NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

REPORT OF PROCEEDINGS

of

SEVENTH ANNUAL AIRCRAFT ENGINEERING RESEARCH CONFERENCE

Under auspices of the National Advisory Committee for Aeronautics

Langley Field, Virginia

May 25, 1932.
THE SEVENTH ANNUAL AIRCRAFT ENGINEERING RESEARCH CONFERENCE:
NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
LANGLEY FIELD, VA
MAY 25, 1932
The Seventh Annual Aircraft Engineering Research Conference between representatives of aircraft manufacturers and of the National Advisory Committee for Aeronautics was held on Wednesday, May 25, 1932, at the Committee's laboratory, known as the Langley Memorial Aeronautical Laboratory, located at Langley Field, Virginia.

The National Advisory Committee for Aeronautics was represented by its officers and members and also by its Committees on Aerodynamics and Power Plants for Aircraft, and members of its laboratory staff.

Most of those attending the conference went by boat from Washington to Old Point Comfort and were conveyed to Langley Field by automobiles. Others went by train, and some flew direct to Langley Field.

The Washington steamer arrived at Old Point at 6:45 a.m. Breakfast was served at the New Chamberlin Hotel at 7:00 a.m., after which the party proceeded to Langley Field, arriving there about 8:30 a.m.
MORNING SESSION.

The opening session was held at 8:40 a.m., in the Officers' Club at Langley Field, which was made available through the courtesy of the Commanding Officer of the Field. Dr. Joseph S. Ames, Chairman of the National Advisory Committee for Aeronautics, presided as Chairman of the Conference.

The Chairman stated that he was very glad to welcome those attending the Seventh Annual Aircraft Engineering Research Conference of the National Advisory Committee for Aeronautics. He said that inasmuch as the entire party were also guests of the Army, he would like to have the Commanding Officer of the Field, Lieutenant Colonel Roy C. Kirtland, say a few words before the meeting began.

Lieutenant Colonel Roy C. Kirtland,
Commanding Officer.

Colonel Kirtland said that he had had the pleasure of welcoming those attending last year's conference and that it was with added warmth that he welcomed the party this year. He said that the Army officials were very glad indeed to have those who represented the brains of aviation meet at Langley Field in connection with the annual conference of the National Advisory Committee for Aeronautics, and the Army appreciated the opportunity of attending these conferences.

The Chairman stated that the purpose of the conference was two-fold—first, to show the results of the investigations conducted by the Committee during the past year, and second, to obtain suggestions from the industry which would aid in formulating a research program for the coming year. He explained the manner in which suggestions and requests for research were handled by the Committee, and stated that at the morning session reports on the results of investigations conducted at the Langley Memorial Aeronautical Laboratory during the past year would be presented by the Committee's engineers. The Chairman then introduced Mr. H. J. E. Reid, Engineer-in-Charge of the Langley Memorial Aeronautical Laboratory.
Mr. H. J. E. Reid, Engineer-in-Charge.

Mr. Reid stated that on behalf of the research laboratory, he was very glad to welcome the guests attending the Conference. He stated that he and the members of the laboratory staff looked forward every year to making contact with the industry at these conferences, renewing old acquaintances, and obtaining ideas and suggestions as to how the research should proceed in order to be of the greatest benefit. Mr. Reid said that, as in the past, the morning session would be devoted to reports presented by the engineers at the laboratory explaining the results of their investigations conducted during the past year. He explained that the laboratory was divided into the aerodynamics, the power plants, and the hydrodynamics divisions, and that recently a new division had been added, known as the physical research division. He said that this division did most of the purely theoretical work, and was under the direction of Dr. Theodore Theodorsen. Mr. Reid stated that reports from each of these divisions would be presented at the morning session, and that he would first call upon Mr. Elton W. Miller, Chief of the Aerodynamics Division, who would tell something of the work that was being done in the variable-density wind tunnel, the propeller research tunnel, and the full-scale wind tunnel.

The Chairman at this point requested that the information presented at the conference be regarded as confidential. He said that there would be available for distribution at the end of the afternoon session a number of the Committee's reports, some of which contained information that would be reported upon at the morning session.

Mr. Elton W. Miller, Aerodynamics Division.

Mr. Miller said that the principal project of the variable-density wind tunnel section during the past year had been an extensive investigation of airfoil characteristics, including a study of the aerodynamic effects of changes in thickness and camber. He said that tests had been completed on more than sixty airfoils and that the results had been published as a series of preliminary reports and were now being further analyzed. Mr. Miller
said that this analysis was yielding very valuable information with reference to airfoil theory. He then presented a chart which illustrated the use of the results obtained.

Mr. Miller stated that one valuable result of this airfoil investigation was the development of airfoils which were better for particular application than any airfoils used heretofore. He said that the characteristics of one of these airfoils, designated as the N.A.C.A. 2412, had been published, and that an investigation was now in progress to see what improvements could be made using this basic section and making small modifications in the profile form. He exhibited a chart showing the effect of one such modification.

Mr. Miller stated that questions are often asked as to how fast an airplane can be flown without supplying an excessive amount of power, and what are the possibilities of high speed in the future. He said the Committee's high-speed wind tunnel was now in operation, making it possible to test airfoils up to about 90 per cent of the speed of sound, or nearly 700 miles per hour. At such speeds, Mr. Miller said, it was found that compressibility effects became important. He exhibited a chart showing the minimum drag coefficient at zero angle of attack for a symmetrical airfoil of 12 per cent thickness, the N.A.C.A. 0012, plotted against air speed.

Mr. Miller said that propeller tests in the propeller research tunnel, as well as experience in flight, indicated that there was a definite loss in propeller efficiency when the tip speed passed beyond about 1000 feet per second. He said that if this loss of efficiency could be avoided, propellers could be operated at higher speeds and much gearing could be saved. He presented a chart showing the results of tests in the high-speed tunnel of the commonly used Navy propeller section of eight per cent thickness. He said that further investigations may result in improvements in airfoil profiles for high-speed work.

Mr. Miller said that the propeller research tunnel section had been engaged in a continuation of the research on wing-nacelle-propeller interference. He said that last year some of the important results for tractor propellers were shown and that these results were being
published as a series of reports, two of which would be available after the afternoon session of the conference. 

Mr. Miller said that this year the Committee was able to show some of the preliminary results of the investigation of tandem propellers. He said that the factors which must be included in making such comparisons were first, the propulsive efficiency, which included the efficiency of the propeller and took account of the fractional part of the motor power expended in overcoming the drag due to the slipstream, second, the nacelle-drag efficiency factor, representing the fractional part of the motor power which is used in overcoming the drag and interference of the nacelle; and third, the net efficiency, which is the fractional part of the motor power available for overcoming the drag of other parts of the airplane. Mr. Miller exhibited several charts. The first showed the results obtained with tandem nacelles without cowling in two commonly used positions with reference to the wing; one above and one below. The second chart showed the same arrangements with cowling, tandem arrangements above and below the wing, and tractor propellers in corresponding positions. The next chart showed the effect of placing the nacelle further forward on the wing. The last chart showed a comparison of the results for tandem nacelles in line with the wing with the corresponding tractor arrangements, all the nacelles being cowled.

Mr. Miller said that the full-scale tunnel had been in operation throughout the year and a number of airplanes had been tested, although a considerable portion of the time had been devoted to a calibration of the tunnel and a study of the air flow. He cited two examples of the work done in the full-scale wind tunnel. The first was the test of a nacelle of a P3M-1 flying boat for the Bureau of Aeronautics. Mr. Miller said that some difficulty had been experienced by the Navy in cooling these engines and the Committee was requested to investigate the matter, make recommendations for improving the cooling, and if possible improve the design aerodynamically at the same time. He exhibited a chart showing the results of this test.

The second example covered the results of tests in the full-scale wind tunnel and a chart was exhibited which showed a comparison of the wind tunnel results on a high-wing monoplane, the Fairchild 22, with the results of flight tests of the same airplane. Mr. Miller said that
all wind tunnel results had to be corrected for the effect of the tunnel walls or the jet boundaries, as the case might be. He said that methods of making such corrections had been developed theoretically and checked experimentally for the commoner shapes of jet, but that there were in any open tunnel conditions of air flow which could not be taken account of in the theory, and that for a jet shaped like that of the full-scale tunnel, which was of oval form, the difficulties were exaggerated. He stated that a correction factor had been derived by testing a series of airfoils in the model of the full-scale tunnel. He said this correction had been applied in the present instance to the results obtained in the full-scale wind tunnel, and it would be observed that the curves for the tunnel as corrected agreed very satisfactorily with those from flight. He stated that while it was not felt that the final correction for tunnel walls had been obtained, the agreement with flight tests was so satisfactory that it was believed that this figure would soon be reached. He said that some features of the air flow had not been fully investigated but that it was shown that the dynamic pressure distribution throughout the area of the jet occupied by an airplane was uniform within 1 per cent, which was considered very satisfactory. Mr. Miller stated that a demonstration test would be given in the wind tunnel in the afternoon of a modern military type airplane which was being tested at the request of the Army Air Corps.

Mr. Reid said that at the conference last year, those attending had witnessed one of the new wind tunnels in operation with a six-component balance. He said that during the past year investigations had been conducted in the atmospheric wind tunnel on high-lift devices and various means and methods of control, and that Mr. Weick would show some charts and tell about some of the more interesting devices that he had tested in this wind tunnel. Mr. Reid said that a flight demonstration would be given in the afternoon which would show some of the results of these tests.

Mr. Fred E. Weick, Atmospheric Wind Tunnel.

Mr. Weick said that in connection with the general program covering the flying and handling characteristics
of airplanes from the standpoint of safety, the Committee was now making a series of investigations on various lateral-control devices with particular reference to the high angles of attack, where present ailerons are unsatisfactory. He said that in this series it was expected to include all devices which had been satisfactorily used in the past, or which showed reasonable promise. He stated that tests were being made in the 7-by-10-foot wind tunnel and that it was intended to include all tests which could be made in a routine manner in a wind tunnel to show the effect of the control devices on the lateral stability, and the general performance of the wing. He said this was done by means of 6-component tests, free-rotation tests, and forced-rotation tests.

Mr. Weick said that the various control devices were first being tested on rectangular wings of aspect ratio 6, having the Clark Y airfoil section, and that they were then being extended to include different plan forms and also such factors as wash-out, sweepback, and dihedral, which influence the lateral stability. He said the stability portion of the program also included slots and other devices, such as floating-tip ailerons, and that finally devices giving satisfactory control and stability for high-lift wings developed under a different part of the program would be investigated.

Mr. Weick presented a chart listing the devices included in the program. He said that first, under plain wings, there were ordinary ailerons of three proportions—medium-size ailerons, long narrow ailerons, and short wide ailerons. Mr. Weick said that all of these were tested with five different differential movements, including floating, and that the same ailerons were also tested when rigged up 10 degrees when neutral, because the original tests showed that much more satisfactory yawing moments could be obtained with this arrangement. He said that typical slotted ailerons of two proportions and typical Frise ailerons of the medium or standard size came next. He stated that the tests on all of the above ailerons and also on floating-tip ailerons on rectangular wings had been completed, and that the latter, being of a preliminary nature, were now being followed by tests on narrow-chord floating-tip ailerons, such as that used on the Curtiss Tanager, and also floating-tip ailerons on tapered wings with two different amounts of taper.
Mr. Weick said that another investigation which was being undertaken dealt with ailerons consisting of the airfoil separate from the wing proper. He said these would be of various sizes and profiles and that they would be tested at a large number of locations around the main wing. He stated that the tests would be made with the ailerons controlled in the usual manner and also with them floating.

Mr. Weick said that another form of lateral control on which a considerable amount of work had just been completed was the spoiler, which consisted of a small flap which could be raised, thus breaking the smooth contour of the upper surface of the wing.

With reference to the stability portion of the program, Mr. Weick said that tests had been made on wings with Handley Page tip slots and ordinary ailerons rigged up 10 degrees, and with ordinary ailerons with spoilers and interceptors. He said that in the field of high-lift angles, tests had been made with the Handley Page slot along the full span of ordinary ailerons and also ailerons with spoilers. Mr. Weick said that similar tests had been made on a wing with a fixed auxiliary airfoil.

For comparing the various control devices, Mr. Weick said that several criterions had been established. He presented a chart giving examples of two of the criterions for four typical control devices. He stated that the most satisfactory control obtained to date was with an automatic Handley Page tip slot, interceptors, and ailerons. With these, Mr. Weick said, satisfactory control was maintained all through an angle of attack of 30 degrees, and satisfactory yawing moments were obtained at the higher angles of attack.

Mr. Weick stated that the tests with the Handley Page tip slot brought out an interesting point which had been given little attention up to the present; and that was, how long to make the tip slots. He then presented a chart showing the results of tests with slots of different lengths, from no slot at all to full-span slot on a Clark Y airfoil. He said that at slot lengths greater than 50 per cent of the semispan, no autorotation was caused by the stall of the plain portion of the wing, and the angle of attack above which autorotation would start was increased from about 17 degrees to over 30 degrees,
a slot length of which over 30 per cent was the optimum of the point of lateral stability.

Mr. Weick said that another program of research which was now being considered by the Committee covered devices which aimed to increase the speed range of an airplane. He said that wind tunnel tests were being made which showed the lift, drag, and pitching moment with faired movable devices, such as slots, flaps, etc. He then presented a chart describing several of these devices, which included the Handley Page slot, the plain flap, fixed slots and a flap, the Hall wing, the split flap, and the Fowler wing.

Mr. Weick then presented a chart showing the results of tests on a combination of a Clark Y airfoil with a narrow auxiliary airfoil 15 per cent of the chord of the main wing. He said the auxiliary airfoil was tested in about 140 different positions, with respect to the main airfoil, in order to cover the entire likely range and determine the optimum position.

He next presented a chart showing the polars obtained in these flight tests.

Mr. Weick stated that probably the most interesting feature of the airplane equipped with the auxiliary airfoil was the fact that the maximum gliding angle was 19 degrees, giving a range of 12.3 degrees as compared with 1.4 degrees for the original airplane. He said this should be of great value in making precision landings over obstacles.

Mr. Reid said that during the past year the flight research section had done much research work and had conducted more tests than in the past, because of the additional equipment and instruments available. He said that Mr. Crowley had selected the results which he thought would be of greatest interest and would tell something about the flight research work.

Mr. J. W. Crowley, Jr., Flight Research Section.

Mr. Crowley said that for the purpose of establishing the value of rotating-wing systems in promoting safety
in flight, the Committee had formulated a program of research on the subject of rotating-wing systems. He said that in investigating the data existing on such systems, it was found that there was a lack of authoritative information on their fundamental aerodynamic characteristics and it was decided that the most promising initial step in research on the subject was to determine the full-scale characteristics of an aircraft employing this system of sustentation. For this purpose, he said, the Committee purchased an autogiro, and measurements in flight of its aerodynamic characteristics had been completed. Mr. Crowley then presented two charts illustrating the interesting features of the investigation. The first chart showed the lift, drag, and resultant force coefficients plotted against the angle of attack, and the second chart showed the gliding performance of the autogiro. He said that a pressure distribution investigation was now being conducted on the autogiro for the purpose of determining the distribution of load between the rotor and the fixed wing, and to ascertain the loads applied in maneuvers which would serve as a basis for specifying design loads for aircraft using rotating wings.

Mr. Crowley said that the flight research section had completed a number of spinning investigations during the past year. He said one of these investigations consisted of determining the nature of the air flow about the tail surfaces in a spin by photographing smoke flow over those surfaces during a spin. He presented a chart showing some interesting results of these tests. Mr. Crowley said that a further discussion of the work on flight spinning investigations would be given in the afternoon at the hangar.

Mr. Crowley said that some time ago the Committee started a flight investigation of the distribution of load over wing tips in an effort definitely to establish the relation between wing-tip shape and load distribution. He said the flight tests were now completed on a number of tips, including several odd cases in addition to a series in which the plan form was systematically varied. He exhibited a chart showing the general conclusions drawn from these tests.

Mr. Crowley stated that all of the results of this investigation, particularly those having to do with effects of change of airfoil section and incidence, had not
as yet been completely analyzed, but there were indications that further general conclusions might be drawn which it was hoped would definitely settle the question of the effect of wing-tip shape on load distribution in all respects.

Mr. Crowley stated that for some time the Committee had been engaged in various airplane load investigations in flight with the ultimate aim of formulating rational methods for predicting the critical loads that may be encountered in flight. He said that a quantity of statistical information had been obtained under actual flight conditions, and he presented a chart summarizing briefly the results. Mr. Crowley said that to aid in the accumulation of this type of information, the laboratory had developed a new instrument which recorded acceleration and air speeds simultaneously, and which, if used in a sufficient number of airplanes, should provide a solution to the load factor problem. He said that a description of the instrument and further specific information on load factor investigations would be discussed later in the morning at the hangar.

Mr. Reid said that in connection with the various researches conducted by the Committee, problems were often encountered which appeared difficult to solve, and were referred to the physical research division, under the direction of Dr. Theodore Theodorsen, who was always helpful in offering solutions. Mr. Reid then introduced Dr. Theodorsen.

Dr. Theodore Theodorsen,
Physical Research Division.

Dr. Theodorsen said that in order to apply the test results obtained in a wind tunnel to actual conditions, it was necessary to make use of the so-called tunnel-wall correction. He said this correction was due to the fact that the model airplane or airship was operated in a stream of restricted cross section, while the actual aircraft was working in an infinite working section. He stated that a good knowledge of the problem was of particular importance in order to make the full use of the tunnel, that is, to obtain the largest possible Reynolds numbers. Dr. Theodorsen said that there were two kinds of corrections which must be applied to the results of wind-tunnel
experiments - one was the correction for static gradients in the field, and the other was the correction due to changes in the average direction of flow as compared with the corresponding direction in free flight. He said that the first correction was only of importance in airship model testing, while the second was of particular importance in airplane testing, and that it was this latter correction which he would discuss. He then exhibited a diagram showing the result of a theoretical analysis of the interference in rectangular tunnels and the value of using one or two vertical or horizontal boundaries.

Dr. Theodorsen said that the laboratory had conducted some tests on the heat transmission from airfoils. He said the tests were conducted primarily for the purpose of obtaining reliable technical data as to the quantity of heat required to prevent ice formation and also to answer certain questions in connection with wing radiators. He then presented a chart showing the essential result of the experiments.

Mr. Reid said that a great many of the engine manufacturers were interested in the fuel injection engine, and that during the past year the Committee had conducted a number of investigations in this connection and he thought the results would be of interest to those present. Mr. Reid then called upon Mr. Carlton Kemper, who is in charge of the power plants division, to describe some of the work being done by that division during the past year.

Mr. Carlton Kemper, Power Plants Division.

Mr. Kemper stated that the present tendency in aircraft transportation was towards higher cruising speeds, and that to obtain these higher speeds required a reduction in the drag of aircraft structures and an increase in the power output of aircraft engines. He said that the manufacturers of aircraft engines were at present active in the development of fuel-injection systems to replace the carburetors of aircraft engines. He stated that the use of a fuel-injection system gave better fuel distribution, increased engine power, and decreased fuel consumption. He also stated that with the injection of fuel into the engine cylinder an increase in engine performance could be obtained efficiently by operating with a large valve overlap and using a slight boost pressure in
the inlet manifold to scavenge the clearance volume of the engine. Mr. Kemper then presented charts showing some of the results of investigations conducted by the Committee during the past year in connection with fuel injection engines having improved scavenging.

Mr. Kemper said that the Committee had continued the investigation of engine performance obtained when using hydrogenated safety fuels. He said that the purpose of this investigation was to reduce the fire hazard in aircraft by using a fuel having a flash point higher than that of gasoline. Mr. Kemper stated that although the power performance of the test engine when using safety fuel and a fuel-injection system had been approximately that obtained when using gasoline and a carburetor, the fuel consumption at the same power had been from 10 to 20 per cent greater with the safety fuel. He said that investigations had been undertaken to determine possible methods of decreasing the fuel consumption when using safety fuels, and it had been found that operating the engine with a high temperature coolant appreciably reduced the fuel consumption. Mr. Kemper then presented a chart showing the performance obtained at various compression ratios with the injection of safety fuel into the engine cylinder.

Mr. Kemper said that the effect of operating with improved scavenging and increased valve overlap had been investigated, using a high-speed Diesel engine. He said that because of the high compression ratio and corresponding small clearance volume of this type of engine, the improvement in power due to complete scavenging would not be as great as with the spark ignition engine, but that it was found that removing the small volume of exhaust gases in the clearance had an appreciable effect on the combustion of the injected fuel. He said this effect was shown by the large improvement obtained in the fuel consumption of the engine. Mr. Kemper presented a chart showing the indicated and brake mean effective pressures, maximum cylinder pressure and fuel consumptions plotted against fuel quantity.

To illustrate the manner in which the use of engines of this type would affect the performance of commercial aircraft, Mr. Kemper presented a chart which showed the comparative performance of a three-engine airplane with equal power Diesel and carburetor engines. He said that the airplane selected for this comparison was of the type
in use on one of the present transport lines. Mr. Kemper stated that for equal pay loads, equal maximum speeds, and equal cruising speed, the airplane equipped with the Diesel engines would show a 40 per cent increase in cruising range and a decrease in fuel cost per mile of 64 per cent. He said because of the constant value of the fuel consumption curve for a wide range of throttle settings, the Diesel engine could cruise with clear exhaust at a speed 13 per cent in excess of that obtained with the carburetor engines and still show an 8 per cent increase in cruising range and a 54 per cent decrease in fuel cost per mile.

Mr. Kemper said that the Committee was also investigating the factors controlling the transfer of heat from finned cylinders to an air stream. He said that to study the effect of fin pitch and fin length on the quantity of heat dissipated to an air stream, a method had been developed for electrically heating the test cylinders and accurately measuring the energy dissipated. Mr. Kemper exhibited a chart showing some of the results of this investigation.

Mr. Kemper stated that although many types of fuel sprays were used in fuel injection engines, there was little information available as to the mechanism by which a solid stream of fuel issuing from an orifice was atomized into a spray. He said that several theories had been proposed to explain this phenomenon. Mr. Kemper stated that Dr. Castleman, of the Bureau of Standards, had suggested that the atomization process was similar to that occurring in carburetors and that due to the relative motion of the air and the fuel, fine ligaments were formed at the gas-liquid interface, and that these ligaments collapsed under the influence of surface tension to form drops in the spray. He stated that the Committee had recently succeeded in obtaining photomicrographs of fuel sprays at 10 diameters, which showed that the theory proposed by Dr. Castleman was probably correct. Mr. Kemper then presented a chart showing photomicrographs of various stages in the atomization of a fuel jet.

Mr. Kemper stated that the research to determine the injection and combustion characteristics of fuel sprays under conditions comparable to those occurring in high-speed internal combustion engines had been continued. He described the apparatus used for making these tests and exhibited a chart showing diagrammatically the arrangement
of the equipment and some of the results of this investigation. Mr. Kemper said that the investigation had shown that the rate of vaporization of Diesel oil under conditions comparable to those occurring in a high-speed Diesel engine was sufficiently rapid to permit the combustion of a considerable part of the fuel from the vapor phase.

Mr. Reid said that at the conference last year the N.A.C.A. Tank was put into operation by Dr. D. W. Taylor for the first time and that there of course remained quite a lot of work to be done and many details to be attended to before satisfactory operation could be assured. He said that during the past year these details had been taken care of and investigations had been conducted in the tank. Mr. Reid then called upon Mr. Starr Truscott, who is in charge of the hydrodynamics division, to describe some of the tests conducted in the N.A.C.A. Tank during the past year.

Mr. Starr Truscott, Hydrodynamics Division.

Mr. Truscott stated that after the N.A.C.A. Tank had been officially placed in operation at the conference last year, there were three rather difficult problems - first, to make the equipment work, second, to devise a program for using it effectively, and third, to accomplish some effective work with it. He said that at that time certain statements were made as to valuable results which might be expected from investigations conducted in this new tank, and he was glad to say that the past year had shown that these statements were not exaggerated. He added, however, that there was one point which he regretted to have to report and that was that a speed of about 60 miles an hour as a maximum for the tank had been predicted, but that so far a speed of only 56 1/2 miles an hour had been obtained. Mr. Truscott stated that the N.A.C.A. Tank was the first seaplane towing tank in the world, and the third towing basin in the United States.

With regard to the program of investigations for the tank, Mr. Truscott stated that a number of suggestions had been received by letter from the manufacturers, from the Navy, and from the floor of the conference. He said that all of the problems suggested were found to fit into the program of work for the tank. Mr. Truscott said
that one of the first suggestions offered was to determine the advantage gained by retracting the tail wheel on amphibians. He said that this problem had been incorporated as a part of the program which covered the study of the effect of variations in dimensions and form of hull on performance during take-off. He stated that another suggestion offered was to investigate Froude's law of scale effect on water models. Mr. Truscott said that the validity of this law had been questioned but as far as he knew it had never been seriously attacked. He said that before a check of Froude's law could be made it was necessary to have very accurate information on the frictional resistance of surfaces such as the bottoms of flying boats and seaplane floats at high speeds.

Mr. Truscott said that the following program of investigation was finally adopted:

1. Seaplane floats, both twin and single;
2. Flying boat hulls;
3. Planing surfaces, solid, vee, and hollow;
4. Frictional resistances, rivets, butts and butt strips.

He said that the first investigation undertaken was to determine the effect of small changes in form on the performance of a flying boat hull, and that the results of this investigation would be shown at the tank in the afternoon.

INSPECTION OF LABORATORY.

The Chairman stated that Mr. Truscott's presentation was the last on the morning's program. He requested the guests to assemble in front of the Officers' Club in four groups, for a tour of inspection of the laboratory. The groups were composed of those with red tags, those with white, those with blue, and those with brown. The tags had been handed to the guests as they boarded the boat in Washington, and to others as they registered upon arrival. The Chairman stated that the white group would be under the direction of Mr. Lewis, the blue group
under Mr. Victory, the brown group under Mr. Reid, and that he would be in charge of the red group. He request-
ed each group to keep together as much as possible in or-
der to avoid confusion and delay. The Chairman asked
those who were planning to go to New York by the Cape
Charles route to notify the gentleman at the door as they
left the room, so that proper transportation arrangements
could be made.

The members of the conference then proceeded on a
tour of inspection of the laboratory in accordance with
the following program:

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At 12:30 p.m. all groups reassembled for lunch at the
Officers' Club, after which a group photograph of the
guests was taken.

At 1:45 p.m. the entire party proceeded to the N.A.C.A.
Tank, where Mr. Truscott gave a more detailed description
of the program of tests for this equipment. Following
this, a demonstration was given of a model float equipped
with a spray strip on one side and without one on the
other, to show the difference in the form of spray.

At 2:05 p.m. the party visited the full-scale wind
tunnel, where a Douglas YO-31A airplane was in position
for testing. Mr. DeFrance stated that at the request of
the Army Air Corps, the Committee was making a study of
the wing-fuselage interference of this airplane.

AFTERNOON SESSION.

At 2:40 p.m. the conference reconvened in the Offi-
cers' Club, with Dr. Ames presiding.

The Chairman opened the session with an invitation
to the representatives of the manufacturers to present
suggestions as to investigations to be undertaken by the
Committee. His remarks were substantially as follows:
This portion of the meeting is set apart for what the Committee regards as the real conference between the manufacturers and the representatives of the Committee. Of course as you can see from your inspection of the laboratory this morning the Committee has been busily engaged in carrying out suggestions presented at previous conferences. We are in earnest in saying that we wish to have you offer suggestions as to problems of the industry which you think the Committee could solve.

I don't know what is the best way to proceed; I fancy it is best to proceed as in the past—for me to call on representatives of the industry present to make any comment they wish or to present any requests for investigations to be undertaken by the Committee.

The Chairman then called on

MR. HAROLD F. PITCAIRN,

of the Autogiro Company of America, Philadelphia, Pennsylvania. Mr. Pitcairn expressed appreciation for the attitude of the National Advisory Committee toward the autogiro, saying that the Committee had conducted flight tests on this type of machine, the results of which would no doubt be made available to the industry when they were completed. He stated that he looked forward to tests of autogiro rotors in the full-scale wind tunnel, and referred to the lack of knowledge as to the effect of scale on the autogiro, where the factors of weight and rotation, in addition to size, were involved, and said he hoped that later tests of the rotors could be conducted in the variable-density tunnel.

Mr. Reid said that the Committee intended to conduct tests of the autogiro rotors both in the full-scale tunnel and the variable-density tunnel, but that the program had not yet been planned in detail. He stated that it was a difficult problem to reproduce in the wind tunnel the exact conditions of the full-size machine, especially where mass distribution and deflections of full-scale members were involved.

The Chairman called on
Honorable EDWARD P. WARNER,
a member of the National Advisory Committee, and editor of AVIATION, who presented the following statement:

I don't know that I have anything in particular to say in detail this year. The Committee seems to have covered some part, to have touched on some tangent, of almost every imaginable engineering problem. Nevertheless, although those actually engaged in the manufacture and operation of aircraft can speak of detail questions and particular problems arising in design better than any of us who make contact from other points of view, there is one proposal in particular I have to present. This being a year of a political campaign a great deal is heard about the "forgotten man." There is a "forgotten man" in aviation—forgotten by his own modesty, the transport operator. However, he is not so much forgotten as in the past, as I note there are a few transport companies represented here.

The work of the Committee may be classified roughly under three headings:

1st, military and naval problems, problems of efficiency of aircraft in special application to military functions. The Army and Navy take care of these problems by asking the Committee for the investigations they need.

2nd, problems of the aircraft for private use. At the moment this type of aircraft is in some degree in the background, but the Committee has done a great deal of work during the past year on investigations of value in the improvement of the small privately owned airplane.

3rd, problems of transport operation. It would be desirable to classify all that can be done to transport airplanes in order that transport can be put on a sound basis economically, in order that transport flying with purely commercial loads may be self-sustained. It should then be the Committee's interest to follow them down one by one. These include the question of the
comfort of the passenger and questions of economy. It is suggested that the Committee call a general conference of those most actively interested in transport operation, including representatives of transport companies and manufacturers concerned with the transport side of aviation, to prepare a list of the problems that seem to them most important in order that the manufacturers may be enabled to give transport operators equipment better suited to their economic problems of the moment.

When called on by the Chairman,

Major R. H. FLEET,

of the Consolidated Aircraft Corporation, Buffalo, New York, expressed appreciation of the importance of the work being done by the Committee and of the value of the conference in familiarizing the industry and various branches of the Government with this work. He compared the military air forces of this country with those of European nations, referring to his observations on a recent airplane tour in Europe, and called attention in particular to the need of our Army Air Corps, in spite of the widespread demand for economy, for adequate appropriations to maintain a sufficient air establishment for national defense.

The Chairman called on

Mr. GEORGE J. MEAD,

of the United Aircraft and Transport Corporation, Hartford, Connecticut. Mr. Mead's comments were in substance as follows:

In connection with Major Fleet's remarks, I think those of us who are representing the industry in this meeting will agree that the work done by the Committee is necessary and well-directed, and work which none of us, or at least very few can afford to do, and then only on a limited scale; and that this is the last place where the aircraft industry would like to see activities curtailed as far as aviation is concerned.
In viewing the various exhibits at the laboratory it is interesting to realize that future progress, as far as performance goes, may be summed up in the problems of minimum drag and maximum thrust horsepower. In the past we have been inclined to think some of this matter was too theoretical to receive practical consideration. Now complaints are heard from operators that airplane operation costs too much. One way to cut down cost is to make operation as economical as possible, and we cannot afford to throw away power. I am not entirely in accord with the demand for more power. The work the Committee is doing is showing that more performance may be obtained without more horsepower. The point has been reached where increase in power provides little increase in performance but costs tremendously. It is interesting to look at pictures of airplanes that were considered excellent in 1920 and see how many things have been added and how many taken off since that time. For instance, retractable landing gears were then considered impractical.

In regard to Mr. Warner's remarks, I would like to know what the Committee is doing on two problems of air transport which I think are most important and receive the least consideration. There is considerable discussion of speed and cost; as to safety, I should say airplane operation is reasonably safe on standard lines. But the problem of regularity of service has not been solved. Business men must have dependable service, almost regardless of speed, and if it is reasonably certain that an airplane will complete its trips on schedule it will have immediately more passengers than it can carry.

The other problem is that of comfort. Certain airplanes are very uncomfortable to ride in and have characteristics not at all interesting to a poor sailor. Operators will have increased passenger business if they can assure the passengers of a comfortable ride.

When called on by the Chairman,

Mr. ROLAND CHILTON,

of the Wright Aeronautical Corporation, Paterson, New Jersey, presented two suggestions. With reference to the
Committee's research into fin design for aircraft engine cylinders, Mr. Chilton said he was extremely interested to know that as far as the Committee's work had gone the results checked quite well with conclusions reached by his company by rather more empirical methods, and he hoped that research would be continued.

Mr. Chilton referred to the results presented at last year's conference on the investigation of the two-stroke cycle engine, and expressed the opinion that in years to come this type of engine would be a matter of greatly increasing interest. He said that there were many alternatives in the basic construction of engines; that it appeared that perhaps the basic problem involved was to determine the design of valve or the piston arrangement which was most economical to scavenge air; and that there were some results that indicated that there was a great discrepancy, tied up with turbulence chiefly, in the air requirements. He suggested that research on this problem, even if rather elementary; would be of considerable value and interest.

Mr. Kemper, replying to Mr. Chilton's comments, said that the Committee had not dropped the problem of the two-stroke-cycle engine; that a single-cylinder engine of this type which would be liquid-cooled and would operate at about 1800 r.p.m. was scheduled for early delivery, and it was planned to measure accurately the volume and flow of the scavenging air.

The Chairman called on

Mr. CHARLES WARD HALL,

of the Hall-Aluminum Aircraft Corporation, Buffalo, New York. He thanked the Committee for the interesting and useful information he had obtained in the morning session and on his visit to the laboratories. He presented the following suggestions:

In connection with flying boat hulls I think it would be very interesting to test a given hull at various displacements and also with various assumed wing areas, as I believe there is some optimum combination of the two. There has been considerable investigation
and thought on this problem, but the results are not in available form and were not obtained in a towing basin such as the Committee has.

The investigation of the fixed auxiliary airfoil seems to promise very good results and should be carried further. It appears to be logical to apply a slot along the edge of the wing to large monoplanes particularly. It would be desirable to conduct this investigation on a wing tapered in thickness as well as tapered in plan form.

The nacelle investigations on which results have been shown cover almost exclusively monoplane arrangements, but there are still many uses for biplanes. The inter-wing nacelle must have rather different interference effects on a biplane. The extension of nacelle interference investigations to biplane combinations would be very interesting and useful.

Most of the investigations of nacelles in relation to wings have referred to radial type engines. Recently, however, in-line air-cooled engines have come into wider use. Comparatively little aerodynamic investigation has been made of the interference of the in-line type of engine. I think the type has very great possibilities and would merit investigation.

Mr. Truscott, replying to Mr. Hall's suggestion regarding the study of flying boats, stated that running the flying boat models at varying displacements was part of the routine tests; that varying the assumed wing areas was a trifle more difficult, but could be carried out 'at practically the same time; and that in effect both these items were already on the program. He added that the program included the construction of a series of models of flying boat hulls utilizing a parent set of lines, then stretching the lines, pulling them up and pulling them sidewise, the fundamental form from which all would be derived being the same; and that in this investigation Mr. Hall's suggestion would naturally form a part.

When called on by the Chairman,

Dr. J. C. HUNSAKER,
of the Goodyear-Zeppelin Corporation, Akron, Ohio, expressed appreciation for the opportunity to see the work of the laboratory first-hand and talk with those who were conducting the work. He said he was particularly pleased to hear Mr. Truscott say that it was planned to conduct investigations in the N.A.C.A. Tank on variations from a standard form, and was also interested to learn of the aerodynamic investigation of the boundary layer and pressure distribution on the Akron in the twenty-foot wind tunnel and its correlation with flight tests of the full-size airship. He referred to the desirability of correlating the study of the effect of obstructions on airplane wings with the study of smoke flow over wing models in the special smoke flow tunnel.

The Chairman called on

Mr. SHERMAN M. FAIRCHILD,

of the Fairchild Aviation Corporation, New York City, who expressed the opinion that one of the reasons for the lack of private flying was that there had not been developed an airplane which was what the majority of people desired, and that the work of the Committee would do much to aid the industry to build safer airplanes.

Mr. Fairchild referred to the remarks of Mr. Hall regarding the in-line engine, and stated that at one stage in their development the in-line type of engine offered less aerodynamic resistance or drag than the radial type, but improvements in the cowling of radial engines had reduced the resistance of this type to the point where it now had considerably less than the in-line type. He said that there was need for a study of the cowling of in-line engines, with reference to the exit opening, to the size and position of the inlet opening, and to methods of cowling around the cylinders.

Mr. Reid replied that the Committee was still working on the problem of the cowling of engines. He referred to the results shown in the power plant laboratory that morning on the cooling of finned specimens, and stated that that was part of the general program for the cowling and cooling of aircraft engines which would include in-line engines and engines of different type from either radial or in-line, and also liquid-cooled engines.
The Chairman then inquired whether anyone else present had any comments he desired to make.

Lieutenant Colonel ROY C. KIRTLAND, U.S.A.,

Commanding Officer of Langley Field, referred to the remarks made earlier in the meeting regarding the strength of the military and naval air forces of the United States in the event of war, and explained many of the difficulties and problems which would confront the Army Air Corps in such an emergency, in connection with the production of aircraft, the training of personnel, the procurement and distribution of supplies, and the general expansion of the organization.

In addition to the suggestions presented at the conference, the following suggestions for investigations to be conducted by the Committee have been received in writing:

Investigation in propeller research tunnel or full-scale tunnel, of interference effects between wing and fuselage.

Investigation of possibility of mounting air-cooled engine in wing and taking in air through leading edge of wing.

Fundamental study of drag in variable-density tunnel, with prismatic cylinders of various cross-sectional shapes, the drag being obtained as a function of angle.

Systematic investigation in variable-density tunnel on a series of flat plates of various aspect ratios.

Systematic study in full-scale wind tunnel, of static longitudinal stability, with different wings and different tail surfaces in various locations.

Investigation of balanced controls - hinge moments, etc.

Investigation of elevator trimming devices, such as the Boeing trailing-edge flap, designed to eliminate stabilizer adjustment.
Further investigation of flaps, slots, and high-lift devices, including the effect in landing due to drag effect of flaps set at large angles, lateral control arrangements in combination with flaps, and effect of high-lift devices on take-off distance and angle.

Further investigation of low-moment wings

Further study of boundary layer control on wings

Preparation of report giving simplified method for conduct of flight tests for commercial airplanes, with recommendations as to instruments to be used, procedure, etc.

Further investigation of prevention of ice formation on aircraft in flight

Investigation in twenty-foot wind tunnel of variable-pitch propeller hub, similar to the Eclipse type, with standard blades

Investigation of possibility of utilizing the forward bending of propeller blades due to thrust, in varying the pitch of the propeller

Study of tailless airplanes, including their stability and control characteristics, to determine their suitability as privately owned machines

Determination of performance characteristics of autogiro, and also similar computations for other commercial aircraft

Investigation of possibility of combining the features of rotating and fixed wings into one unit

Study of airship boundary layer control, including the use of backward-opening slots around the hull at various points

Study of physical and chemical properties of fuels best suited for use in compression-ignition engines for aircraft

Investigation of characteristics of compression-ignition engine with a view to decreasing maximum cylinder pressures and promoting smooth operation
Study of the possibilities of the injection type engine operating on fuel oil at a lower compression ratio and spark ignition

Investigation of steam power plants for aircraft

Investigation of the cooling of in-line engines

Study of the possibilities of electric spot welding in aircraft structures, especially in connection with stainless steel

Each of these suggestions, as well as those presented orally at the afternoon session of the conference, will be given careful consideration by the appropriate subcommittee of the National Advisory Committee for Aeronautics.

Announcements. The Chairman announced that at the close of the session copies of the following reports would be available at the rear of the hall for those who desired them:


"Wind-Tunnel Tests of a Clark Y Wing with a Narrow Auxiliary Airfoil in Different Positions."

"Wind-Tunnel Tests of a Hall High-Lift Wing."

"The Effect of Propellers and Nacelles on the Landing Speeds of Tractor Monoplanes."

"Wind-Tunnel Tests of the Fowler Variable-Area Wing."

"The Nature of Air Flow about the Tail of an Airplane in a Spin."

"The Aerodynamic Characteristics of a Model Wing Having a Split Flap Deflected Downward and Moved to the Rear."

Mr. Reid stated that on the flying field there would be the following flight demonstrations: a Fairchild F-22 airplane equipped with the small auxiliary airfoil; the Committee's PC-2 autogiro; and the Verville AT airplane with the special long-travel landing gear for making short...
landings. He added that at the hangar there would be moving pictures showing the smoke flow in various parts of a spin on a Fleet N2Y-1 airplane; that in the special smoke-flow tunnel in the variable-density tunnel building other models than those shown in the morning were available for demonstration; and that the full-scale wind tunnel, the tank, the power plant laboratory, and the atmospheric wind tunnel were open for those who wished to return for further inspection of these activities. He said that at 4:50 p.m. automobiles would be ready to take the members of the conference back to Old Point Comfort.

Thereupon, at 3:40 p.m., the Chairman declared the conference adjourned.

The following were present at the conference:

Members and Officers of the National Advisory Committee for Aeronautics:

Dr. Joseph S. Ames, Johns Hopkins University, Chairman,
Captain A. B. Cook, U.S.N.,
Honorable William P. MacCracken, Jr.,
Professor C. F. Marvin, U. S. Weather Bureau,
Rear Admiral W. A. Moffett, U.S.N.,
Brigadier General Henry C. Pratt, U.S.A.,
Honorable Edward P. Warner,
Dr. Orville Wright,

Mr. G. W. Lewis, Director of Aeronautical Research,
Mr. J. F. Victory, Secretary,
Mr. E. H. Chamberlin, Assistant Secretary,

Members of Committee on Aerodynamics:

Dr. L. J. Briggs, Bureau of Standards,
Lieutenant Commander W. S. Diehl (C.C.), U.S.N.,
Dr. H. L. Dryden, Bureau of Standards,
Captain A. C. Fouk, U.S.A.,
Mr. Richard C. Gazley, Department of Commerce,
Major C. W. Howard, U.S.A.,
Mr. G. W. Lewis,

1 Also officer of the National Advisory Committee for Aeronautics.
1Honorble Edward P. Warner,
Commander W. W. Webster (C.C.), U.S.N.,
Dr. A. F. Zahm, Division of Aeronautics, Library of
Congress,

Members of Committee on Power Plants for Aircraft:

2Mr. G. W. Lewis,
Professor Harvey N. Davis, Stevens Institute of Tech-
nology,
Dr. H. C. Dickinson, Bureau of Standards,
Mr. Carlton Kemper, Langley Memorial Aeronautical
Laboratory,
Commander C. A. Pownall, U.S.N.,
Professor C. Fayette Taylor, Massachusetts Institute
of Technology,

Representatives of Manufacturers and Operators:

Allison Engineering Company, Indianapolis, Indiana:
Mr. Harold Camine,

Aluminum Company of America, Pittsburgh, Pennsylvania:
Mr. W. H. Hunton,
Mr. C. F. Nagel, Jr.,

American Airways, Incorporated, New York City:
Mr. W. Littlewood,

Autogiro Specialties Company, Philadelphia, Pennsylvania:
Mr. L. H. von Schilling,

Autogiro Company of America, Philadelphia, Pennsylvania:
Mr. A. E. Larsen,
Mr. Harold F. Pitcairn,
Mr. James G. Ray,
Mr. Paul H. Stanley,

1Also member of the National Advisory Committee for Aero-
nautics
2Also officer of the National Advisory Committee for Aero-
nautics.
B/J Aircraft Corporation, Baltimore, Maryland:
  Mr. F. S. Hubbard,
  Mr. Temple N. Joyce;

Bell Telephone Laboratories, Incorporated, New York City:
  Mr. H. B. Ely,
  Mr. F. M. Ryan,

Bendix Aviation Corporation, New York City:
  Mr. Charles Marcus,

Boeing Airplane Company, Seattle, Washington:
  Mr. James P. Murray,

Cleveland Pneumatic Tool Company, Cleveland, Ohio:
  Mr. J. F. Wallace,

Consolidated Aircraft Corporation, Buffalo, New York:
  Major R. H. Fleet,

Crucible Steel Company of America, Baltimore, Maryland:
  Mr. R. W. Dietrich,

Cunningham-Hall Aircraft Corporation, Rochester, New York:
  Mr. F. E. Cunningham,
  Mr. W. R. R. Winans,

Curtiss-Wright Corporation, New York City:
  Mr. Thomas A. Morgan,
  Mr. Burdette S. Wright,

The Douglas Aircraft Company, Santa Monica, California:
  Mr. J. H. Kindelberger,
  Mr. John M. Rogers,

Eclipse Aviation Corporation, East Orange, New Jersey:
  Mr. C. H. Havill,
  Mr. R. P. Lansing,
  Mr. Charles Marcus,
  Mr. F. C. Mock,

1Also representing the Eclipse Aviation Corporation.
2Also representing North American Aviation, Incorporated.
3Also representing the Bendix Aviation Corporation.
Edo Aircraft Corporation, College Point, Long Island, New York:  
Mr. Earl D. Osborn,  

Engineering and Research Corporation, Washington, D.C.:  
Mr. Henry Berliner,  

Fairchild Aviation Corporation, New York City:  
Mr. S. M. Fairchild,  
Mr. D. W. Hardman,  
Mr. A. E. Nesbitt,  
Mr. W. H. Schwebel,  

Ford Motor Company, Dearborn, Michigan:  
Mr. W. B. Mayo,  

General Aviation Manufacturing Corporation, Dundalk, Maryland:  
Mr. T. H. Huff,  
Mr. F. Nagel,  
Mr. H. V. Thaden,  
Mr. D. B. Weaver,  

General Electric Company, Schenectady, New York:  
Mr. E. G. Haven,  
Mr. T. B. Jacocks,  
Mr. John C. Miller,  

The B. F. Goodrich Rubber Company, Akron, Ohio:  
Mr. Henry Schippel,  

Goodyear-Zeppelin Corporation, Akron, Ohio:  
Dr. Karl Arnstein,  
Dr. J. C. Hunsaker,  
Dr. W. Klemperer,  

Hall-Aluminum Aircraft Corporation, Buffalo, New York:  
Mr. Charles Ward Hall,  
Mr. A. M. Hall,  

Hamilton Standard Propeller Company, Hartford, Connecticut:  
Mr. F. W. Caldwell,  

Hurley-Townsend Corporation, New York City:  
Mr. Roy Hill,  
Mr. James Taylor,  
Mr. George H. Townsend,
International Airways, Cleveland, Ohio:
    Mr. C. L. Ofenstein,
    Mr. C. J. Weger,

Jacobs Aircraft Engine Company, Camden, New Jersey:
    Mr. Thomas Carroll,
    Mr. A. R. Jacobs,

Kellett Autogiro Corporation, Philadelphia, Pennsylvania:
    Mr. W. Laurence LePage,

Kreider-Reisner Aircraft Company, Hagerstown, Maryland:
    Mr. L. E. Reisner,

Lawrance Engineering and Research Corporation, New York City:
    Mr. Charles L. Lawrance,

Grover Loening Aircraft Company, Incorporated, Garden City, Long Island, New York:
    Mr. H. Larson,
    Mr. J. C. Reddig,

The Glenn L. Martin Company, Baltimore, Maryland:
    Mr. Glenn L. Martin,
    Mr. L. C. Milburn,

Pennsylvania Aircraft Syndicate, Philadelphia, Pennsylvania:
    Mr. Elliot Daland,
    Mr. Adolph Herzog,
    Mr. Van Allen,
    Mr. E. Burke Wilford,
    Mr. J. S. Wilford,

Pioneer Instrument Company, Brooklyn, New York:
    Mr. J. D. Peace, Jr.,
    Mr. W. A. Reichel,

Pitcairn Aircraft, Incorporated, Willow Grove, Pennsylvania:
    Mr. Walter C. Clayton,

Pittsburgh Screw and Bolt Corporation, Pittsburgh, Pennsylvania:
    Mr. Hamilton Foley,
The Pratt and Whitney Aircraft Company, Hartford, Connecticut:
  Mr. W. G. Chamberlain,
  Mr. W. A. Parkins,
  Mr. A. Willgoos,

S.K.F. Industries, New York City:
  Mr. H. A. Allen,

Seversky Aircraft Corporation, New York City:
  Mr. A. P. de Seversky,

Shell Petroleum Corporation, St. Louis, Missouri:
  Mr. J. H. Doolittle,

Sikorsky Aviation Corporation, Bridgeport, Connecticut:
  Mr. M. Gluhareff,

Sperry Gyroscope Company, Brooklyn, New York:
  Mr. P. R. Bassett,

Standard Oil Company of New Jersey, New York City:
  Mr. E. E. Aldrin,

Charles N. Stieff, Incorporated, Baltimore, Maryland:
  Mr. E. M. Bertran,

Transcontinental and Western Air, Incorporated, Kansas City, Missouri:
  Mr. Paul H. Brattain,
  Mr. A. D. Smith,
  Mr. D. W. Tomlinson,

The United Aircraft and Transport Corporation, Hartford, Connecticut:
  Mr. C. H. Chatfield,
  Mr. George J. Mead,

Chance Vought Corporation, Hartford, Connecticut:
  Mr. R. B. Beisel,
  Mr. O. J. McCarthy,

Wright Aeronautical Corporation, Paterson, New Jersey:
  Mr. Roland Chilton,
  Mr. B. G. Leighton,
  Mr. C. A. Portman,
Representatives of Aeronautical and Technical Societies:

Aeronautical Chamber of Commerce, New York City:
  Mr. Luther K. Bell,

American Society of Mechanical Engineers, New York City:
  Professor Alexander Klemin,

National Aeronautic Association, Washington, D. C.:
  Mr. William R. Enyart,

Society of Automotive Engineers, New York City:
  Mr. A. J. Underwood,

Representatives of Aeronautical Journals:

AVIATION, New York City:
  Mr. Leslie E. Neville,
  Honorable Edward P. Warner,

SCIENCE SERVICE, Washington, D. C.:
  Mr. Watson Davis,

Representatives of the Press:

Associated Press:
  Mr. Oscar Leiding,

New York TIMES:
  Mr. R. M. Cleveland,

Washington DAILY NEWS:
  Mr. Ernie Pyle,

Washington POST:
  Mr. H. B. Hull,

Special Guests:

  Mr. A. Alcorn, Aeronautics Branch, Department of Commerce,
  Mr. Howard Baker, Bureau of the Budget,

1Also member of the National Advisory Committee for Aeronautics.
Lieutenant Commander R. S. Barnaby (C.C.), U.S.N., Bureau of Aeronautics, Navy Department,
Mr. Paul Brockett, National Academy of Sciences,
Mr. J. W. Cable, Aeronautics Branch, Department of Commerce,
Mr. H. K. Cummings, Bureau of Standards,
Honorable John J. Coohran, U.S. House of Representa-
tives,
Professor K. S. M. Davidson, Stevens Institute of Technology,
Major H. A. Dargue, U.S.A., Langley Field, Virginia,
Professor K. J. DeJuhasz, The Pennsylvania State College,
Lieutenant (J.G.) C. E. Ekstrom, U.S.N.,
Lieutenant R. E. Farnsworth, U.S.N., Bureau of Aero-
nautics, Navy Department,
Captain H. H. George, U.S.A., Langley Field, Virginia,
Lieutenant C. D. Glover, U.S.N., Naval Aircraft Factory,
Honorable William J. Granfield, U.S. House of Repre-
sentatives,
Commander Norman B. Hall, In charge of Coast Guard Aviation,
Mr. Charles A. Harbaugh, Bureau of the Budget,
Honorable Royal C. Johnson, U.S. House of Representa-
tives,
Lieutenant Colonel Roy C. Kirtland, U.S.A., Commanding Officer, Langley Field,
Professor O. C. Koppen, Massachusetts Institute of Technology,
Lieutenant W. S. Kurtz (C.C.), U.S.N., Norfolk Navy Yard,
Mr. F. A. Louden, Bureau of Aeronautics, Navy Depart-
ment,
Lieutenant Commander R. D. MacCart (C.C.), U.S.N.,
Bureau of Aeronautics, Navy Department,
Lieutenant Commander A. R. Marron (C.C.), U.S.N.,
Norfolk Navy Yard,
Lieutenant Commander Robert P. Molten, Jr., U.S.N.,
Aide to the Assistant Secretary of the Navy for Aeronautics,
Mr. John L. Moran, Aeronautics Branch, Department of Commerce,
Mr. Robert L. Nagle, Clerk, Committee on Appropria-
tions, U.S. House of Representatives,
Commander E. L. Patch (C.C.), U.S.N., Norfolk Navy Yard,
Mr. H. H. Platt, New York City,
Lieutenant Commander L. B. Richardson (C.C.), U.S.N.,
Bureau of Aeronautics, Navy Department,
Lieutenant A. R. Sanborn (C.C.), U.S.N., Naval Aircraft Factory,
Major General George O. Squier, U.S.A. (Retired),
Washington, D. C.,
Mr. R. H. Upson, Jackson, Michigan,
Commander R. D. Weyerbacher (C.C.), U.S.N., Bureau of Aeronautics, Navy Department,
Captain Kenneth Whiting, U.S.N., Hampton Roads Naval Air Station,
Honorable Clarence M. Young, Assistant Secretary of Commerce for Aeronautics,
Mr. O. F. Zahn, The Pennsylvania State College,

Members of Committee's Staff:

Mr. H. J. E. Reid, Engineer-in-Charge,
Mr. John W. Crowley, Jr., head of Flight Research Section,
Mr. Smith J. DeFrance, head of Full-Scale Wind Tunnel Section,
Mr. Harrold C. Gerrish, head of Engine Analysis Section,
Mr. Charles H. Helms, Washington, D. C.,
Mr. Eastman N. Jacobs, head of Variable-Density Tunnel Section,
Mr. Carlton Kemper, head of Power Plants Division,
Mr. William H. McAvoy, head of Flight Operations Division,
Mr. Elton W. Miller, head of Aerodynamics Division,
Mr. Addison M. Rothrock, head of Fuel Injection Section,
Mr. Oscar W. Schey, head of Supercharger Section,
Mr. Edward R. Sharp, Chief Clerk of the Laboratory,
Mr. John A. Spanogle, head of Engine Research Section,
Dr. Theodore Theodorsen, head of Physical Research Division,
Mr. Starr Truscott, head of Hydrodynamics Division,
Mr. Fred E. Weick, head of Atmospheric Wind Tunnel Section,
Mr. Donald H. Wood, head of Propeller Research Section.

1Also member of the Committee on Power Plants for Aircraft.