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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

R E P O R T

OF

TWELFTH ANNUAL AIRCRAFT ENGINEERING
RESEARCH CONFERENCE

Under auspices of the
National Advisory Committee for Aeronautics

Langley Field, Virginia

May 18 and 20, 1937

With photograph of May 20 group

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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RESEARCH CONFERENCE

Langley Field, Virginia
May 18 and 20, 1937

The Twelfth Annual Aircraft Engineering Research Conference of the National Advisory Committee for Aeronautics was held on Tuesday, May 18, and on Thursday, May 20, 1937, at the Committee's laboratory, the Langley Memorial Aeronautical Laboratory, at Langley Field, Virginia. In accordance with the plan inaugurated in 1936, the conference was held on two different days, the same program of discussions and demonstrations being followed both days, in order to provide opportunity for all those engaged in American aeronautical activities who desired to do so to attend the conference.

The purpose of the Committee's annual conferences is two-fold: First, to afford to the representatives of the American aircraft industry, other Government organizations, educational institutions, engineering societies, and others concerned with aeronautics an opportunity to receive first-hand reports of progress in aeronautical research at the Committee's laboratory and to witness demonstrations of the special equipment and methods used; and second, to enable the Committee to obtain the comments and suggestions of those actively engaged in aeronautical activities as to the research problems which are deemed of particular importance at the present time and which the Committee is especially equipped to study.

The National Advisory Committee for Aeronautics was represented at the conference on both days by officers and members, and also on May 18 by its Committees on Aerodynamics

and Power Plants for Aircraft, and on the 20th by its Committee on Aircraft Structures and Materials and Subcommittee on Structural Loads and Methods of Structural Analysis, members of the staff of the laboratory being present on both days.

Most of those attending proceeded from Washington by overnight steamer to Old Point Comfort, leaving at 6:30 p.m. on May 17 and May 19 respectively. After breakfast on the boat, the party left Old Point Comfort at 7:55 a.m. by automobile and proceeded to Langley Field, where they were joined by some who flew direct to Langley Field, and later by others who arrived by train.

MORNING SESSION.

The opening session was held at 8:35 a.m. in the Post Theater at Langley Field, which was made available through the courtesy of the Commanding Officer of the Field.

Acting under direction of Dr. Joseph S. Ames, Chairman of the National Advisory Committee for Aeronautics, who was prevented by illness from being present, Honorable Edward P. Warner, a member of the Committee and Chairman of the Committee on Aerodynamics, served as Chairman of the conference on May 18.

On May 20 Honorable Willis Ray Gregg, Chairman of the Executive Committee of the National Advisory Committee for Aeronautics, was Chairman of the conference.

The Chairman read the following telegram from Dr. Ames:

"To Those Attending the Twelfth Annual Aircraft
Engineering Research Conference
National Advisory Committee for Aeronautics
Langley Field Virginia

"I regret exceedingly my inability to be with you today. The annual conference has always been a great pleasure and inspiration to me personally and to the Committee. Your interest in and the support you have given to the Committee's activities and the many helpful

suggestions which you have made have played an important part in the success of our organization. My best wishes to you all for a most profitable and pleasant day."

On May 18 Honorable William P. MacCracken, a member of the National Advisory Committee, suggested that a telegram of reply be sent to Dr. Ames. The conference by applause signified its approval, and the Chairman appointed Mr. MacCracken and Mr. Lester D. Gardner, of New York City, to collaborate in preparing such a telegram. The following telegram was accordingly prepared and sent:

"Dr. Joseph S. Ames
2 Charlcoate Place
Baltimore Maryland

"Your message to the twelfth conference is greatly appreciated collectively and individually. Those in attendance request me to send to you their sincere wishes for a speedy recovery and to state that your service has added much not only to the former conferences but to the development of aeronautics. They all look forward to your continued service and your presence at the next annual conference.

"Edward P. Warner, Acting Chairman."

On May 20, after the Chairman had read the telegram from Dr. Ames, the suggestion that a reply be sent to him was made by Dr. Lyman J. Briggs, a member of the National Advisory Committee. The conference by applause approved the suggestion, and the following telegram was accordingly sent to Dr. Ames on May 20:

"Your many friends assembled at Langley Field laboratories of the NACA for the Twelfth Engineering Conference send their greetings and kindest regards. The present conference fully maintains the high standard established during the past twelve years. We are having typical NACA conference weather. Our only regret is that you are not with us.

"W. R. Gregg,
Chairman, Executive Committee."

The Chairman announced that the information to be presented at the conference was confidential, and specifically requested that no photographs be taken inside any laboratories and that there be no publication of data, photographs of charts or equipment, or sketches of charts or equipment, except by arrangement with Dr. George W. Lewis, Director of Aeronautical Research.

After briefly welcoming the members of the conference on behalf of the National Advisory Committee for Aeronautics, the Chairman introduced Colonel Walter R. Weaver, Air Corps, Commanding Officer of Langley Field, who welcomed the guests on behalf of the Air Corps, and expressed regret that Major General Frank M. Andrews, Commanding General of the General Headquarters Air Force, and Brigadier General Henry C. Pratt, formerly Commanding Officer of the field and a former member of the National Advisory Committee, were unable to be present.

The Chairman then introduced Mr. Henry J. E. Reid, Engineer-in-Charge of the Langley Memorial Aeronautical Laboratory, who spoke a few words of greeting to the guests and requested the criticisms and suggestions of the members of the conference as to additional problems that should be investigated by the Committee, modifications in existing research programs, and projects already on the Committee's program which it was believed should be expedited.

Mr. Reid called upon certain members of the laboratory staff in turn to present and explain, with the aid of charts, some of the important results of investigations conducted by the Committee during the past year.

Mr. Elton W. Miller, Chief of the Aerodynamics Division of the laboratory, outlined in general the results of investigations being conducted by the Committee on the reduction of wing drag to provide increase in speed, including the effect of rivet heads and surface roughness, and on the use of flaps to provide increased safety in low-speed flight and in landing, particularly the recently developed flap arrangement for control of the stall.

Mr. John W. Crowley, Jr., Chief of the Flight Research Section, discussed the Committee's study of the effect of gusts and other weather conditions on airplane load factors,

describing and exhibiting one of the N.A.C.A. V-G recorders with which data were being collected in air-line operation for this investigation. He also presented results of an analytical study of the factors affecting take-off, including the relation between wing loading and take-off distance, and the effect of constant-speed propellers, flaps, and catapulting devices in the reduction of take-off distance.

Dr. Theodore Theodorsen, Chief of the Physical Research Division, described the investigation of the aerodynamic efficiency of the cowling and baffle system of air-cooled engines, particularly the N.A.C.A. double-slot nose cowling. He also outlined the development of a method of determination of the dangerous vibration frequencies of propellers and the work conducted on the behavior of a vibrating wing in an air stream.

Mr. Starr Truscott, Chief of the Hydrodynamics Division, gave an example of the results to be obtained by the application of data from the N.A.C.A. tank in the reduction of the take-off time and distance of seaplanes, including the effect of reduction in beam, increase in angle of afterbody keel, substitution of countersunk for brazier-head rivets, and the use of the proper trim angle. He exhibited an N.A.C.A. trim-angle indicator for use by the pilot in taking off.

Mr. Carlton Kemper, Chief of the Aircraft Engine Division, described some of the principal results of investigations of the maximum power obtainable without detonation with fuels of high octane number, and the comparative performance of carburetor and Diesel-type engines under conditions corresponding to altitude and to take-off.

The Chairman requested the party to divide into six groups for inspection of the laboratory, according to the color of the tags which had been supplied to and were being worn by the guests, and announced the leaders for the six groups. He said that it was essential that the members of each group keep together, and that the schedule (copies of which had been distributed to the guests) be followed strictly, in order to avoid confusion and delay.

The group leaders were: May 18 - red, Mr. Gregg; white, Mr. Warner; blue, Mr. MacCracken; brown, Captain Sydney M. Kraus, U.S.N.; green, Dr. Lewis; and gold, Mr.

John F. Victory; May 20 - red, Mr. Gregg; white, Dr. Briggs; blue, Commander Garland Fulton, U.S.N.; brown, Captain Paul H. Kemmer, U.S.A.; green, Dr. Lewis; and gold, Mr. Edward H. Chamberlin.

INSPECTION OF LABORATORY.

The members of the conference then proceeded on a tour of inspection of the laboratory, which was interrupted at 12:35 p.m. for lunch at the full-scale wind tunnel. After lunch, at 1:45 p.m., the entire party assembled in the test chamber of the full-scale tunnel where a group photograph was taken, following which the inspection of the laboratory was resumed.

The tour was conducted in accordance with the following schedule:

<u>Arrive</u>	<u>Red</u>	<u>White</u>	<u>Blue</u>	<u>Brown</u>	<u>Green</u>	<u>Gold</u>
High-Speed Tunnel	9:51	3:02	2:31	2:03	12:12	11:14
Gust Tunnel	10:18	9:50	2:58	2:30	2:02	11:41
Full-Scale Tunnel	10:45	10:17	9:49	2:57	2:29	12:08
Spinning Tunnel	11:13	10:45	10:17	9:49	2:57	2:03
N.A.C.A. Tank	11:40	11:12	10:44	10:16	9:48	2:30
N.A.C.A. Hangar	12:10	11:42	11:14	10:46	10:18	3:00
Atmospheric Wind Tunnel	2:05	12:12	11:44	11:16	10:48	9:50
Variable-Density Wind Tunnel	2:19	12:26	11:56	11:30	11:02	10:04
Power Plant Laboratory	2:33	2:05	12:11	11:43	11:15	10:17
Propeller Research Tunnel	3:03	2:35	2:04	12:13	11:45	10:47

Eight-Foot High-Speed Wind Tunnel. At the eight-foot high-speed wind tunnel charts were shown of results obtained in the investigations of pitching moments at high speeds, the drag of de-icers under various conditions, and the increase of drag of a wing due to rivets, lapped joints, and surface roughness. A model of a wing with radial-engine cowling and nacelle was mounted in the tunnel, and the investigation of compressibility effects on this combination was explained.

N.A.C.A. Gust Tunnel. At the new gust tunnel charts were first shown of the results obtained in a theoretical study of the effect of end fixity on the stability of

compression members of a structure and in the rational calculation of the load on compression members, after which a demonstration was given by means of a simple test set-up, of the experimental check of these theoretical results. The operation of the new N.A.C.A. gust tunnel, in which small airplane models are subjected to artificial gusts of known dimension and intensity in order to study the resulting accelerations on the model and the effect on the flight path, was then explained and demonstrated.

Full-Scale Wind Tunnel. Charts were shown at the full-scale wind tunnel of results obtained in the study of slipstream effects, downwash, and the characteristics of autogiro rotors. There was mounted in the wind tunnel a large model for the study of the decrease of drag to be obtained by the installation of the engines within the wing and the use of pusher propellers.

Free-Spinning Wind Tunnel and Free-Flight Tunnel. A demonstration was given of the operation of the new free-flight wind tunnel installed in the free-spinning wind-tunnel building, the effect of ailerons alone, rudder alone, and rudder and ailerons together on control of a small model being shown. In the free-spinning wind tunnel demonstrations were given of the difference in the spinning characteristics of a model of a low-wing monoplane with the vertical fin area blanketed by the fuselage and with the area unblanketed; of the effect of the substitution of a wing with rounded Army tips for rectangular tips; and of the effect of changing the mass distribution, such as would result from changing the airplane from a single-engine to a two-engine type, on the model with rounded Army wing tips.

N.A.C.A. Tank. In the N.A.C.A. tank a demonstration was given on a model of a hull towed through the water of the effect of the best trim angle in the reduction of take-off time and distance and of the use of the N.A.C.A. trim-angle indicator to enable the pilot to take off at the proper trim angle. The value of the 900-foot extension of the tank, now under construction, in making possible tests on larger models and at higher speeds, was explained. Charts were exhibited of the calculated variation of air drag, total resistance, and thrust of a flying boat at three conditions of trim, of the effect of wind on take-off, and of the effect of scale on results of tank tests as indicated by comparative tests of a one-sixth-size and a one-twelfth-size model of the same hull.

N.A.C.A. Hangar. At the hangar (flight research laboratory) the installation of the N.A.C.A. double nose-slot cowling on a full-size airplane was exhibited and explained. Charts were shown of results of the Committee's investigations of lateral control, reduction of take-off distance, and the measurement of the flying and handling qualities of airplanes. An airplane having a wing with the gap sealed between the ailerons and the main portion of the wing and with narrow aileron tabs, for reduction of the forces on the control stick, and another airplane with the wing equipped with the new N.A.C.A. stall-control flap were displayed, as well as other airplanes used in the Committee's flight research.

Atmospheric Wind Tunnel. A demonstration was given on a wing model mounted in the 7- by 10-foot wind tunnel of the use of a differential aileron linkage for reduction of the forces on the control stick of an airplane. The limitations of the method of reducing wheel shimmy by the application of friction were explained, and the effect of permitting a castering wheel to have a certain amount of lateral freedom on its axle was demonstrated with a small model.

Variable-Density Wind Tunnel. In the variable-density wind tunnel charts were shown of results from the study of the stalling characteristics of airplanes and the effect of the N.A.C.A. stall-control flap in changing the character of the stall of a high-lift wing from a sudden loss of lift at the maximum to a gradual stall resulting in a well-rounded lift-curve top. A demonstration was given by means of the operation of the new automatic balance of the tunnel, of the development of the lift curve of an airfoil having both a split flap and a stall-control flap, first without and then with the stall-control flap deflected.

Power Plant Laboratory. At the power plant laboratory a demonstration was given of the variation of cooling with several baffle arrangements on a model engine cylinder, and the design of mixture-ratio indicators was discussed and results described of the effect of air-fuel ratio on combustion. Charts were exhibited presenting data obtained on engine performance with fuels of high octane number; air flow in spark-ignition engines; the performance characteristics of a two-stroke-cycle engine of the compression-ignition type, and of the gasoline-

injection spark-ignition type, and of a boosted compression-ignition engine with displacer-piston combustion chamber, as determined from tests on a single-cylinder engine; the cylinder-temperature correction factor for change in cooling-air temperature; and the design and placing of cylinder fins for most effective cooling.

Propeller Research Tunnel. A number of charts were shown at the propeller research tunnel presenting information regarding the Committee's investigation of full-scale propellers, including an outline of the program, and data on the effect on propeller efficiency of high tip speeds at various angles of attack, of blade section, and of pitch distribution along the blade; the relative drag of an idling and a locked propeller; and the installation of engine intakes so as to take advantage of the dynamic pressure of the air to produce a pressure increase in the carburetor intake of the engine, thus obtaining a supercharging effect. An engine nacelle was shown mounted in the tunnel with spinner around the propeller hub, and data were presented on the effect of spinners on propulsive efficiency.

AFTERNOON CONFERENCES.

Upon completion of the tour of inspection, the party separated to attend the following six simultaneous conferences for the discussion of six different subjects, as had been indicated on the programs and the supplementary outlines which had been supplied to the members of the conference:

1. Airplane Performance and Design Characteristics
2. Aerodynamic Efficiency and Interference
3. Cowling and Cooling Research
4. Aircraft-Engine Research
5. Seaplanes
6. Rotorplanes

CONFERENCE ON AIRPLANE PERFORMANCE AND DESIGN CHARACTERISTICS.

The conference on airplane performance and design characteristics was held in Room A of the full-scale wind-tunnel

building at 3:35 p.m. Honorable Edward P. Warner, a member of the National Advisory Committee for Aeronautics and Chairman of the Committee on Aerodynamics, presided at this conference on May 18, and on May 20 the presiding officer was Dr. George W. Lewis, Director of Aeronautical Research of the National Advisory Committee.

Charts were presented and explained by members of the Committee's staff and questions were asked and suggestions for future work were submitted by the guests and recorded for consideration by the Committee.

The discussion included the following subjects:

1. Lateral control
 - (a) Wing stalling (illustrated by motion pictures)
 - (b) Narrow-chord ailerons and tabs
2. Flaps for landing and take-off
3. Stability
4. Spinning

On May 20, as there was still time available after the discussion of these subjects, the following additional topics were considered:

5. Means for reducing vertical motion due to gusts
6. Take-off

Following the discussion, at about 5:10 p.m., the conference adjourned.

CONFERENCE ON AERODYNAMIC EFFICIENCY
AND INTERFERENCE.

The conference on aerodynamic efficiency and interference was held in Room B of the full-scale wind-tunnel building at 3:35 p.m. On May 18 Dr. H. L. Dryden, of the National Bureau of Standards, a member of the Committee on Aerodynamics, presided. Honorable Willis Ray Gregg, Chairman of the Executive Committee of the National Advisory Committee for Aeronautics, presided on May 20.

Charts showing data obtained by the Committee in connection with the following subjects were presented and explained by members of the Committee's staff:

1. Effects of rivets and surface roughness on airfoil drag
2. Drag of simple forms
3. Compressibility effects
4. Propeller performance characteristics
5. Slipstream effects on wing and tail characteristics
6. Wing-fuselage interference

In the course of the presentation, questions were asked and suggestions for future investigations were submitted by members of the conference.

On conclusion of the discussion, at about 5:10 p.m., the conference adjourned.

CONFERENCE ON COWLING AND COOLING RESEARCH.

The conference on cowling and cooling research was held in Room C of the full-scale wind-tunnel building at about 3:45 p.m. Dr. George W. Lewis, Director of Aeronautical Research of the National Advisory Committee for Aeronautics, presided at this conference on May 18, and on May 20 Honorable Edward P. Warner, a member of the National Advisory Committee and Chairman of the Committee on Aerodynamics, presided.

The discussion of the subject proceeded in accordance with the following outline:

1. Flight research on N.A.C.A. nose-slot cowling
2. Aerodynamic efficiency of baffle system of an air-cooled engine
3. Cylinder-temperature correction factors for flight conditions

4. Design of fins for air-cooled engines
5. Compressibility effects on cowling
6. Cowling of in-line air-cooled engines

Charts showing results obtained by the Committee in connection with these various subjects were presented and explained by members of the Committee's staff. In the course of the presentation questions were asked and suggestions for future work submitted by members of the conference.

Following the discussion the conference adjourned, after which a demonstration of propeller vibration was given in the adjoining room.

CONFERENCE ON AIRCRAFT-ENGINE RESEARCH.

The conference on aircraft-engine research was held in the engine research laboratory at about 3:45 p.m. On May 18 Dr. H. C. Dickinson, of the National Bureau of Standards, a member of the Committee on Power Plants for Aircraft, presided at this conference, and on May 20 the presiding officer was Commander Garland Fulton, U.S.N., a member of the Committee on Aircraft Structures and Materials.

Charts showing data obtained by the Committee in connection with the following subjects were exhibited and explained by members of the Committee's staff:

1. A proposed method for rating fuels
2. Performance of compression-ignition engines under altitude conditions
3. Performance of two-stroke-cycle compression-ignition engine
4. Performance of two-stroke-cycle spark-ignition engine
5. Effect of inert gases on combustion of Diesel oil

6. Pressures within fuel tanks during dives
7. Fuel discharge rates with short injection tube
8. Mixture-ratio indicators.

During the discussion questions were asked and comments and suggestions presented by the guests.

Motion pictures were shown of the air flow in engine cylinders, and a demonstration was given of the M.I.T. knockmeter, after which the conference adjourned.

CONFERENCE ON SEAPLANES.

The conference on seaplanes was held at about 3:45 p.m. at the N.A.C.A. tank, Mr. Starr Truscott, Chief of the Hydrodynamics Division of the Laboratory, presiding both on May 18 and on May 20.

Data obtained by the Committee on the following subjects were presented by members of the staff of the tank with the aid of charts:

1. Effect of span and location of stub wing
2. Effect of certain changes in form of hull
3. Flow patterns of water over a flying-boat hull
4. Comparison of transverse and pointed-step hull
5. Effect of chine flare
6. Scale effect in tank tests

In the course of the presentation questions were asked and comments and suggestions submitted by the members of the conference.

A brief description was given of the instrument being developed by the Committee for recording events during the take-off of seaplanes.

Following the discussion, at about 5:15 p.m., the conference adjourned.

CONFERENCE ON ROTORPLANES.

The conference on rotorplanes was held at the N.A.C.A. hangar (flight research laboratory) at about 3:45 p.m. Mr. John W. Crowley, Jr., Chief of the Flight Research Section of the Langley Memorial Aeronautical Laboratory, presided both days.

Reference was made to the charts in connection with autogiro investigations which had been shown that morning in the full-scale wind tunnel, as follows:

1. Effect of rotor-blade tabs on the control force
2. Drag of autogiro rotor and of complete autogiro
3. Effect on efficiency of decrease in ratio of blade area to swept-disk area of rotors
4. Effect on efficiency of blade plan form

Additional charts presenting the following information were exhibited and explained:

5. Effect of rotor-blade tabs on blade twist
6. Effect of tabs on flapping motion of rotors
7. Effect of tabs on efficiency
8. Effect of blade section on rotor efficiency

Comments and suggestions were submitted by the guests as to the Committee's program of investigation in connection with rotating-wing aircraft. Mention was made of recent European developments on aircraft of this type.

Following the discussion, at about 5:15 p.m., the conference adjourned.

* * * * *

At the close of the six afternoon conferences, at about 5:15 p.m., the party, accompanied by members of the staff of the Committee's laboratory, left Langley Field by automobiles, proceeding on May 18 to the Officers' Club at Fort Monroe, and on the 20th to the Chamberlin Country Club. At 7:00 p.m. the party left Old Point Comfort by steamer and arrived at Washington at 7:00 a.m., one group on May 19 and the other on May 21, 1937.

The following were present at the conference:

Members and Officers of the National Advisory Committee for Aeronautics:

Honorable Willis Ray Gregg, United States Weather Bureau,
 Chairman, Executive Committee,
 Dr. Charles G. Abbot, Smithsonian Institution,
 Dr. Lyman J. Briggs, National Bureau of Standards,
 Rear Admiral Arthur B. Cook, U.S.N.,
 Honorable Fred D. Fagg, Jr., Bureau of Air Commerce, Department of Commerce,
 Captain Sydney M. Kraus, U.S.N.,
 Honorable William P. MacCracken,
 Brigadier General A. W. Robins, Air Corps, U.S.A.,
 Honorable Edward P. Warner,
 Dr. Orville Wright,

Dr. George W. Lewis, Director of Aeronautical Research,
 John F. Victory, Secretary,
 E. H. Chamberlin, Assistant Secretary,
 H. J. E. Reid, Engineer-in-Charge, Langley Memorial Aeronautical Laboratory.

Members of Committee on Aerodynamics:

¹Honorable Edward P. Warner, Chairman,
²Dr. George W. Lewis, Vice Chairman,
 Major Howard Z. Bogert, Air Corps, U.S.A.,

¹Also member of the N.A.C.A.

²Also officer of the N.A.C.A.

- ¹Dr. Lyman J. Briggs, National Bureau of Standards,
Theophile dePort, Materiel Division, Army Air Corps,
Wright Field,
Lieutenant Commander W. S. Diehl, U.S.N.,
Dr. H. L. Dryden, National Bureau of Standards,
Lieutenant Colonel O. P. Echols, Air Corps, U.S.A.,
Richard C. Gazley, Bureau of Air Commerce, Department
of Commerce,
¹Lieutenant Commander L. M. Grant, U.S.N.,
¹Honorable Willis Ray Gregg, United States Weather Bureau,
Lawrence V. Kerber, Bureau of Air Commerce, Department
of Commerce,
Commander A. C. Miles, U.S.N.,
Elton W. Miller, Langley Memorial Aeronautical Labora-
tory.

Members of Committee on Power Plants for Aircraft:

- ¹Honorable William P. MacCracken, Chairman,
²Dr. George W. Lewis, Vice Chairman,
Lieutenant Commander Rico Botta, U.S.N.,
Dr. H. C. Dickinson, National Bureau of Standards,
John H. Geisse, Bureau of Air Commerce, Department of
Commerce,
Carlton Kemper, Langley Memorial Aeronautical Laboratory,
Gaylord W. Newton, Bureau of Air Commerce, Department of
Commerce,
Major E. R. Page, Air Corps, U.S.A.,
C. Fayette Taylor, Massachusetts Institute of Technology.

Members of Committee on Aircraft Structures and Materials:

- ¹Dr. Lyman J. Briggs, National Bureau of Standards, Chair-
man,
³Major Howard Z. Bogert, Air Corps, U.S.A.,
Lieutenant Commander C. F. Cotton, U.S.N.,
Commander Garland Fulton, U.S.N.,
³Richard C. Gazley, Bureau of Air Commerce, Department of
Commerce,
J. T. Gray, Bureau of Air Commerce, Department of Commerce,
Charles H. Helms, National Advisory Committee for Aero-
nautics,
J. B. Johnson, Materiel Division, Army Air Corps, Wright
Field,

¹Also member of the N.A.C.A.

²Also officer of the N.A.C.A.

³Also member of the Committee on Aerodynamics.

- ¹Dr. George W. Lewis,
H. S. Rawdon, National Bureau of Standards,
Starr Truscott, Langley Memorial Aeronautical Laboratory,
²Honorable Edward P. Warner.

Members of Subcommittee on Structural Loads and Methods of Structural Analysis:

- ³Starr Truscott, Langley Memorial Aeronautical Laboratory, Chairman,
M. P. Crews, Bureau of Air Commerce, Department of Commerce,
⁴Richard C. Gazley, Bureau of Air Commerce, Department of Commerce,
⁴Lieutenant Commander L. M. Grant, U.S.N.,
Captain Paul H. Kemmer, Air Corps, U.S.A.,
¹Dr. George W. Lewis,
Lieutenant Commander R. D. MacCart, U.S.N.,
Joseph S. Newell, Massachusetts Institute of Technology,
Lieutenant Commander H. R. Oster, U.S.N.,
¹H. J. E. Reid, Langley Memorial Aeronautical Laboratory,
Richard V. Rhode, Langley Memorial Aeronautical Laboratory.

Representatives of Manufacturers and Operators:

Aeronautical Corporation of America, Cincinnati, Ohio:
R. E. Schlemmer,

Aircraft Development Company, Washington, D. C.:
Jonathan E. Caldwell,
Willard A. Driggers,
John A. Murphy,

Allison Engineering Company, Indianapolis, Indiana:
H. J. Buttner,
Ronald M. Hazen,
O. T. Kreusser,
C. J. McDowall,

¹Also officer of the N.A.C.A.

²Also member of the N.A.C.A.

³Also member of the Committee on Aircraft Structures and Materials.

⁴Also member of the Committee on Aerodynamics.

Aluminum Company of America, Pittsburgh, Pennsylvania:

L. C. Fisher (Washington, D. C.),
H. C. McCord (Washington, D. C.),
C. F. Nagel (Washington, D. C.),
F. C. Pyne (Washington, D. C.),

American Steel and Wire Company, Cleveland, Ohio:

C. W. Meyers,

The Andrews-Hammond Corporation, Chicago, Illinois:

E. F. Andrews,

Arrow Aircraft Corporation, Lincoln, Nebraska:

C. F. Biese-meier,

Aviation Manufacturing Corporation, Lycoming Division,
Williamsport, Pennsylvania:

Val Cronstedt,

Barkley-Grow Aircraft Corporation, Detroit, Michigan:

Dwight C. Maier,

Beech Aircraft Corporation, Wichita, Kansas:

O. L. Davis (New York City),

Bell Aircraft Corporation, Buffalo, New York:

Lawrence D. Bell,
Harland M. Poyer,
Robert J. Woods,

Bell Telephone Laboratories, Incorporated, New York
City:

O. M. Glunt,
F. R. Lack,
E. L. Nelson,

Bellanca Aircraft Corporation, New Castle, Delaware:

G. M. Bellanca,
A. F. Haiduck,
R. D. Morgan,

Bendix Products Corporation, South Bend, Indiana:

Roy Hurley,
J. M. Miller,
F. C. Mock,

Boeing Aircraft Company, Seattle, Washington:
J. P. Murray (Washington, D. C.),

Breeze Corporations, Incorporated, Newark, New Jersey:
J. J. Mascuch,

Brewster Aeronautical Corporation, Long Island City,
New York:
Dayton T. Brown,
F. S. Hubbard,

Edward G. Budd Manufacturing Company, Philadelphia,
Pennsylvania:
Enea Bossi,
E. J. W. Ragsdale,

Carnegie-Illinois Steel Corporation, Pittsburgh, Penn-
sylvania:
H. C. Esgar,
Paul F. Voigt, Jr.,

Chrysler Corporation, Detroit, Michigan:
A. G. Herreshoff,

The Cleveland Pneumatic Tool Company, Cleveland, Ohio:
E. W. Cleveland,
L. W. Greve,
J. F. Wallace,

Consolidated Aircraft Corporation, San Diego, Cali-
fornia:
I. M. Laddon,
H. E. Weihmiller (Washington, D. C.),

Continental Motors Corporation, Detroit, Michigan:
W. R. Angell, Jr.,
F. T. Gould,
N. N. Tilley,

Cunningham-Hall Aircraft Corporation, Rochester, New
York:
Randolph F. Hall,

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