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Minutes of Meeting
COMMITTEE ON AERODYNAMICS
October 4-5, 1954

The Committee on Aerodynamics met at the Ames Aeronautical Laboratory, Moffett Field, California on October 4, 1954, and at the High-Speed Flight Station, Edwards Air Force Base, on October 5, 1954.

Present:

Mr. Preston R. Bassett, Chairman
Dr. T. P. Wright, Vice Chairman
Captain Walter S. Diehl, USN (Ret.)
Rear Admiral Robert S. Hatcher, USN
Mr. Harold D. Hoekstra
Mr. C. L. Johnson
Dr. A. Kartveli
Mr. Bartram Kelley (attended first day only)
Dr. A. E. Lombard, Jr.
Mr. F. A. Louden
Colonel D. D. McKee, USAF
Dr. Clark B. Millikan
Dr. William J. O'Donnell
Dr. W. Bailey Oswald
Mr. Kendall Perkins (attended first day only)
Dr. Allen E. Puckett
Mr. Russell G. Robinson
Mr. George Snyder
Professor E. S. Taylor
Mr. F. L. Thompson
Mr. Charles Tilgner, Jr.
Mr. R. H. Widmer
Mr. Robert J. Woods
Captain John T. Hayward, USN, representing Capt. Bergin
Mr. M. B. Ames, Jr., Secretary;

And:

Mr. John W. Crowley, NACA Headquarters
Mr. Harry J. Goett, Ames Laboratory (Oct. 4 only)
Mr. John V. Becker, Mr. Norris F. Dow } Langley Laboratory (Oct. 5 only)
Brig. General J. Stanley Holtoner, USAF, Commander, Air Force Flight Test Center, Edwards (Oct. 5 only)
Col. William D. Brady, USAF, Col. H. A. Hanes, USAF, Lt. Col. Jack L. Ridley, USAF } Air Force Flight Test Center (Oct. 5 only)
Mr. Walter C. Williams, Mr. De E. Beeler, Mr. A. Scott Crossfield, Mr. Hubert M. Drake, Mr. G. M. Truszynski, Mr. Joseph R. Vensel } NACA High Speed Flight Station (Oct. 5 only)

It was reported that Captain Bergin and General Simon would be unable to attend.

APPROVAL OF MINUTES

Meeting of April 28 and 29, 1954. - Mr. Louden called attention to a correction on page 16, last line, where F3D should be changed to A3D. There being no further corrections to the minutes of the previous meeting, on a motion duly seconded and carried, it was

RESOLVED, That the minutes of the April 28-29, 1954 meeting of the Committee on Aerodynamics be approved as corrected.

REPORT OF CHAIRMAN

Appointment of New Member. - It was announced that ~~Captain~~ R. Adm. Robert S. Hatcher, Assistant Chief of the Bureau of Aeronautics for Research and Development, had been appointed to membership on the committee as an additional representative of the Bureau of Aeronautics.

REPORT OF SECRETARY

Report on Actions of Executive Committee. - The Secretary advised that the Executive Committee, at its meeting on July 15, 1954 had taken the following actions in connection with the recommendations of the Committee on Aerodynamics at its April meeting:

(a) The recommendation of the Aerodynamics Committee regarding the need for a twofold increase in NACA effort on automatic control and guidance, had been referred to the Director for his guidance. The second recommendation, that a high level group re-evaluate the present scope of NACA work and consider the feasibility of extending its efforts into related fields not now covered, was referred back to the Aerodynamics Committee for clarification and further consideration of the views of the Executive Committee concerning extension of programs into related fields not now covered.

(b) The recommendations of the committee regarding direction of effort toward solution of the problem of engine air inlet distortion, and extension of engine duct buzz research at Lewis, were referred to the Director who stated that they could be incorporated in the research program at the Lewis Laboratory.

(c) In connection with the committee's recommendation regarding the need for a research engine program, it was agreed that informal conferences would be held between representatives of the Air Force and the Lewis Laboratory to explore the possibility of undertaking a research engine program. It was agreed that the Air Force and the NACA would arrange for a study of the question. Subsequent to the meeting, correspondence between the NACA and the Air Force had discussed preliminary arrangements for such a meeting.

Report on Plans for NACA Conferences. - The Secretary noted that a Conference on Helicopters had been held at Langley on May 12 and 13, 1954. The compilation of papers presented at this conference had been transmitted to the members of the Aerodynamics Committee shortly thereafter.

It was stated that an NACA - University Conference on Aerodynamics, Structures and Propulsion was scheduled for the Lewis Laboratory on October 20, 21 and 22, 1954. Also to be held at the Lewis Laboratory was an Aircraft Operating Problems Conference, scheduled for November 17 and 18, 1954.

Discussions in Connection with New Research Airplane. - It was noted that a meeting had been held with the military services to discuss the need for a new research airplane to investigate the problems of very high speeds and very high altitudes. The Secretary stated that a copy of a paper entitled, "NACA Views Concerning a New Research Airplane" was to be handed out during the meeting at Edwards on October 5 for consideration by the committee members.

Report on Other Actions. - As recommended by the Aerodynamics Committee at its previous meeting, a panel of the Subcommittee on High-Speed Aerodynamics had been appointed to consider the subject of laminar-flow boundary-layer control. The results of this

MEETING AT EDWARDS AIR FORCE BASE
October 5, 1954

Inspection of Edwards Air Force Base. - General Holtoner and members of his staff briefed the committee on the activities of the Air Force Flight Test Center. After the briefing, the committee toured the Base, inspecting the facilities and the various aircraft undergoing flight tests.

Executive Session, NACA High-Speed Flight Station, Edwards Air Force Base

Review of Research Activities of NACA High-Speed Flight Station. - Mr. Beeler reviewed briefly the activities of the NACA High-Speed Flight Station, and discussed some of the more general results obtained with the various research airplanes.

Proposal for a New Research Airplane. - The Secretary distributed copies of a document entitled, "NACA Views Concerning a New Research Airplane" (Secret). By way of introduction, Mr. Thompson explained that in response to the June 1952 recommendation of the Committee on Aerodynamics that the NACA increase its research on problems of manned and unmanned flight at altitudes between 12 and 50 miles and at Mach numbers between 4 and 10, a special group of NACA staff members at the Langley Laboratory had been organized to undertake such studies. Copies of a report on these studies were circulated and discussed at the Aerodynamics Committee meeting in April 1954.

It was concluded from the Langley study that of the many problems which would be encountered in flight at high speeds and high altitudes, two were outstanding. These were: (1) preventing the distortion of the aircraft structure by the direct or indirect effects of aerodynamic heating, and (2) achievement of stability and control at very high altitudes at very high speeds, and during atmospheric re-entry from ballistic flight paths. It is possible to study certain phases of these problems in the laboratory and this is being done by the NACA. However, these laboratory studies leave unanswered questions which the NACA believes can be answered only through research in flight.

It is not feasible to expose a complete full-scale airplane structure to severe aerodynamic heating conditions in a wind tunnel. The problem of attitude control in the absence of aerodynamic control, and control during re-entry into the atmosphere can only be studied adequately in flight. Some problems of pilot environment cannot be simulated in the laboratory, including conditions of weightless flight. These problems can be studied in a piloted aircraft because the most severe conditions need not be encountered at the start of the flight program. Flights can proceed moderately and with reasonable safety, starting from speeds and altitudes at which experience is already available. A flight research program

of this nature can probably be accomplished in the shortest length of time by the use of manned aircraft.

Having concluded that the study of these problems would require a new research airplane, the various NACA laboratories undertook to examine the feasibility of designing and constructing such an airplane now. Mr. Thompson explained that the results to be presented to this meeting and which are contained in the document distributed at the meeting are based principally on the Langley study, which although generally similar to the other NACA studies, was the more detailed of the three undertaken.

Mr. Williams outlined the performance required for a new research airplane. It was considered that the performance must constitute a substantial step increase over the performance of both existing research airplanes as well as tactical airplanes now under development. At the same time, the design goal was not set so high that serious delay would result from the time required to solve problems encountered in design of the airplane.

Mr. John Becker of the Langley Laboratory discussed the results of aerodynamic heating and associated performance limitations, and the stability and control aspects of the Langley Laboratory study. The configuration used was selected to illustrate some of the features which are believed to be important for a research airplane of the type proposed. Some of the factors considered were that it must be a piloted aircraft capable of being landed in a normal manner; the airplane should be air-launched to capitalize on existing techniques and obviate development and operational problems; it should use a rocket power plant that does not require extensive development. The following factors were given heavy weight in the Langley study:

(1) The structural and aerodynamic design features of the airplane must be feasible based upon existing knowledge and practices;

(2) Wherever feasible, efforts should be maintained to achieve maximum simplicity in the design and operation;

(3) Special consideration should be given in the design to insure early delivery and operation of the flight article.

Mr. Norris Dow of the Langley Laboratory discussed the structural aspects of the Langley study. He explained how the temperature limitations used to establish the permissible flight plan affected the structure, and the characteristics of the various high-temperature materials which might be available for fabricating the structure. He outlined some of the problems to be encountered in construction of the wing to avoid buckling of the sheetmetal structure due to thermal stresses. As a result of the Langley study, a number of suggestions were made regarding ways in which the wing

structure could be fabricated so that no gross thermal stresses are induced by interior restraints. The effects of wing structural distortion under unequal heating of the upper and lower wing skins were discussed. Also the effects of the difference in temperature of the wing surfaces on both the spanwise and chordwise deflections of the wing were explained.

Mr. Dow noted that some structural development would be essential to establish structural details of such a research airplane, but that facilities are available for such work, and he believed that with concentrated effort, the necessary work could be accomplished in a reasonable time period.

Mr. Crossfield discussed some of the operational aspects of the proposed research airplane, emphasizing that experience has shown that the success of research aircraft appears to be related directly to its simplicity of design and operation. He also dealt with such matters as pilot environment, including means of providing adequate protection.

Some geographical studies have been made of the terrain over which the new research aircraft would be operated, and it was contemplated that it would be launched some distance away from Edwards, for example, the Las Vegas or Great Salt Lake areas. It was stated that adequate emergency landing areas could be found in these parts of the country.

At this point in the meeting, Dr. Puckett reviewed the discussions of this proposal at the September meeting of the Subcommittee on High-Speed Aerodynamics. A resolution of the High-Speed Subcommittee was presented, as follows:

> WHEREAS, The NACA staff presented their views concerning a new research airplane, and
>
> WHEREAS, The NACA investigation indicates that a man-carrying recoverable vehicle can be built to achieve Mach numbers in the order of 7 and altitudes of many 100,000's of feet, limited by structural temperatures of the order of 1500°F:
>
> The Subcommittee on High-Speed Aerodynamics resolved to transmit the following opinions to the Aerodynamics Committee:
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> 1. The conclusion reached by the NACA as to the feasibility of such a vehicle is valid;
>
> 2. Because this next step in performance capabilities is now possible, steps should be taken to design and build such a vehicle;

3. An important objective should be to solve the problems of carrying human beings at these extended speed and altitude regimes;

4. As pointed out by the NACA, the particular design as presented in the NACA preliminary report is not necessarily the best type to build to fulfill the objective;

5. The skill of all the principal aircraft design teams in the country should be brought to bear by some means, such as, for example, a design competition.

In the discussion which followed, Mr. Louden reported that the Navy is interested in the NACA proposal for a new research airplane, but would like to suggest the desirability of making it a two-man airplane in order to provide another observer and possibly an assistant to the pilot.

Mr. Crossfield pointed out that practically all of the data are recorded automatically on the ground. As far as additional crew or flight engineers were concerned, he felt that since the NACA telemetering is of the indicating type, all of the flight engineers should be stationed on the ground. As far as operating the airplane is concerned, the major problems are ones of malfunctioning of various pieces of equipment and stability and control difficulties, all of which, in his opinion, are a one-man job which should be handled by an experienced research pilot.

Mr. Johnson felt that an unmanned research vehicle should be built to investigate the Mach number range discussed. In his opinion, since one of the major reasons for building the device is for its use in structural investigations, it could be build more quickly and operated satisfactorily by remote control. He also felt that the cost of an unmanned vehicle would be substantially less than for the manned aircraft. As an example of what he had in mind, he cited Lockheed's experience with the ramjet test vehicle.

Dr. Millikan emphasized the importance of obtaining flight experience on "the man" operating throughout the proposed Mach number and altitude range in order to better define the many research problems currently anticipated. He stated that the "no-gravity" condition could best be studied in flight.

Mr. Thompson discussed briefly the Langley high-velocity rocket program at Wallops Island to investigate operational and aircraft design problems at Mach numbers approaching 10, and pointed out that unmanned programs of this nature are not adequate substitutes for manned flights such as those contained in the research airplane proposal.

Considering the feasibility of such an aircraft, Mr. Johnson proposed that design and development of a tactical aircraft should be started at this time. He was strongly of the opinion that the development of a manned aircraft having the proposed performance capabilities discussed should be completed and flying in about two years from the time the money is made available.

Admiral Hatcher pointed out that the research airplane should be considered as a very special vehicle and that the tactics of an aircraft having the proposed performance capabilities would have to be developed at a later date.

Dr. Oswald questioned whether the tactical objectives could be adequately established in time to avoid delay in the development of the research project. It was his opinion that the tactical job could be developed more soundly after the research phase of the program was completed, and with this in mind, a research machine should be well enough advanced to insure this result.

Mr. Johnson expressed the view that experience with research airplanes from the D-558-II through the X-3 types had been generally unsatisfactory in that the aerodynamic designs were actually behind tactical aircraft designs by the time research flights could be performed. He felt that a number of research airplanes have developed startling performances only by the use of rocket engines and by flying essentially in a vacuum, and that these flights had proven mainly the bravery of the test pilots. While noting that a great deal of information has been developed on stability and control at high Mach numbers, he opined that these data have applied to aerodynamic forms not typical of airplanes actually designed for supersonic flight speeds. He recommended that an unmanned vehicle be constructed first to obtain data on the structural temperature, control and stability aspects. Subsequently, if it is decided that the aeromedical problems are predominant, then the research airplane should be designed and built in not over two years and constructed in such a manner that it would provide a useful tactical reconnaissance airplane.

Various members of the committee took issue with Mr. Johnson's views. It was recalled by one member that as early as 1947, the X-1 airplanes, which were designed in 1944-1945 with 10-percent and 8-percent-thick wings, had made both climbing and level flight runs at Mach numbers between 1.0 to about 1.5, between altitudes of from 26,000 to about 55,000 feet. It was from five to seven years later that tactical airplanes achieved supersonic flights at altitudes and Mach numbers of these magnitudes. Also mentioned was the ability of the research aircraft to fly beyond normal limits of stability and control and to explore regions of buffeting well beyond the normal buffet boundaries at transonic and supersonic speeds.

Mr. Crowley explained that the NACA proposal had been developed on the conclusion that the proposed research airplane should be based in principle on the "X-1 concept", which was to build the simplist and soundest aircraft that could be designed on currently

available knowledge and put into flight research status in the shortest time possible. In comparing research airplane operations with automatically controlled flights, he called attention to the fact that the X-1 and other research airplanes had made hundreds of successful flights and investigated many non-linear or divergent conditions, sometimes experiencing excessive loading and buffeting, and on numerous occasions, malfunctioning of various pieces of the installed equipment. In spite of these difficulties, the research pilots had successfully landed the aircraft (even though at times the airplane was out of control) thereby permitting further exploratory flights of the conditions experienced. In his opinion, automatic control equipment could not be depended upon in cases similar to these.

In summary, it was the general sense of the majority of the members that there are no known limits in flight to which we will or can take human beings, that guided missiles have not eliminated the use of manned aircraft, and that carefully conducted engineering and research studies show that we are so close to the achievement of the performance proposed by the NACA that we should proceed to accomplish these objectives with manned research aircraft in the shortest possible time, presumably within the next two years. In addition to obtaining transient effects of aerodynamic heating on aircraft structures and related equipment, and obtaining operation characteristics of aircraft at extremely high altitudes and Mach numbers, including re-entry to the denser atmosphere, considerable emphasis should be placed on obtaining data on manned aircraft in the "zero-gravity" field for extended time periods. There was general agreement that other approaches to these problems currently underway and being contemplated at this time should also be continued.

After some further discussion, on a motion duly seconded and carried, a resolution was passed that

> WHEREAS, The necessity of maintaining supremacy in the air continues to place great urgency on solving the problems of flight with man-carrying aircraft at greater speeds and extreme altitudes, and
>
> WHEREAS, Propulsion systems are now capable of propelling such aircraft to speeds and altitudes that impose entirely new and unexplored aircraft design problems, and
>
> WHEREAS, It now appears feasible to construct a research airplane capable of initial exploration of these problems,
>
> BE IT HEREBY RESOLVED, That the Aerodynamics Committee endorses the proposal of the immediate initiation of a project to design and construct a research airplane capable of achieving speeds of the order of Mach number 7 and altitudes of several hundred thousand feet for the exploration

of the problems of stability and control of manned aircraft and aerodynamic heating in the severe form associated with flight at extreme speeds and altitudes.

The Committee on Aerodynamics also accepted the resolution of the Subcommittee on High-Speed Aerodynamics, and it was agreed to advise the NACA of this endorsement.

Mr. Johnson expressed further disagreement with the conclusions of the committee. In response to his request, there is attached to these minutes a copy of his letter of October 21, 1954, subject: "Minority Opinion on Extremely High Altitude Research Airplane".

NEXT MEETING

After a brief discussion, it was agreed that the next meeting of the committee would be held in the late winter or early spring of 1955. A suggestion was made that consideration be given to holding a meeting at the AEDC facility at some future date.

EXPRESSION OF APPRECIATION TO THE AIR FORCE FLIGHT TEST CENTER

Mr. Bassett thanked General Holtoner and the members of his staff for the fine reception of the Aerodynamics Committee, and the profitable morning spent in touring Air Force Flight Test Center facilities. He also thanked Mr. Williams and the members of his staff at the NACA High Speed Flight Station for their assistance in making the visit to Edwards Air Force Base a successful one.

There being no further business, the meeting was adjourned at 5:00 p.m. PST.

LOCKHEED AIRCRAFT CORPORATION
California Division
Burbank, California

COPY

October 21, 1954

Mr. Milton B. Ames, Jr.
Secretary, Committee on Aerodynamics
National Advisory Committee for Aeronautics
1512 H Street, Northwest
Washington 25, D.C.

Subject: Minority Opinion on Extremely High Altitude Research Airplane

Dear Milton:

At the recent meeting of the Committee on Aerodynamics at Muroc on October 5th, 1954, I expressed a dissenting vote on the proposal that a certain type of high altitude research airplane be constructed by industry and tested by the NACA. I would like to make clear the reasons for my vote.

1. I do agree that a vehicle should be built to investigate the Mach number range discussed.

2. I would recommend that, due to the danger involved, an unmanned vehicle be used for the structural investigations, which are half the reason for building the device. Enough progress has been made with remote control to assure satisfactory control being available for the vehicle within two years or less.

3. The cost of the unmanned vehicle would be substantially less than for the manned type.

4. The important reason advanced for using a manned vehicle is to study the aero-medical problems of flying in a nearly weightless condition. I believe a considerable amount of investigation can be made on this subject doing push-overs to zero g on our current high speed fighters.

5. Should the aero-medical viewpoint predominate, then I recommend that an airplane capable of tactical reconnaissance use be used for the research type. With very few compromises in design, the volume taken

up by flight test equipment could be properly adapted to cameras and navigational equipment. This would give the U. S. a tactical type, should it be successful, several years in advance of the normal procedures that might otherwise be followed.

During the discussion, I referred to several outcomes of the current research aircraft program. Due to the delay in getting research airplanes built in a timely manner, I claim the following conditions have developed:

1. At any given time period in which we were flying the research airplanes from the type 558-I through the X-3, tactical airplane types were available which had better aerodynamic form and higher performance at reasonable altitudes than the research airplanes involved. For instance, wing thicknesses, wing sweep angles, and general aerodynamic design of the research airplanes were actually behind tactical aircraft designs by the time any research flights could be performed.

2. Our research airplanes have developed startling performance only by the use of rocket engines and flying essentially in a vacuum. Testing airplanes designed for transonic flight speeds at Mach numbers between 2 and 3 has proven, mainly, the bravery of the test pilots and the fact that when there is no drag, the rocket engine can propel even mediocre aerodynamic forms at high Mach numbers.

3. I am not aware of any aerodynamic or power plant improvements to air-burning engines that have resulted from our very expensive research airplane program. Our modern tactical airplanes have been designed almost entirely on NACA and other wind tunnel data, plus certain rocket model tests. The flight expenditure for one type of research airplane was, roughly, one and one-half million dollars per flight, with very little flight information obtained that is useful in future designs. Lack of suitable power plants and terrifically long development periods were responsible for such costs.

4. While a great deal of information has been developed on stability and control at high Mach numbers, this data has applied to aerodynamic forms not typical of airplanes actually designed for supersonic flight speeds.

In summary, I would recommend that an unmanned vehicle be constructed first to obtain data on the structural temperature, control and stability aspects. Subsequently, if it is decided that the aero-medical problems are predominant, then the research airplane should be designed and built in not over two years and constructed in such a manner that it would provide a useful tactical reconnaissance airplane.

Yours very truly,

/s/

Clarence L. Johnson
Chief Engineer

CLJ:vmp