synoptic reporting stations in British Isles.
- 2 Stations contributing reports to be broadcast from Borough Hill.
- 3 Existing distributive stations (Civil and R.A.F.), 30th November, 1937.
- 4 Proposed main Forecast Stations, Types 1 and 2, under present reorganisation scheme.

B.—Overseas (Empire Air Routes)

- A. Stations in United Kingdom.
- B. Overseas Stations controlled by Meteorological Office, Air Ministry.
- C. Overseas Services controlled by Colonial Governments.

Note.—In order to provide a proper background it has been necessary to go back further than the two years indicated in the title of the memorandum.

METEOROLOGICAL SERVICES FOR CIVIL AVIATION

A.—Home and Continental Air Services

1. The day-to-day meteorological services for aviation, whether civil or military, consist of two main parts :—

(1) The provision of information regarding existing weather conditions and the changes likely to occur within the relatively few hours occupied by flights.

(2) The organisation of a number of local stations, situated on aerodromes, where this information may be obtained and professional meteorologists consulted.

2. 1 (1) involves, in the British Isles :—

Chart I for British Stations

(a) The collection at Headquarters of reports of observations made mainly at 3- or 6-hourly intervals throughout the day and night at stations in the British Isles, Europe, N. Africa, Greenland, Iceland and by ships at sea. Observations from America are received twice a day. This collection of observations from a wide area is the essential basis of forecasting for all purposes. For the information of local forecasting centres the necessary selection of station reports is disseminated without delay. The present dissemination by W/T will eventually be replaced by a broadcast distribution to all local centres by means of teleprinters.

Chart II for Reporting Stations

(b) The collection of reports from a large number (about 70) British stations (service and civil aerodromes, coastguard and signal stations, private observers) at hourly intervals from 7 h. to 18 h. G.M.T. and the immediate broadcasting of these reports by radio-telephony through the Air Ministry Meteorological radio station at Borough Hill. This service from Borough Hill was inaugurated in 1935-6 to replace broadcasts from Heston which had been initiated by the A.A. The service has developed considerably during the past two years, and the number of stations for which reports are broadcast and the frequency of the reports were further increased in October, 1937. With the completion of arrangements now in hand, the broadcasts will include reports from the majority of civil airports in this country.

Reception of these broadcasts at aerodromes provides a comprehensive picture of current weather conditions in the British Isles, and should greatly diminish the necessity for the *ad hoc* transmission of reports for individual flights.

Particulars of the broadcasts are given in Notice to Airmen 232/1937.

(c) The preparation of synoptic charts at Headquarters and at local forecasting centres, for the purpose of making forecasts. General forecasts for aviation in Great Britain and Northern Ireland are prepared at Headquarters and broadcast by W/T from the Air Ministry, and by R/T from Borough Hill as follows :—

Aviation Forecasts Broadcast by W/T (GFA) and R/T (Borough Hill)
W/T (GFA) Air Ministry *R/T (Borough Hill)*

Clock Time of Issue.		Period of Forecast.	Clock Time of Issue.		Period of Forecast.
Winter.	Summer.		Winter.	Summer.	
0001	0101	For next 8 hours.	—	—	—
0825	*0715	For next 10 hours.	(None)	0745	For next 10 hours.
—	—	—	0845	0945	For next 10 hours.
1200	1300	For next 8 hours.	1145	1245	For next 8 hours.
1530	1600	Time of issue till midnight.	1445	1545	Time of issue till midnight.
1600	1630	To-morrow from midnight (in general terms).	1545	1645	To-morrow from midnight (in general terms).
1920	2020	Time of issue till midnight.	1945	2045	(i) Time of issue till midnight. (ii) To-morrow from midnight.

* 0925 Sundays.

(41298)

E 4

3. With regard to 1 (2) there are at present 34 meteorological stations, known as Distributive Stations (because their business is to distribute meteorological information and advice to those requiring it), on aerodromes in the British Isles. These stations are shown on the accompanying map. Of these stations five, viz., Croydon, Manchester, Bristol (Whitchurch), Foynes, and Hythe, are wholly or mainly engaged in providing services for civil aviation; while the stations at Abbotsinch, Calshot, Mount Batten and Aldergrove, though primarily serving the Royal Air Force, also provide services for civil aviation. All the stations named receive, according to requirements, the broadcasts of data mentioned in 2 (a) and (b), and prepare synoptic charts and forecasts.

Note.—Chart III shows stations actually operating at present.

Chart IV shows the distribution of the main forecast stations (type I and type II) proposed in the current reorganisation scheme to meet Royal Air Force and existing civil aviation requirements.

(Additional forecast stations are being considered in connection with the Maybury Report Scheme.)

The functions of these stations relating to civil aviation are described briefly below. (Foynes and Hythe are dealt with in the Overseas—Empire Air Routes Section.)

Croydon is concerned primarily with the requirements of the organised air lines to the Continent, but in recent years has provided increasing services required by the internal air lines (e.g., Railway Air Services, Irish Airways, North-Eastern Airways, Jersey Airways), operating from Croydon, Heston, Shoreham and Gatwick. The special meteorological organisation and services provided at Croydon conform to the highly developed procedure laid down by the International Commission for Air Navigation and International Aeronautical Conferences.

A forecast service is maintained from 7 a.m. to 9 or 10 p.m. Forecasts required outside this period are provided by Headquarters, with which there is now direct teleprinter connection. A service for the issue and reception of weather reports is maintained throughout the 24 hours.

In addition to the general information described in 2 (a) and (b), Croydon receives regularly the hourly and half-hourly W/T regional issues from Continental centres, viz., Paris, Brussels, Amsterdam, Cologne and from other centres as and when the requirements of civil air services necessitate. It also issues similar W/T messages containing reports from stations in S.E. England. Since February, 1937, the radio station has transmitted by W/T the current report of Croydon weather at intervals of 15 minutes. These transmissions are made in the Q code for the special information of aircraft approaching the airport and with a view to reducing the necessity for individual requests (Notice to Airmen 21/1937).

Prior to departure from Croydon, the pilot of each aircraft is provided with a form containing the forecast and necessary warnings for his flight and the latest available (usually less than an hour old) reports from stations along or near his route. The meteorologist discusses with the pilot the general weather situation, and advises, as necessary, on the best height and route for the particular flight.

Manchester (Barton) provides forecasts and reports of weather for the internal air lines which operate from Barton, Speke, Blackpool and Ronaldsway (e.g., Railway Air Services, Isle of Man Air Services, Irish Sea Airways), and during summer months for the K.L.M. service to Amsterdam.

A forecast service is provided from 8 a.m. to 5 or 6 p.m., and a reporting service from 7 a.m. to 6 p.m., G.M.T., or later as required.

Manchester is in direct reception of weather reports at hourly or other frequent intervals, from neighbouring airports, e.g., Speke, Blackpool, Ronaldsway, Yeaton, Doncaster, Stoke.

Abbotsinch supplies weather forecasts and reports in connexion with the services which operate from Renfrew Aerodrome (e.g., Railway Air Services and Isle of Man Air Services, Southward; Northern and Scottish Airways to the Hebrides).

A forecast service is available to cover all departures. A reporting service is maintained from 7 a.m. (4 a.m. in summer) until 6 p.m. G.M.T., or later as required.

In recent years auxiliary reporting stations have been established at Corsewall Point, Prestwick, Campbeltown, Glen Brittle and Loch Boisdale, from which weather reports are sent to Abbotsinch at times appropriate to the requirements of the air services.

Bristol (Whitchurch) was established in May, 1937. Forecasts and reports are supplied for the services.

Railway Air Services	..	Liverpool-Bristol-Brighton. Bristol-Cardiff-Exeter-Plymouth.
Irish Sea Airways	.. ..	Dublin-Bristol-Croydon.
Jersey Airways	.. ..	Exeter-Jersey.

A forecast service is available from 8 a.m. to 5 p.m. A reporting service is maintained from 7 a.m. G.M.T. (4 a.m. in summer) until 6 p.m. G.M.T.

Weather reports are obtained from Roborough, Exeter and Moretonhampstead at times appropriate to the air services.

Mount Batten provides services similar to those provided by Bristol for the route Plymouth-Exeter-Cardiff-Bristol, operated by Railway Air Services.

Calshot is in direct telephone communication with the airports at Southampton and Portsmouth. Forecasts are provided for the Jersey Airways' services which operate from Southampton to Jersey.

With the inauguration early in 1937 of the regular Empire flying boat services from Hythe (Southampton) across France to Egypt, Calshot supplied the necessary forecasts and route reports for the stage Southampton-Macon-Marseilles. Later this work was taken over by the newly established meteorological station at Hythe, but Calshot supplies to Hythe certain of the necessary Continental observations. A teleprinter service is now installed between Hythe and Calshot for this purpose. (*See also Overseas-Empire Air Routes Section.*)

Aldergrove. Occasional information is supplied to Newtownards for the Railway Air Services operating on the route Renfrew-Newtownards-Speke-Croydon.

4. The services, outlined in 3, performed by Distributive Stations cover most of the requirements of the regular air services operating within or from the British Isles, but certain meteorological services are provided direct from Headquarters, viz.,

- (1) forecasts (and route reports as necessary) are supplied direct to Distributive Stations at week-ends and in the early morning, when the local forecast service is not in operation.
- (2) the supply of forecasts and station reports to airports (used by air lines) at which there are no meteorological staff. Examples:—
 - (a) Forecasts to Dublin for the Dublin-Bristol-Croydon route.
 - (b) Forecasts to Jersey for the Jersey-Southampton route.

(c) For the North-Eastern Airways' service from Aberdeen (or Perth) to Croydon, forecasts are sent direct to Aberdeen (or Perth) and arrangements made for appropriate station reports for the next stages of the flight to be available at intermediate airports.

(d) During the operation of the Aberdeen Airways service between Newcastle and Stavanger in July–September, 1937, forecasts for the flight from Newcastle were supplied direct to Woolsington Airport. By arrangement with the Norwegian Meteorological Service, reports of weather at five stations in S.W. Norway were transmitted by W/T to Newcastle shortly before the commencement of the flight. For the return flight to Newcastle, reports from six stations on the east coast of Scotland and England were concentrated at Woolsington and thence transmitted to Stavanger.

5. Summary of Meteorological Facilities according to Air Services

(1) Continental services :—

(a) Croydon (or Heston) to France, Switzerland, Belgium, Holland, Germany, Austria, Sweden.

Meteorological service provided by Croydon, comprising the supply of forecasts and warnings, hourly or half-hourly weather reports from stations on or near the routes. Reporting stations in S.E. England :—

Croydon, Biggin Hill, Lympne, Manston (all 24-hour service), Dungeness, Beachy Head, Crowborough, Marden, Gatwick, Gravesend.

(b) K.L.M. service between Amsterdam–Doncaster–Liverpool.

Meteorological forecasts and route reports provided by Manchester to Liverpool (Speke), Doncaster and Amsterdam. Reporting stations on English portion of route :—

Hull, Doncaster, Yeadon, Manchester, Speke, Cranwell, Gorleston and Spurn Head.

(c) Aberdeen Airways : Newcastle–Stavanger.

During the first season, July–September, 1937, arrangements were as follows :—

(i) Newcastle–Stavanger.

Pilot at Woolsington supplied with a forecast transmitted from Headquarters and latest weather reports (transmitted by W/T from Stavanger), from the Norwegian stations Slattery, Utsira, Scia, Eigeray and Lista.

Later Norwegian weather reports were transmitted by Stavanger to the aircraft whilst in flight.

(ii) Stavanger–Newcastle.

Pilot at Stavanger supplied with a forecast by the Norwegian Meteorological Service at Bergen and latest weather reports from Lerwick, Wick, Aberdeen, Leuchars, St. Abb's Head, Woolsington and Spurn Head, transmitted by W/T from Woolsington.

Woolsington supplied local weather reports to the incoming aircraft on request.

(2) Railway Air Services :—

(a) Glasgow–Belfast–Liverpool–London.

Forecasts and route reports supplied by Abbotsinch, Aldergrove (as required), Manchester and Croydon.

(b) Liverpool–Birmingham–Bristol–Southampton–Brighton.

Forecasts and route reports supplied by Manchester, Bristol and Croydon.

(c) Cardiff–Bristol–Exeter–Plymouth.

Forecasts and route reports supplied by Bristol and Mount Batten.

(3) North Eastern Airways : London–Doncaster–Newcastle–Perth (or Aberdeen).

Forecasts and route reports supplied by Croydon and Headquarters. Reports of weather at stations ahead are concentrated at intermediate airports for information of pilots on landing, or for transmission to aircraft in flight.

(4) Isle of Man Air Services : Manchester–Liverpool–Blackpool–Isle of Man–Belfast–Glasgow.

Forecasts and route reports supplied by Manchester and Abbotsinch.

(5) Irish sea Airways :

(a) Dublin–Liverpool.

Forecasts and station reports supplied by Manchester.

(b) Dublin–Bristol–London.

Forecasts and station reports supplied by Headquarters, Bristol and Croydon.

(6) Northern and Scottish Airways :

(a) Glasgow–Hebrides.

Forecasts and station reports supplied by Abbotsinch.

(b) Glasgow–Isle of Man.

Forecast, and station reports supplied by Abbotsinch and Manchester.

(7) Jersey Airways :

(a) Jersey–Southampton–Heston.

Forecasts and reports supplied by Headquarters, Calshot and Croydon.

(b) Jersey–Exeter.

(c) Jersey–Shoreham.

Forecasts for (b), the Exeter–Jersey flight, were supplied by Bristol in 1937. More complete arrangements for (b) and (c) have been under consideration recently for introduction with the resumed services in 1938.

B.—Overseas (Empire Air Routes)

Meteorological information for the Empire Air Routes Services is supplied partly by stations in the United Kingdom, partly by stations overseas manned by Meteorological Office staff, and partly by Meteorological Services organised by the Colonial Governments. These are detailed below.

A.—Stations in United Kingdom

(1) *Foynes*.—A meteorological station was established at Foynes in February, 1937. It is equipped by the Eire Government, but is staffed and controlled by the Meteorological Office, Air Ministry, on an agency basis.

The station is manned by 3 Technical Officers and 3 Assistants, and a full meteorological observing and charting routine is carried out.

The work of the station in regard to Trans-Atlantic flights consists of :—

(a) Supply of information before the commencement of a flight ;

(b) Supply of information during flight.

(a) *Supply of information before the commencement of a flight*.—(1) Gale and squall warnings are issued for the safety of aircraft moored at Foynes.

(2) Conferences are held with the Captain of the aircraft and the Control Officer in regard to anticipated meteorological conditions during the flight.

(3) When a decision to commence the flight has been reached, the Captain of the aircraft is supplied with—

- (i) a copy of the latest synoptic weather chart of the North Atlantic,
- (ii) a statement of the general meteorological situation,
- (iii) a detailed forecast for the route,
- (iv) a forecast of conditions at Botwood at the estimated time of arrival.

(b) *Supply of information during flight.*—(i) After the completion of each synoptic chart following the commencement of a flight, the aircraft is notified by W/T of the developments in the meteorological situation along the route. This procedure is continued until the control of the aircraft is transferred from Foynes to Botwood, when it is taken over by Botwood.

(ii) For west to east flights, the procedure commences when Foynes takes over control of the aircraft from Botwood.

(2) *Hythe (Southampton).*—Pending the establishment of the permanent Empire Air Base, a meteorological station was established at Hythe in May, 1937, specially to meet the requirements of the Empire Air Services.

The staff consists of 3 Technical Officers and 2 Assistants, and a full observing and charting routine is carried out.

Captains of outgoing aircraft receive a written report of existing conditions on the route, together with a forecast. Aircraft in flight can obtain forecasts of probable conditions at any time on request through Portsmouth Radio Stations. In addition to written and other forecasts and reports, conferences take place with pilots before and after flights.

Four hours prior to the estimated time of arrival at Hythe, reports are sent for information of the aircraft in flight, via Croydon and Le Bourget, but one to two hours before the expected time of arrival at Hythe, reports are supplied direct by Portsmouth Radio.

B.—Overseas Stations controlled by Meteorological Office, Air Ministry

(1) *Gibraltar.*—A permanent meteorological station was established at Gibraltar in August, 1937, the station having been first opened on a temporary basis at the end of 1935. Though the station was established primarily to meet the needs of the Defence Services, nevertheless the possible requirements of civil aviation were borne in mind when its establishment was settled.

Observations at present made cover the period from 0700 to 1800 G.M.T. daily, and synoptic charts are drawn.

Reports and forecasts are available, and communications are effected through the Naval W/T Station at Gibraltar.

(2) *Malta.*—The meteorological station at Malta was established in 1922. It caters mainly for the needs of the Services, as no British civil air services have had occasion to use the island as a regular air base. All information necessary for special flights of civil aircraft has been, and continues to be, supplied.

Action is in progress, and additional staff approved, to meet the requirements of the regular service by Imperial Airways, anticipated to commence early in 1938. A small sub-office is being established on the aerodrome to be used by Imperial Airways at Takali.

(3) *Heliopolis.*—A meteorological section was established at Heliopolis in 1927. One of the main functions of this station has been the supply of reports and forecasts to meet the requirements of civil aviation in Egypt generally, and Imperial Airways in particular. To meet recent developments

in this connection, approval was given in the current year for an increase of staff of 1 Technical Officer, 1 Assistant and 1 Observer at Heliopolis, and for the establishment of a new subsidiary station at Alexandria.

(4) *Hinaidi*.—The meteorological station at Hinaidi was established in 1932. One of its functions has been the supply of information for civil air line services operating in and through Iraq. The office is shortly moving to Dhibban and is at present in the process of handing over the civil aviation side of its work to the recently formed Iraqi Meteorological Service.

All these stations are collecting centres, and receive reports several times daily from a large number of stations in Europe, North Africa, and Western Asia, and from ships at sea. These are used in the construction of synoptic weather maps and for the information of pilots.

C.—Overseas Services controlled by Colonial Governments

With the development of Empire Air Mail Services, arrangements were made with the Dominions and Colonies affected, for their co-operation in providing meteorological facilities for air routes services over or near their territories. Meteorological services have recently been established in the Sudan and in British West Africa, while the service in British East Africa has been expanded, so that in these territories anticipated requirements will be fully met.

Mr. Entwistle, Head of the Overseas Division of the Meteorological Office, visited, early in 1937, British East Africa and British West Africa to advise the authorities concerned in regard to the provision of the meteorological facilities required.

The Meteorological Office has further co-operated with the Colonies in the provision and training of staff. This has been done under difficulties and has been a great drain on the resources of the office in the matter of experienced staff.

CHART I

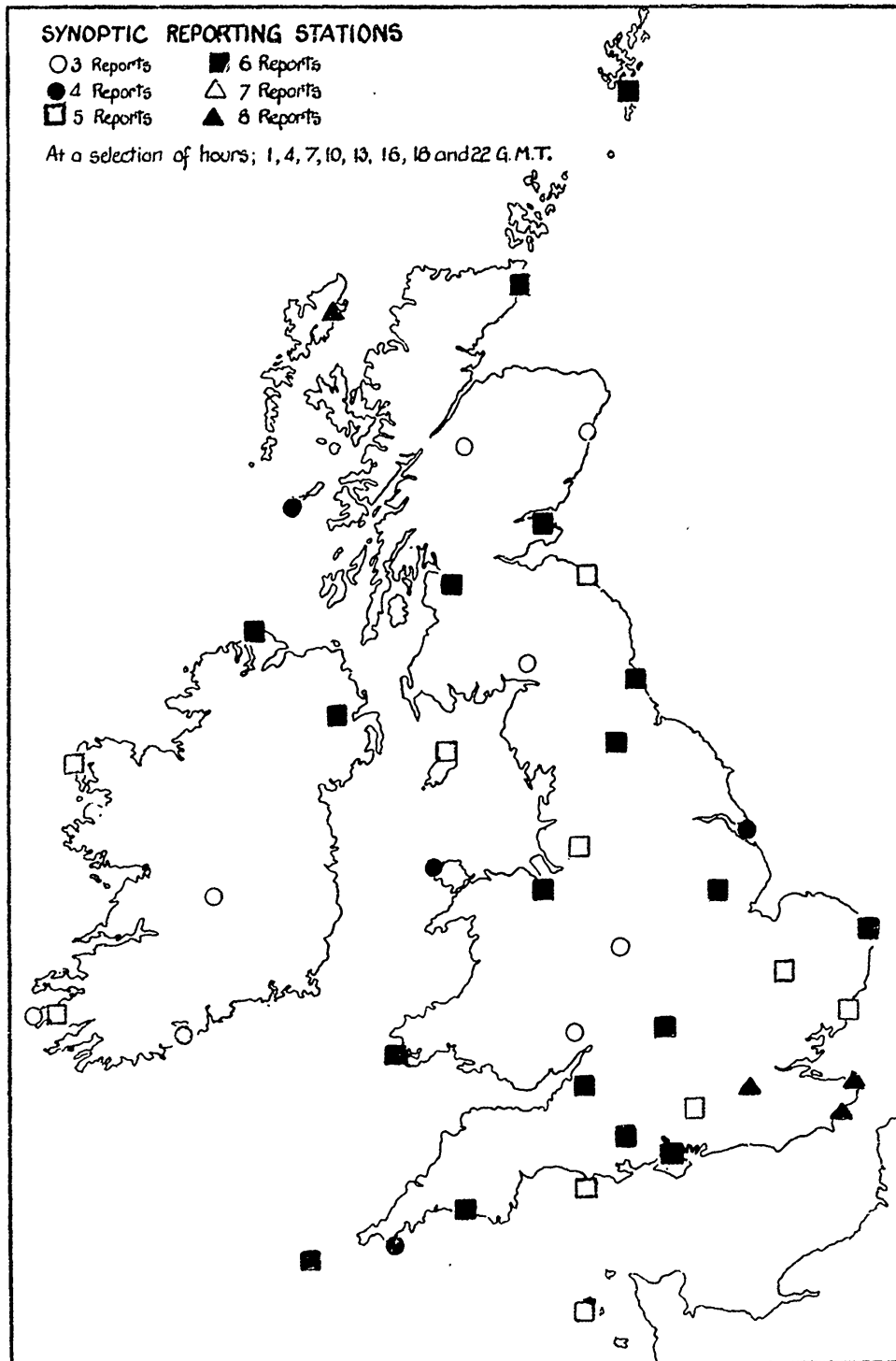


CHART II

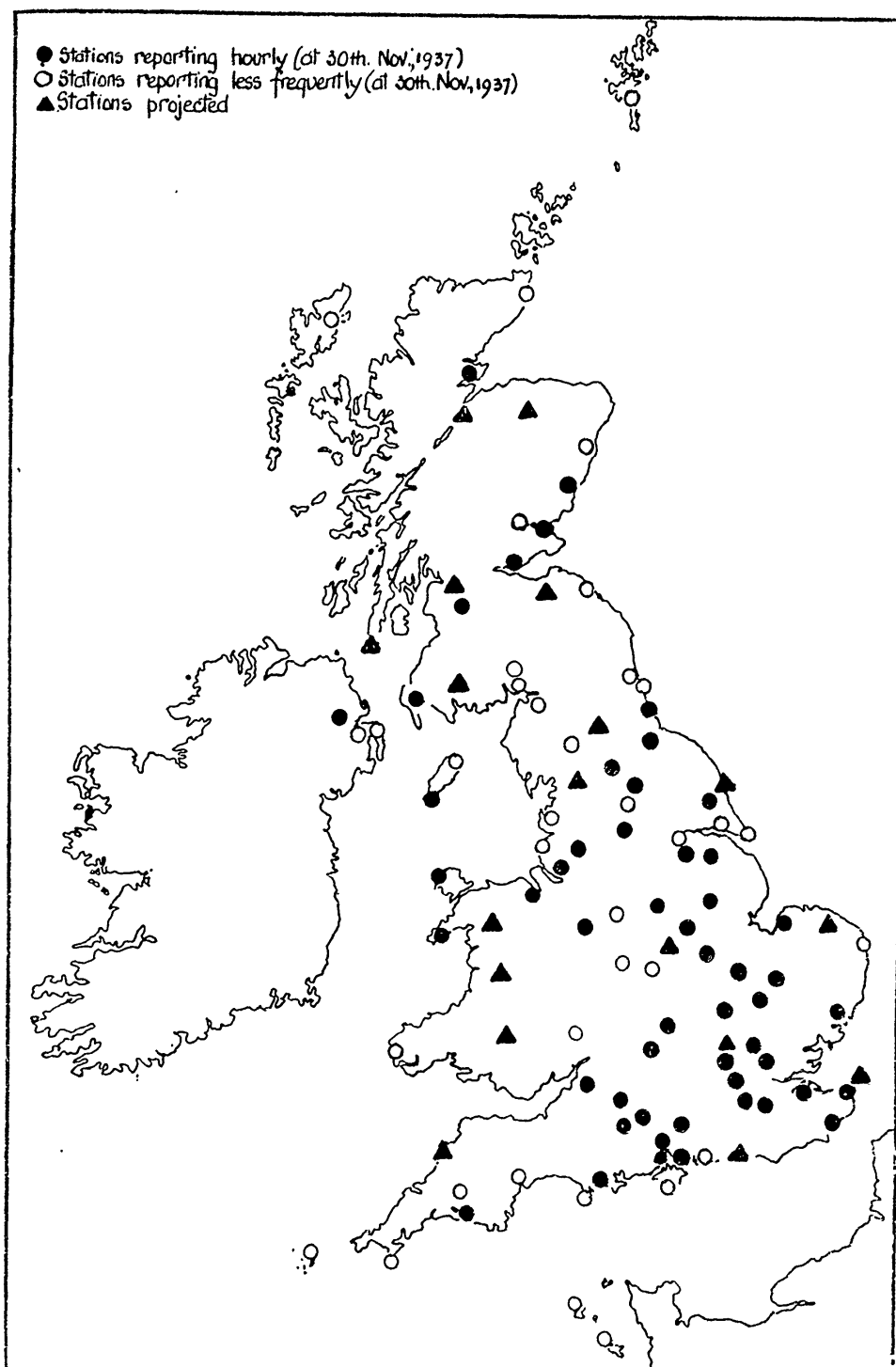


CHART III

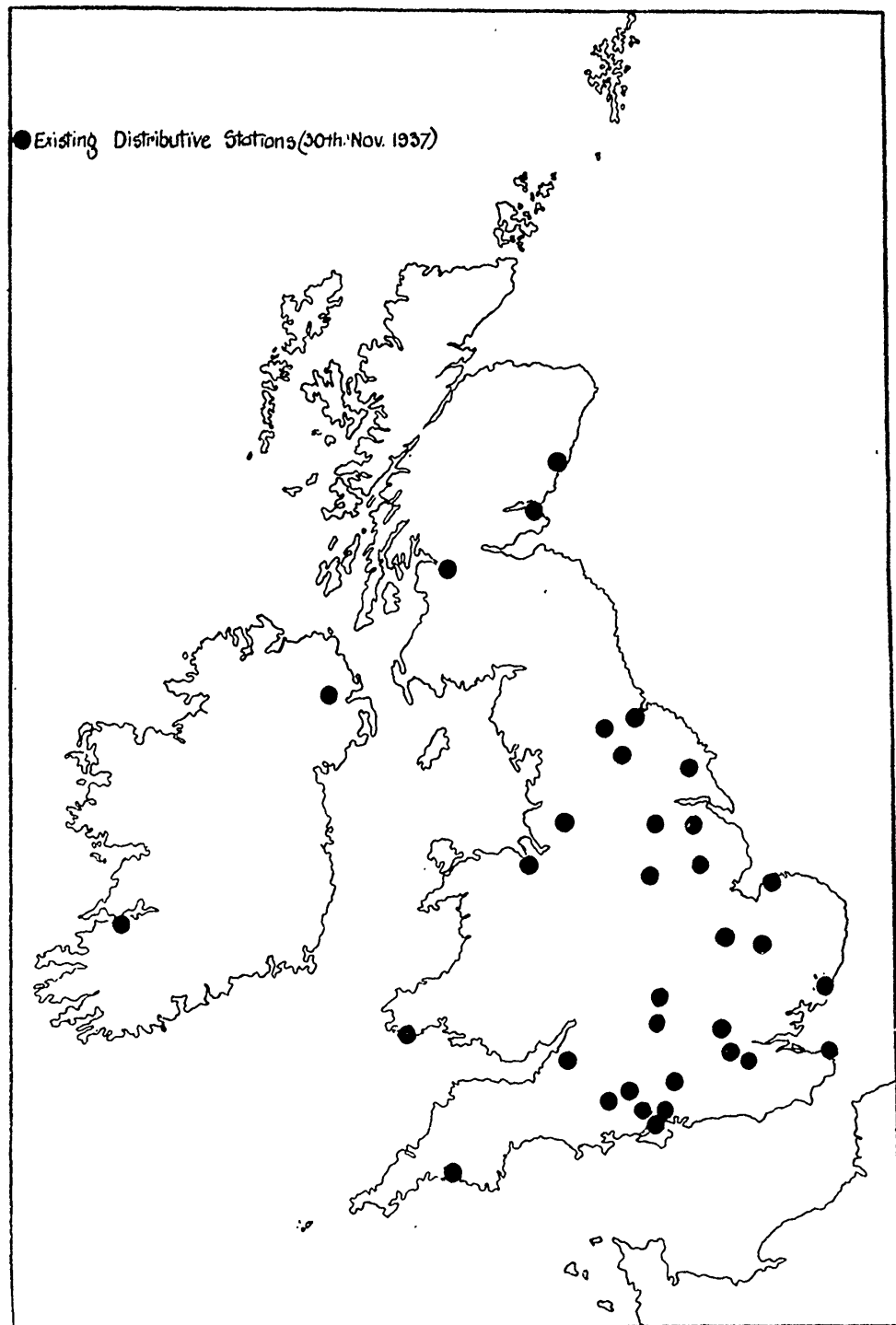
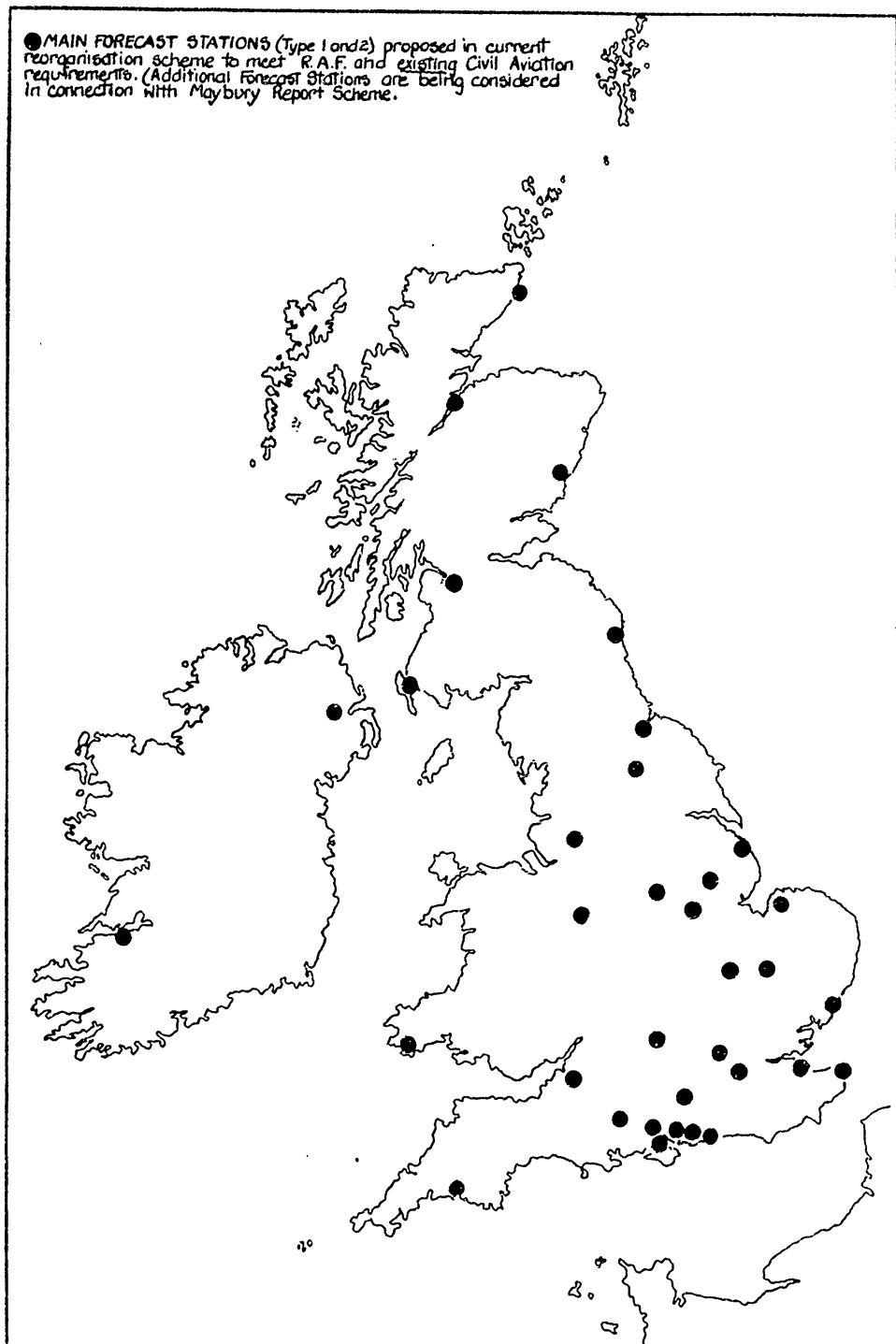


CHART IV



PART II

COMMUNICATIONS

A.—Direction-Finding Facilities created by the Air Ministry during the last two years (1936–1937)*Home***1. Direction-finding installations.—**

- 1936 .. Sumburgh (Shetlands).
 Kirkwall (Orkneys).
 Newcastle.
 Doncaster.
 Gatwick (since withdrawn).
 Perth.
 Southampton.
 Yeadon (Leeds).
 Pulham. Conversion of second channel to Adcock (night error-free direction finder).
 North Uist (Hebrides). (By arrangement with Northern and Scottish Airways, Ltd.)
- 1937 .. Isle of Man.
 Manchester, second channel.
 Croydon, fourth channel.
 Lympne, second channel. Conversion to Adcock system.
 Inverness. Just completed. Not yet open for service.

Fifteen new stations have thus been erected.

2. Radiobeacons.—*(a) Ultra Short Wave (landing/approach) beacons :—*

- Heston, 1936. By arrangement with the local authority.
 Gatwick, 1936. By arrangement with the local authority.
 Croydon, 1937.
 Croydon, 1936. Two experimental beacons designed by British manufacturers.

(b) Medium Wave (landing/approach) beacons :—

- Liverpool, 1937. By arrangement with local authority.
 Completed and now opened for service.

(c) Omni-directional (long-range navigating) beacons :—

- Croydon, 1937. Completed. Opening delayed by failure of French authorities to vacate the wavelength allotted to Croydon ; commenced service January, 1938.

Direction finders in aircraft.—The practice of equipping larger types of aircraft with their own direction finders is rapidly growing. This enables the aircraft to take their own bearings on various classes of ground transmitter, such as broadcasting stations. The possibilities are limited, so far as British internal air-routes are concerned, because the aircraft often employed are too small either to carry a wireless operator or the equipment.

B.—Direction-finding facilities prior to 1936 :—

Strictly speaking the expansion of the Home wireless organisation began in 1934/35, during which time the following were erected :—

Hull.
 Newtownards (Belfast).
 Portsmouth.
 Bristol.
 Heston.
 Renfrew (conversion from Meteorological to Direction-finding Station).
 Croydon, third channel.
 Lympne, second channel.
 Pulham, second channel.
 Lympne, first channel converted to Adcock.
 Jersey (by arrangement with the local authority).

C.—Facilities prior to 1934 :—

Croydon, 2 channels.
 Lympne, 1 channel.
 Pulham, 1 channel.
 Manchester (1933), 1 channel.
 Croydon, medium wave track beacon (since modified).
 Orfordness (Royal Air Force), rotating beacon.
 Tangmere (Royal Air Force), rotating beacon. Utilisable by civil aviation.

In total, the aeronautical facilities detailed above amount to—

27 direction finders,
 10 radiobeacons (of which some are experimental).

It is instructive to observe that the sum of direction-finding facilities provided in Great Britain for all shipping is—

7 direction finders,
 22 radiobeacons (omni-directional ; similar to A.2 (c) above).

There are 188 British aircraft equipped with wireless (the second highest total in Europe)—but many thousands of ships.

Overseas

Country and Place	Type of Equipment	Remarks
<i>Sudan :</i>		
Wadi Halfa ..	Marconi M/W Adcock*	In operation.
Kareima ..	Marconi M/W Adcock*	In operation.
Khartoum ..	Marconi M/W Adcock*	In operation.
Kosti ..	Marconi M/W Adcock*	In operation.
Malakal ..	Marconi M/W Adcock*	In operation.
<i>Uganda :</i>		
Entebbe ..	Marconi M/W Adcock*	In course of installation.
Laropi ..	Marconi M/W Adcock*	On site awaiting installation.

* This equipment was purchased and delivered by the Air Ministry on behalf of the local Governments concerned.

Overseas—contd.

Country and Place	Type of Equipment	Remarks
<i>Kenya :</i>		
Kisumu ..	Marconi M/W Adcock*	In operation.
Mombasa ..	Marconi M/W Adcock*	In course of installation.
Nairobi ..	Marconi M/W Adcock	By arrangement with Cable & Wireless, Ltd.
<i>Tanganyika :</i>		
Dar-Es-Salaam	Marconi M/W Adcock*	In course of installation.
Lindi	Marconi M/W Adcock*	In course of installation.
Moshi	Marconi M/W Adcock*	In course of installation.
Dodoma	Marconi M/W Adcock*	In course of installation.
Mbeya.. ..	Marconi M/W Adcock*	In course of installation.
<i>N. Rhodesia :</i>		
Lusaka ..	Marconi M/W Adcock*	On site awaiting installation.
Kasama ..	Marconi M/W Adcock*	On site awaiting installation.
<i>Gold Coast :</i>		
Accra	Marconi M/W Adcock*	In course of installation.
<i>Nigeria :</i>		
Maidugari ..	M/W Transmitter* ..	In operation for " homing."
Kano	M/W Transmitter* ..	In operation for " homing."
	Marconi M/W Adcock*	In course of installation.
Lagos	Marconi M/W Adcock*	In course of installation.
<i>Iraq :</i>		
Dhibban ..	Marconi M/W Adcock	Being installed. R.A.F. station used by Imperial Airways, Ltd.
<i>Persian Gulf :</i>		
Bahrein ..	Marconi M/W Adcock	By arrangement with Cable & Wireless, Ltd.
Sharjah ..	Marconi M/W Adcock†	On site awaiting installation.
Gwador ..	Marconi M/W Adcock†	On site awaiting installation.
<i>Bermuda</i> ..	Marconi S/W Adcock	By arrangement with Cable & Wireless, Ltd.
<i>Newfoundland :</i>		
Botwood ..	Marconi M/W Adcock‡	In operation.
	Marconi S/W Adcock‡	In operation.
Gandar Lake ..	Marconi D/F Loops‡	Awaiting installation.
Hatties Camp	Marconi D/F Loops‡	Awaiting installation.
	Blind Landing Beacon‡	Awaiting delivery.

* This equipment was purchased and delivered by the Air Ministry on behalf of the local Governments concerned.

† This equipment was purchased and is being installed by the Air Ministry.

‡ This equipment is being or has been installed and operated by the Air Ministry.

APPENDIX F

PARTICULARS OF FATAL ACCIDENTS TO AIRCRAFT OF IMPERIAL AIRWAYS AND OF CERTAIN OTHER EUROPEAN AIR TRANSPORT COMPANIES. 1934-1937.

(Memorandum furnished by the Air Ministry.)

	No. of Fatal Accidents					No. of Persons Killed														
	1934	1935	1936	1937	Total	1934			1935			1936			1937			Total 1934-1937		
						Passengers	Crew	Total	Passengers	Crew	Total	Passengers	Crew	Total	Passengers	Crew	Total	Passengers	Crew	Total
Imperial Airways.	—	1	3	4	8	—	—	—	9	3	12	2	6	8	5	8(a)	13	16	17	33
Deutsche Lufthansa.	2	3	4	5	14	—	6	6	1	7	8	12	8	20	8	12	20	21	33	54
K.L.M. ..	1	3	1	2	7	3	4	7	13	13	26	12	3	15	11	8	19	39	28	67
Air France	4	3	4	3	14	3	8	11	—	8	8	3	17(a)	20	1	9(b)	10	7	42	49
Sabena ..	—	1	1	2	4	—	—	—	7	4	11	—	2	2	16	7	23	23	13	36

(a) Includes 1 company's executive.

(b) Includes 3 company's employees.

Notes

1. 1934-1936 figures confirmed from statistics published by the International Commission for Air Navigation. (Except for Germany, which is not a member of the I.C.A.N.)
2. Figures for D.L.H. 1934-1936 based on Nachrichten für Luftfahrer (official publication of German Air Ministry).
3. 1937 figures based on press and official reports.

APPENDIX G

**PASSENGER-MILEAGES FLOWN BY CERTAIN EUROPEAN
AIR TRANSPORT COMPANIES**

1934-1936

(Memorandum furnished by the Air Ministry.)

				Total Passenger-miles.	Percentage of Total Passenger-miles <i>outside Europe and the Mediterranean.</i>
Imperial Airways	..	1934	22,411,000	54	
		1935	30,825,000	59	
		1936	27,921,000	55	
Deutsche Lufthansa	..	1934	31,610,738	} Nil.*	
		1935	48,237,065		
		1936	60,317,476		
K.L.M.	.. ..	1934	14,245,694	19
		1935	15,963,566	31	
		1936	22,474,309	37	
Air France	.. ..	1934	18,482,905	38
		1935	19,920,412	36	
		1936	21,236,497	39	
Sabena	.. ..	1934	3,025,191	20
		1935	4,990,660	21	
		1936	6,894,482	23	

* Deutsche Lufthansa do not take passengers on their South American service.

APPENDIX H

**LIST OF ACCIDENTS TO IMPERIAL AIRWAYS' AIRCRAFT SINCE
1st JANUARY, 1934**

(Memorandum furnished by the Air Ministry.)

No.	Year.	Date.	Aircraft.	Place.	Casualties.			
					Killed.		Injured.	
					Passengers.	Crew.	Passengers.	Crew.
1	1935	6 Oct.	" Hanno "	Entebbe	—	—	—	—
2		10 Oct.	" Syrinx "	Brussels	—	—	—	3
3*		22 Oct.	" Draco "	Zwepple (near Vienna).	—	—	—	—
4		25 Oct.	" Britomart "	Brussels	—	—	7	1
5		2 Nov.	AW15 Type	Rangoon	—	—	—	1
6		2 Nov.	Atalanta	Kisumu	—	—	—	1
7		31 Dec.	" City of Khartoum."	Alexandria	9	3	—	—
8	1936	10 Feb.	" Artemis "	Pietersburg	—	—	—	2
9		10 Aug.	" Vellox "	Croydon	—	4	—	—
10		22 Aug.	" Scipio "	Mirabella	2	—	5	4
11		25 Sept.	" Boadicea "	English Channel.	—	2	—	—
12*	1937	15 Mar.	" Jupiter "	Elsdorf (Cologne).	—	3†	—	—
13		24 Mar.	" Capri- cornus "‡	Macon	1	4	—	1
14		1 Oct.	" Courtier "‡	Athens	3	—	4	—
15		5 Dec.	" Cygnus "‡	Brindisi	1	1	6	5
					16	17	22	18

* Nos. 3 and 12 on Budapest route. † Includes 1 company executive.
‡ Short Empire flying boats.

**COMPARISON OF ACCIDENTS AND DEATHS OF PASSENGERS
WITH TOTAL PASSENGERS CARRIED**

	Passengers carried. (Individual.)	Number of Accidents involving Fatalities.	Number of Passengers Killed.
1934	54,875	—	—
1935	66,324	1	9
1936	60,374	3	2

APPENDIX I

COMPARATIVE STATISTICS OF THE CROSS-CHANNEL TRAFFIC TO AND FROM CROYDON OF IMPERIAL AIRWAYS AND CERTAIN OTHER AIR TRANSPORT COMPANIES

(Compiled from information furnished by the Air Ministry.)

TABLE A

Passenger Traffic on Regular Continental Air Services

Year.	Number of Passengers.		Percentage of Imperial Airways' Traffic to Total Traffic.
	Total.	Carried by Imperial Airways.	
1931	44,944	20,683	46
1932	70,162	41,500	59
1933	87,115	49,842	57
1934	93,830	49,570	53
1935	116,137	58,852	51
1936	129,824	55,410	43
1937	150,310 (a)	54,614 (a)	36 (a)

TABLE B

Traffic on Routes from Croydon to the Continent over which Imperial Airways have operated Services

Year.	Percentage of Total Traffic carried by British Companies.	Percentage of Total Traffic carried by Imperial Airways.	Percentage of British Companies' Traffic carried by Imperial Airways.
1931	57	57	100
1932	68	68	100
1933	70	66	95
1934	74	64	87
1935	70	60	86
1936	64	52	82
1937	60 (a)	47 (a)	78 (a)

(a) Excluding Empire services from Southampton.

For the years 1931-6 details are not available to enable passengers carried by Imperial Airways on European services to be distinguished from those carried on Empire services from Croydon.

APPENDIX I—continued

TABLE C

**STATEMENT OF REGULAR SERVICES IN OPERATION FROM
ENGLAND TO THE CONTINENT ON ROUTES OPERATED BY
IMPERIAL AIRWAYS, LTD.**

(Note.—The number of inward services is not in all cases identical.)

	Number of services per day (weekdays)				
	July, 1933	July, 1934	July, 1935	July, 1936	July, 1937
<i>London-Paris—</i>					
Imperial Airways ..	4 (e)	4 (e)	6 (e)	4	4
Air France	4	6	4	4	5
Hillman's Airways ..	—	—	3 (b)	—	—
British Airways	—	—	—	3 (c)	4
Wrightways	—	—	1 (a)	1 (a)	1 (a)
Commercial Air Hire and Air Dispatch.	—	—	1 (a)	{ 1 (a) 1 }	1 (a)
Total	8	10	15	14	15
<i>London-Basle-Zurich—</i>					
Imperial Airways ..	1 (d)	1 (d)	2 (d)	1	1
Swissair	—	—	1	1	1
Total	1	1	3	2	2
<i>London-Brussels—</i>					
Imperial Airways ..	1	1	2 (f)	3 (f)	2 (f)
Sabena	2	2	1	2	3
Hillman's Airways ..	—	—	2 (b)	—	—
British Continental Air- ways.	—	—	—	1	—
Total	3	3	5	6	5

- (a) Operated mainly for freight.
 (b) Operated from Romford.
 (c) Operated from Gatwick.
 (d) Operated via Paris and included in Paris figures.
 (e) Includes Zurich service operated via Paris.
 (f) Includes Imperial Airways' Budapest service (once daily) which did *not*, however, call at Brussels in July, 1936.

APPENDIX I—continued

TABLE D

Regular Air Transport Companies : Passenger traffic in and out of Croydon : Continental Air Routes, 1937

<i>Foreign Companies :—</i>						
Air France	..	..	..	..	..	23,529
D.L.H. (German)	..	..	..	..	..	9,889
K.L.M. (Dutch)	..	..	..	..	..	25,819
Sabena (Belgian)	..	..	..	..	..	12,291
Swissair (Swiss)	..	..	..	..	..	8,439
				Total	..	79,967
<i>British Companies :—</i>						
British Airways	..	..	..	..	..	14,995
Imperial Airways	..	..	..	..	..	54,614
Other companies	..	..	..	..	..	734
				Total	..	70,343
<i>All companies</i>	..	..	..	..	..	150,310
Percentage carried by Imperial Airways :—						
(a) Of total of all companies' traffic	..	..	..	..	..	36 per cent.
(b) Of British companies' traffic	..	..	..	..	..	78 per cent.

TABLE E

Proportion of European to Empire traffic

The subjoined table shows the proportion of European to Empire traffic of Imperial Airways :—

	Passengers accepted for Transport.		Passenger Mileage.	
	European Services	Empire Services	European Services	Empire Services
	Per cent.	Per cent.	Per cent.	Per cent.
1931	94	6	70	30
1932	90	10	60	40
1933	90	10	55	45
1934	88	12	46	54
1935	87	13	41	59
1936	87	13	45	55
*1937 (Jan.—May)	81	19	29	71

Separate details are not available from existing records as to the number of passengers carried to and from England on European services, as distinct from those carried on the Empire services during 1931–1936. These passengers are included under European services for these years. As from March, 1937, when the Empire services were transferred to Southampton, the figures were—

Passengers in and out of Southampton	..	6 per cent.
“ “ “ Croydon	..	94 per cent.

*Note.—These figures do not cover the summer months of peak traffic on the European services. Passenger mileage figures for June onwards are not yet available.

APPENDIX J

BRITISH GOVERNMENT SUBSIDY PAID TO IMPERIAL AIRWAYS, LTD.

(Memorandum furnished by Imperial Airways, Ltd. The amounts shown are those credited in the Company's accounts.)

Years ended 31st March.	European Services.	England- India Services.	Egypt- South Africa Services.	Other Services.	Total.
	£	£	£	£	£
1925	137,000	—	—	—	137,000
1926	137,000	—	—	—	137,000
1927	137,000	15,600(a)	—	—	152,600
1928	137,000	98,100(a)	—	—	235,100
1929	137,000	93,600(a)	—	—	230,600
1930	125,000	239,650	—	—	364,650
1931	125,000	205,565	9,760(b)	—	340,325
1932	110,000	200,000	157,513(b)	—	467,513
1933	110,000	200,000	235,008	—	545,008
1934	110,000	200,000	204,494	29,200	543,694
1935	110,000	210,000	174,495	67,061	561,556
1936	80,000	150,000	144,760	51,835	426,595
1937	65,000	92,500	135,247	89,020	381,767

(a) Cairo-Basra section only.

(b) Northern section only.

APPENDIX K

COMPARATIVE SUBSIDIES PER TRAFFIC TON-MILE**(Memorandum furnished by Imperial Airways, Ltd.)**

	Per Ton-mile.			Total Subsidy.
	<i>s.</i>	<i>d.</i>		£
Imperial Airways	1	5·72	(1936-37)	381,767
Air France	7	2·72	(1936)	1,246,807
D.L.H. (German)	3	2·82	(1936)	1,038,308
Sabena (Belgian)	1	10·46	(1936)	82,447
A.B. Aero Transport (Swedish)	1	9·79	(1936)	35,628

APPENDIX L

SUBSIDIES PAID TO CERTAIN EUROPEAN AIR TRANSPORT COMPANIES
 Expressed as Percentages of Total Receipts.
 (Compiled from information furnished by the Air Ministry and Imperial Airways.)

Company	Year	Subsidy	Total Receipts (including Subsidy)	Subsidy as Percentage of Total Receipts
Imperial Airways, Ltd. . .	1934	£543,694	£1,197,807	Per cent. 45·4
	1935	£561,556	£1,425,167	39·4
	1936	£426,595	£1,539,065	27·7
	1937	£381,767	£1,604,061	23·8
Air France	1934	Fcs. 163,405,167 (£1,315,555) ..	Fcs. 219,390,442 (£1,766,286) ..	74·48
	1935	Fcs. 161,553,925 (£1,300,619) ..	Fcs. 220,385,737 (£1,774,305) ..	73·31
	1936	Fcs. 154,865,873 (£1,246,807) ..	Fcs. 235,952,747 (£1,899,626) ..	65·63
Deutsche Lufthansa ..	1934	Rm. 20,649,903 (£1,010,764) ..	Rm. 40,542,988 (£1,984,483) ..	50·93
	1935	Rm. 19,656,115 (£962,120) ..	Rm. 45,525,259 (£2,228,333) ..	43·18
	1936	Rm. 21,212,643 (£1,038,308) ..	Rm. 50,050,082 (£2,449,833) ..	42·38
S.A.B.E.N.A.	1935	Fcs. 12,605,499 (£72,031) ..	Fcs. 35,026,450 (£200,151) ..	35·99
	1936	Fcs. 14,428,232 (£82,447) ..	Fcs. 42,022,408 (£240,129) ..	34·33
Ala Littoria	1931-1935	Lire 49,696,300 (£537,478) ..	Lire 55,822,011 (£603,742) ..	89·02
	1935-1936	Lire 65,983,140 (£713,640) ..	Lire 97,327,982 (£1,052,650) ..	67·79

Note.—Conversions have been calculated at " par " rates of exchange.