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COMMITTEE

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FOR THE YEAR
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VOL. I

Aerodynamics General, Performance,
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R. & M. No. 1868 contains abstracts of papers published in full elsewhere.
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[3] War Office.

[4] Royal Aircraft Establishment.

[5] Directorate of the Meteorological Office, Air Ministry.

[6] Directorate of Scientific Research, Air Ministry.

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AERONAUTICAL RESEARCH COMMITTEE

Report for the Year 1939

May, 1940.

The Right Hon. Sir Archibald Sinclair, M.P.,
Secretary of State for Air.

Sir,

We, the Aeronautical Research Committee, beg leave to submit our Report for the year 1939.

In view of the war, we confine ourselves to a brief record of work done on problems of special importance. The usual detailed accounts of the work of our Sub-Committees are omitted.

1. *Policy of the Committee.*—Soon after the outbreak of war, two small executive committees were appointed by the Director of Scientific Research, Air Ministry, to ensure that the best use was made of facilities at the National Physical Laboratory, and the Royal Aircraft Establishment, and to discuss the progress of urgent work on aerodynamics and engine development. The Main Committee is represented on these Committees. The Committee has also been meeting regularly to discharge its normal duties of initiating and advising on work of less immediate urgency.

2. *Aerodynamics.*—Considerable importance is attached to the experiments now in progress which have for their object the reduction of resistance by the development of wing sections in which the change from a laminar to a turbulent boundary layer occurs far back along the chord. Both flight and model experiments are being made on this subject, and a successful outcome would lead to a marked improvement of performance.

High lift devices are being designed, more particularly with a view to enabling the Fleet Air Arm to increase the speed range or carrying capacity of aircraft without any increase in the overall size of each aeroplane when folded. To confirm the results of preliminary tests, large single and double slotted flaps are being fitted to experimental wings for existing monoplanes and a complete model with large double flaps is ready for tests in the 24-ft. wind tunnel. Since with normal ailerons the span of the brake flaps is limited, full scale tests on lateral control devices which can be used with full span flaps are also being made. These devices take the form of upper surface spoiler-ailerons. The high lift possibilities offered by the Handley Page leading edge slot at large wing incidences which cannot normally be reached in flight are to be investigated in an experimental aeroplane in which the angle of incidence of the wing relative to the fuselage can be varied in flight.

Work is continuing on the analysis of the drag of different aeroplanes with the object of eliminating sources of high drag. A technique has been developed for this purpose which is based upon the momentum method of measuring the drag of wing sections. Three modern aircraft of clean design have been examined by this method in the large wind tunnel at the Royal Aircraft Establishment and further experiments are in progress. Work is also continuing on the investigation of the problem of adequately cooling engines at the minimum cost in head resistance.

3. *Stability and Control.*—The longitudinal stability of aeroplanes, particularly as affected by the slipstream, continues to engage the attention of the Committee. The matter has been investigated on a number of complete models of specific designs at both the National Physical Laboratory and the Royal Aircraft Establishment and a comprehensive general research is in progress.

It has been proved by experiment that neutral stability is not necessary in an aircraft fitted with an automatic pilot, and that a degree of stability which is desirable for operation without the automatic pilot is also quite suitable for use with it. Adequate longitudinal stability is now recognised as of special importance for operations in bad weather. Some types of bombers lack sufficient longitudinal stability, and the tendency to design for a small margin of stability is unsound. Wind tunnel tests of many models have indicated that increased tail surfaces are necessary for stability.

Horn-balanced elevators are being fitted in some aeroplanes in order to improve the longitudinal stability with stick free. In some cases, however, this improved longitudinal stability has been accompanied by an increased heaviness of the elevator control, and this has now been shown to be associated with the response of the aeroplane to a movement of the control. As soon as the elevator is moved the aeroplane starts to pitch ; this alters the effective tail incidence and so affects the force on the control.

Other problems affecting stability and control have been discussed by the Committee. Some modern aeroplanes have developed violent rudder oscillations at high speeds of flight, accompanied by yawing of the whole aeroplane with very little roll. This matter has been investigated theoretically and the general value of the effects is now understood. The conclusions of the investigation have been supported by the results obtained by applying them to two different aeroplanes. Investigations have also been made on the tendency shown by some aeroplanes to dive when yawed.

4. *Oscillation.*—In addition to general theoretical and experimental investigations, methods are under examination for the prediction of the critical speeds for flutter of wings carrying heavy concentrated masses along the span. This is important in connection with the design of multi-engined aeroplanes with the engines carried in nacelles along the wings. Other problems under consideration are associated with the effect of flexibility of the structure on both wing and tail flutter, and with flutter at high angles of incidence.

5. *Engines.*—The call for engines of increased power and small frontal area continues. Research on single cylinder two-stroke petrol engines with fuel injection having these characteristics has been encouraging, and complete aircraft engines are being developed.

Our Engine Sub-Committee has had under consideration a number of aircraft power schemes employing internal combustion turbines. In all these an air compressor is required and is driven either by a turbine or by a reciprocating engine. After compression, air is expanded at constant

pressure by burning fuel in it and it is then allowed to expand through turbine blading. The thrust is obtained either from a turbine-driven airscrew or from a power jet using a proportion of the thermal energy of the hot gases. Great variety in the combination of the various units is possible, and a wide range of power plants can be designed to suit different purposes. Experimental work is in hand covering a wide field of possible power plants.

6. *Structures.*—Our Structure Sub-Committee has continued to supervise research into problems relating to the structure of aircraft, and has held one joint meeting with representatives of the Society of British Aircraft Constructors. Further consideration has been given to the forces imposed on flying-boat hulls in operation on the water. The related problem of the forces imposed on undercarriages of land aircraft has also been considered.

7. *Experimental Apparatus.*—The four new wind tunnels under construction at the National Physical Laboratory will be completed in 1940. Their construction has been delayed by the demand for materials for war purposes and by the heavy frosts in the winter, but work is now proceeding normally. The largest of these tunnels will have a jet 13 ft. × 9 ft. and the design includes a long settling chamber which, it is hoped, will make the air stream considerably less turbulent than has hitherto been common in large wind tunnels. If this expectation is fulfilled, the tunnel should be of considerable value in connection with investigations of low drag wings.

In addition to the high speed tunnel at the R.A.E. mentioned below, a second small high speed tunnel is being installed in the new High Speed Laboratory at the N.P.L.

8. *New Sub-Committees and Panels.*—Two new bodies—the Fleet Air Arm Research Sub-Committee and the Kite Balloon Panel—have been appointed to consider certain matters which assumed special importance on the outbreak of war. The Fleet Air Arm Research Sub-Committee advises on researches required to fulfil the special requirements of the Fleet Air Arm. As an example we may mention one problem peculiar to the aircraft carrier. It is doubtful whether the stalling speed is the best characteristic to be laid down in a specification for an aeroplane which has to land on a carrier ship. An alternative is a minimum safe speed of approach, together with a minimum reserve of climb to enable the aeroplane to fly off again if for any reason it is unable to land. The Committee has asked for a number of calculations to be made with a view to arriving at some specification for a minimum speed for flying level under complete control with flaps in the landing position and with a specified rate of climb when the throttle is open.

On the experimental side the N.P.L. have made a number of interesting experiments on the airflow over models of landing decks. It has been found possible to effect considerable improvement of the flow over the deck, and the Admiralty is now considering how the wind tunnel results can be applied in practice to improve landing on a carrier ship steaming at a large angle of yaw to the wind.

The Kite Balloon Panel is concerned with a number of problems connected with the use of kite balloons and kites. Kites have been proposed both for use at low heights and to supplement the lift of kite balloons. Experiments on both balloons and kites are in progress at the N.P.L.

At the end of last year a High Speed Wind Tunnel Panel was formed to discuss the design of the tunnel to be erected at the Royal Aircraft Establishment. A model of this tunnel was tested and found satisfactory ; it has therefore formed the basis of the actual design and construction at the various contractors' works is now well advanced.

The slow progress which has been made in preventing the accretion of ice on aircraft is a matter of concern. Knowledge of the several conditions in which ice may be formed is still very scanty. In order that the problem may be properly investigated, it is proposed that a special wind tunnel shall be built. The design and construction of such a tunnel presents a good many difficulties of a novel character but preliminary plans have been made and it is expected that construction will begin shortly. Both the High Speed Tunnel and the De-icing Tunnel require large refrigerating plants, and the two tunnels are being placed together for convenience and economy.

The use of synthetic resin materials is increasing, but so far it has not extended, except experimentally and for certain details, to the construction of aircraft. Little is known about the mechanical properties of plastic materials, and a Sub-Committee has been formed to consider the properties of composite and reinforced materials with special reference to stressed components suitable for the construction of aircraft. Some experimental work has been started at the N.P.L., who have communicated a first report on the mechanical properties of fibre-filled synthetic resin materials. It is yet too early to say whether synthetic materials can be used for highly stressed parts.

(Signed) H. T. Tizard,
Chairman.

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December, 1939

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A.M.	Air Ministry.
M.A.E.E.	Marine Aircraft Experimental Establishment.
N.P.L.	National Physical Laboratory.
W.O.	War Office.
R.A.E.	Royal Aircraft Establishment.