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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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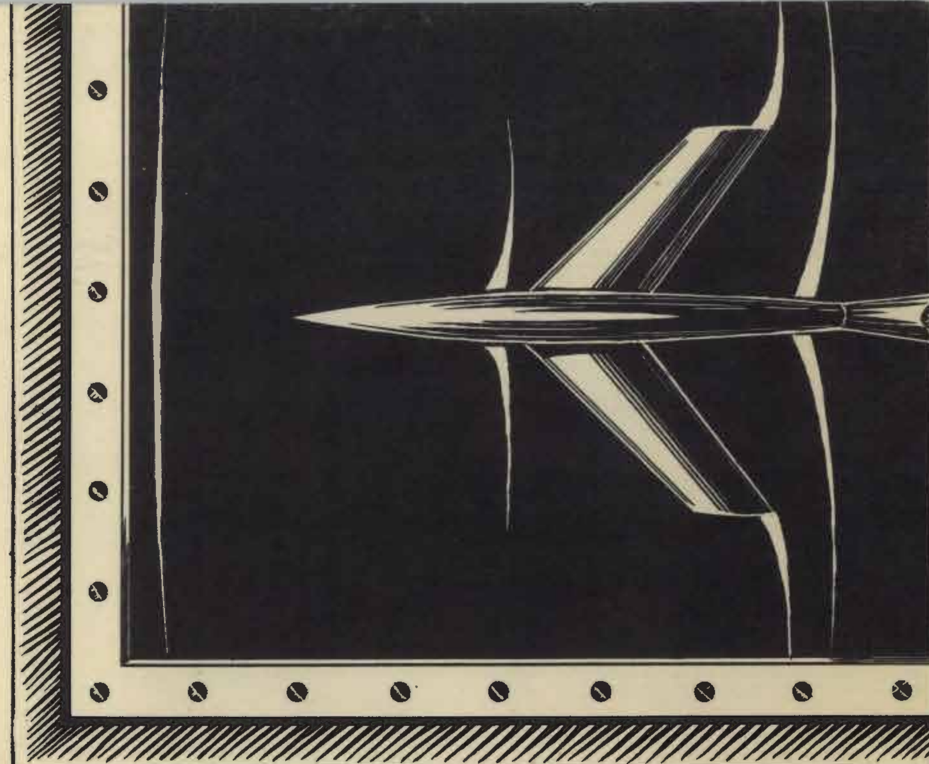


NACA

1951 INSPECTION

WELCOME

On behalf of the National Advisory Committee for Aeronautics and its supporting staff, it is my privilege to welcome you to the Langley Aeronautical Laboratory and its 1951 Inspection.

This year, when civilization lives in the shadow of a continuing crisis, the hope that our way of life may survive depends increasingly upon the strength and quality of American air power. In the international race for technological superiority, it is essential that our new military aircraft exploit extreme frontiers of human knowledge. These frontiers are not fixed; they are constantly expanded by the pressure of discoveries and scientific developments throughout the world.

It is the purpose of this Inspection to note trends and new techniques in aeronautical research in the United States. May your stay with us be both profitable and enjoyable.

J C Hunsaker
Chairman
National Advisory Committee for Aeronautics

Transonic information
.... for tomorrow's airplanes

Aircraft engines powerful enough to enable faster-than-sound flight by tactical military airplanes have been successfully developed, and now are being put into production. As a result, the need has become immediate for a mass of detail information covering aerodynamic characteristics in both the transonic and low supersonic ranges for use in the design of tomorrow's airplanes.

Substantial progress has been made in the exploration of air flow behavior in the transonic and low supersonic speed ranges. What the aeronautical research scientists have accomplished already brings into sharper focus the great amount of work yet to be done. Tomorrow's airplanes will be supersonic, it is conceded. They will also be transonic, because during every flight to faster-than-sound speeds, the airplane must pass twice through the transonic region, where air flow is a mixture, part slower than the speed of sound, part faster.

This need for the mass of aerodynamic information about the transonic area that can be used for design of tomorrow's airplanes and missiles is, of course, only one of the many demands being made upon the talents and resources of the aeronautical researcher. It is, however, a requirement which may be overriding in its urgency.

The problems presented by transonic flight were first anticipated in the late thirties, when fighter airplanes in dives occasionally approached speeds where the laws of subsonic flow were valid no longer. Even earlier, the vexing problem of "compressibility" had been encountered when propeller tip speeds approached the velocity of sound, and had been circumvented by slowing the propellers.

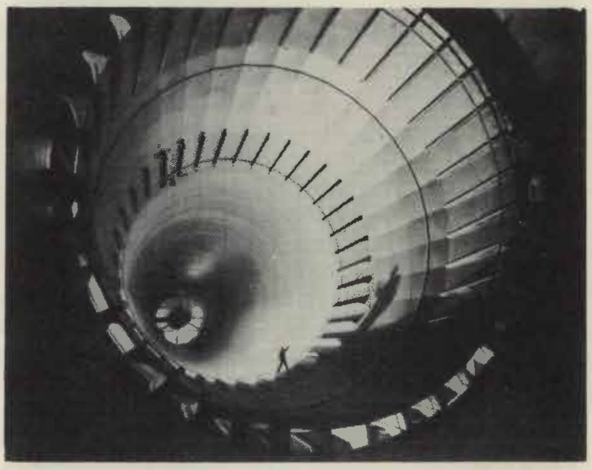
Two conditions retarded research exploration into the transonic area. Development of theory covering compressible flow at such speeds was, and continues to be, slow and difficult. In addition, the aeronautical researcher's principal tool, the wind tunnel, was found to have crippling limitations in the transonic area, especially near the speed of sound.

In World War II the insatiable demand for greater speed gave new impetus to the search for information about compressible flow in the high subsonic and transonic speed areas. In 1940, a first step was taken to develop alternate research techniques with which to explore the problem. NACA pilots dove a Navy fighter to supercritical speeds to establish the character of air flow under such free-flight conditions. This information was valuable also in studying the choking phenomena experienced in wind tunnels at supercritical speeds.

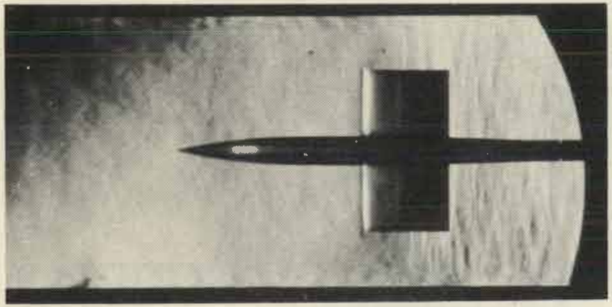
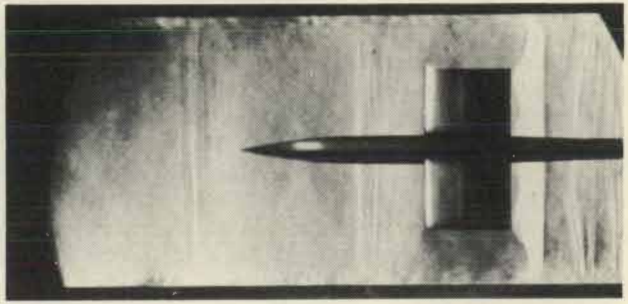
Although the speed requirements of World War II placed a premium on such aerodynamic information, the global conflict paradoxically delayed the research attack on the problem. This was because of the policy decision made at the highest level of government to fight the war with the best of the available aircraft designs, and to concentrate virtually all laboratory effort upon improvement of those types.

Even so, aerodynamic scientists continued to ponder the transonic problem, and in 1944 with victory in sight, several promising approaches were begun. One of these, first proposed earlier, involved dropping bodies from great altitudes. Radar and radio telemetering increased the effectiveness of this technique.

By placing a model, usually a wing, in the supersonic flow region that exists on an airplane wing being flown at supercritical but subsonic speeds, it was possible to study the problem from another angle. Similar in approach was the "bump" technique, in which the model



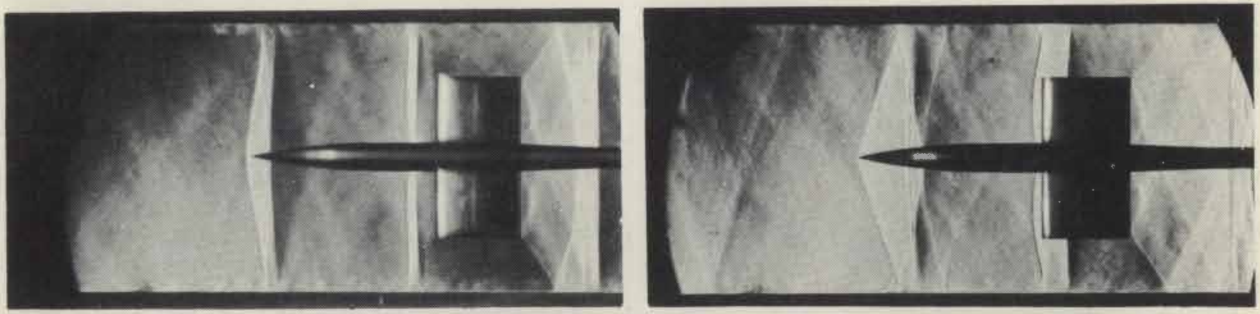
Cooling vents of 16-foot transonic tunnel

Four schlieren photos of models in transonic tunnel

to be studied is positioned in the region of accelerated flow on a bump located on a wind-tunnel floor. These methods were useful in providing trend-type information, but their value was limited by several factors, including the matter of small-scale. In 1945, an annular-type transonic tunnel was used in the study of transonic flow around airfoil models of 4-inch span. This information was valuable from an exploratory standpoint, but serious questions were raised concerning the quality of the results. This tunnel was described at the Langley 1949 Inspection. Other efforts to modify tunnel design to enable gathering of reliable information about flow in the transonic speed range suggested use of half-open and open throat tunnels, but here too, flow disturbances were found to exist.

There were two approaches to the problem which have been productive of much valuable information, and are likely to continue to be used as proven means of providing a considerable amount and variety of aerodynamic information concerning the transonic area. One uses rocket-propelled models launched from the ground. The second uses full-scale, specially-designed, high-speed airplanes. Each of these techniques is outlined in some detail elsewhere in this booklet.



Left to right, photos at Mach numbers of 0.98, 1.03, 1.06, and 1.10

Meantime, work was being continued to narrow the speed range in which the closed-throat wind tunnel was choked. By designing new-type model supports, new-type nozzles, entrance cones and throats, considerable success along this line was achieved. It became apparent, however, that even with development of closed-throat tunnel design to the ultimate, there would still remain a small but important choked-out region.

....and now, transonic tunnels

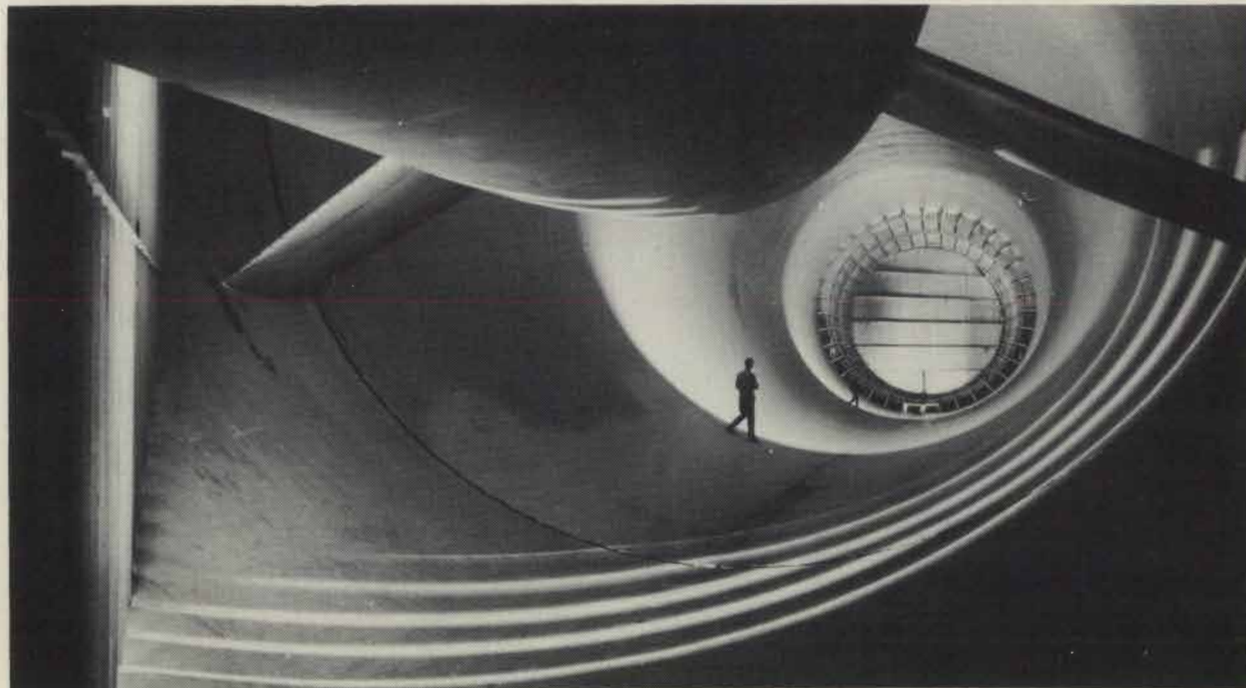
The importance of a reliable laboratory method for transonic experimentation was not decreased by the progress made in developing alternate techniques; rather, it was increased as information from these other methods focused attention more sharply on fundamental problems of fluid mechanics. In order to complete theoretical and mathematical calculation of transonic air flow, there was still needed the opportunity to experiment with standardized equipment, using nonexpendable models under conditions so closely controlled as to permit detailed measurements of local pressures as well as the application of optical means for visualization and measurement of the flows.

To this end very great effort was placed upon development of a new concept of wind tunnel, which would permit gathering such precise information under laboratory conditions. The effort has been successful. Already, the NACA has placed in operation two large tunnels, as well as smaller ones, which are capable of providing accurate aerodynamic information about flow conditions in the full transonic range. Transonic test sections now are being installed in other large tunnels.

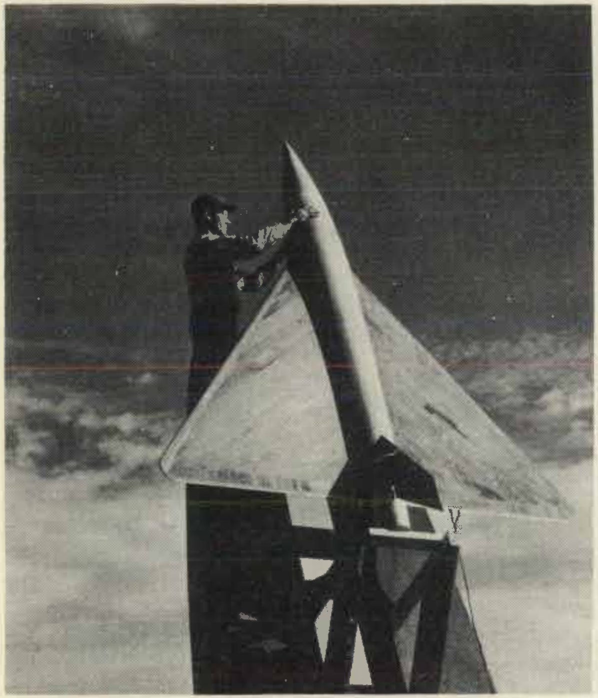
Because of world conditions, security requirements do not permit discussion of the "how" of this new tunnel concept. Consideration may be given, however, to what uses the aeronautical scientists are putting these new tunnels. The largest of the transonic wind tunnels currently completed is the 16-foot tunnel at the Langley Laboratory. The 8-foot transonic tunnel at the Langley Laboratory was the first of these new, large research tools to be completed and placed in operation. Throughout the entire transonic speed range, air flow through the test section is as accurate as can be maintained in modern tunnels designed for use on aerodynamic problems in other speed ranges. Tunnel airspeed can be held precisely or varied smoothly through a Mach number of 1.

One of the models which has been installed in the 16-foot transonic tunnel for correlation purposes has been a quarter-scale X-1, so instrumented that as many as 200 pressure distribution readings from the loading over the wing can be recorded simultaneously. Using models of this size, it may be possible to gather sufficient experimental information for analysis to permit development of mathematical and theoretical understanding of transonic flow phenomena.

The drive for the 16-foot transonic tunnel consists of two 30,000-hp motors connected by 60-foot shafts to the fans. These counter-rotating fans have an aerodynamic efficiency of 95 percent. Rigid connection between the drive end and the remainder of the tunnel was avoided by using rubber seals, thus preventing vibrations generated in the drive end from being transmitted to other parts of the tunnel. At both the inlet and exhaust openings of the air-exchange tower acoustical baffles were installed. Noise level surveys show that the tunnel with its 60,000-hp today is more quiet than when it was powered with 16,000 hp.



View inside 16-foot transonic tunnel, facing turning vanes and air vents for cooling



Rocket-powered delta-wing model

In addition to aerodynamic study of airplane and missile models in the transonic speed range, the tunnel will be used in the investigation of high-speed propeller characteristics. A 6000-hp propeller dynamometer can be installed in the test section of the tunnel, permitting testing of high-speed and supersonic-type propellers at large scale up to low supersonic speeds. Both aerodynamic and vibration characteristics of such propellers will be surveyed.

Rocket models supply data....

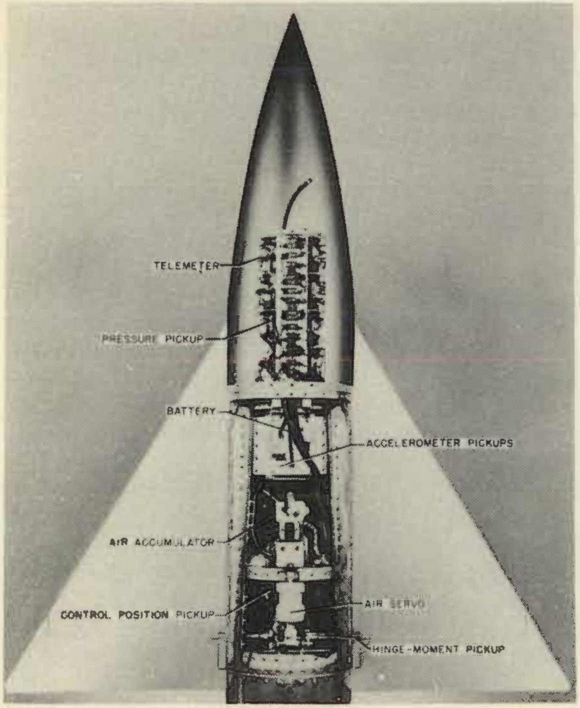
For the past 6 years extensive use of rocket-propelled free-flight models launched from the ground has enabled the research scientist to gather quickly large amounts of varied information about aerodynamic behavior in the transonic and supersonic ranges. For some time these rocket model techniques have been a principal source of large-scale transonic and supersonic information.

The firing of these rocket-propelled models is done at Wallops Island, a sparsely settled area located on the Atlantic Ocean near the Maryland-Virginia state line. The models to be tested are instrumented in the Langley Laboratory and then taken to the Wallops Island firing area where both radar tracking and telemeter recording are used to gather information during flight.

The models themselves must be light and strong in order to attain high speeds with the rocket power available and to withstand the high aerodynamic loads and accelerations experienced in the relatively dense air in which they are flown. The instruments installed in these models must be compact in order to fit in the limited space available and must be capable of high precision and highly reliable even when subjected to large acceleration.

Solid propellant-type rockets are used to obtain the speeds required. The models usually contain an internal rocket which is ignited after a booster rocket has brought the model part way up to speed. The largest rocket in current use produces about 6000 pounds of thrust and can accelerate a 130-pound model to a Mach number of 1.5 in 3 seconds. The booster rocket must be designed to separate from the model under tests after it is fired without disturbing the model.

Model at moment of launching



Cutaway drawing of research model

The research models vary in complexity depending on the type of test being made. Where only drag or control effectiveness are being studied, simple models can be used with little or no instrumentation. For drag studies, the basic information is obtained from the ground-based radar equipment alone and with no instrumentation in the model. For studies of control effectiveness, the controls are preset and a small radio transmits the rate of roll of the model to the ground. The rate of roll is, of course, a measure of control effectiveness.

In the more complicated studies, the model is equipped with a transmitter, various instrument pick-ups, and a mechanism for deflecting the elevator in a programmed pattern of flight. Such a model is accelerated to supersonic speeds by a booster rocket and following the separation of the booster rocket the elevator movements cause the model to perform various maneuvers throughout the angle-of-attack range at various Mach numbers. The recorded reactions of such a model are analyzed to obtain data on lift, drag, static and dynamic stability, control forces, and control effectiveness. The variation of these quantities with angle of attack and control setting is determined over the entire speed range in a single flight.

The design of tactical and research airplanes and guided missiles, now in use, reflects aerodynamic data obtained through the use of these models. For some time the rocket model techniques have been principal sources of large-scale transonic data. As the transonic wind tunnels come into full operation, it will be possible to relieve the rocket model technique of much detail work in the transonic range and permit greater concentration of effort on dynamic stability, measurements on flutter research, and on tests at higher Mach numbers where information at large scale is greatly needed.

Special airplanes aid research

Despite continued development of the accuracy and versatility of laboratory techniques, ultimate verification of information gained from the use of such research tools can be obtained only by actual flight-proving of the data in full-scale airplanes. In addition, there are problems related to loads, dynamics, and operation, which can best be attacked by flight tests with

Ram-jet preflight test setup

full-scale airplanes. Some of these problems can be isolated for study in flight.

In the study of transonic problems, specially designed and instrumented airplanes provide valuable information. The research airplane program, in which the Air Force, the Navy, the aviation industry, and the NACA are participating, continues to be productive of good results. This year it may be accelerated with the availability of additional research airplanes.

To assure maximum success of the program it was necessary to remove all possible limitations on the use of the airplanes for the purposes required. One important step in this direction was development by the military services and the industry of the technique of air launching the heavily loaded research airplane from a mother ship flying at high altitude over the virtually unlimited landing area at Muroc Dry Lake, Cal. In this manner, some of the limitations associated with take-off, climb, and landing were removed. This technique, together with use of rocket engines, which suffer no decrease of thrust at high altitude, makes it possible to reach transonic or supersonic speeds in level or climbing flight at high altitude, and to slow down to safe speeds if dangerous control characteristics develop.

Another advantage of such high altitude flight is that it eliminates the danger of overloading the structure in case the research airplane gets out of control. Likewise, the difficulty of large control forces is avoided. One need which this flight work has demonstrated is for all-moving horizontal-tail surfaces to cope with marked trim changes experienced during flight at transonic speed.

Satisfactory operation of an all-moving tail during transonic flight requires a system capable of positioning precisely the control surfaces. Usually a power boost system for the controls is needed because of the very high aerodynamic forces involved, and the NACA is investigating the general design requirements of such booster systems, especially with respect to the handling qualities of airplanes. An airplane, equipped with a control boost and simulated feel system, is being used in flight studies of the several difficult problems involved. Already, this work has shown the need for reducing friction existing in the slide valves of power boost systems.

Propeller research dynamometer

Because of the high speeds which tomorrow's tactical airplanes may be expected to attain, attention is being given to the problems of automatic flight controls. Such automatic systems, responsive either to the wishes of the pilot or a ground operator, can be studied effectively only by actual flight research.

Supersonic speed problems....

Information about aerodynamic behavior in the supersonic range is a matter of immediate need both for missiles and high-speed airplanes, and the NACA's large, faster-than-sound tunnels are being used intensively to provide such data. The Langley 4 × 4-foot supersonic pressure tunnel, with an operating Mach number range from 1.2 to 2.2 and variable density to permit attainment of large-scale results, is particularly adapted for research on both supersonic airplane and supersonic missile shapes.

One phase of the work done in this tunnel utilizes complete missile models in the study of wing-body interference, downwash, inlet characteristics, stability factors, and other basic problems of current interest. Instrumentation, connected to outside-the-tunnel recording apparatus through the sting-type model mount, includes a six-component balance. The control surfaces of the model can be controlled electrically, and mass flow through the inlets can be varied to simulate full-scale operation under varying conditions.

A second phase of this experimental research which also is closely connected with missile work involves study of the effects of scale on the skin-friction drag characteristics. The desirability of maintaining laminar boundary layers as a means of reducing drag has long been recognized. The attainment of laminar layers at subsonic speeds has been found impracticable in the majority of cases; however, research results indicate that conditions more favorable to the maintenance of laminar flows may exist at supersonic speeds.

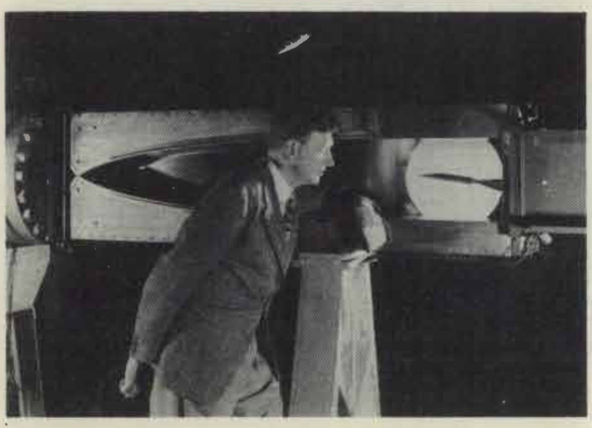
If means can be developed for maintaining a laminar boundary layer for the high-altitude and high-speed flight conditions of a typical missile, the skin-friction drag could be reduced to about one fourth of the values currently existing for turbulent boundary layers. The overall drag would be reduced by about one half.

Aerodynamic heating, at the high Mach numbers at which tomorrow's missiles will be flying, may become of equal or even greater importance than drag. Here again, delay of the flow transition from laminar to turbulent offers an opportunity to extend greatly both the speed and duration of flight which now are limited severely by allowable structural temperatures.

A missile initially at atmospheric temperature absorbs heat from the hot boundary layer and rises in temperature. By attaining laminar flow the amount of heat absorption would be lessened greatly. Another important factor in aerodynamic heating is atmospheric density. At 100,000 feet, for example, the atmospheric temperature is the same as at 50,000 feet, but the density is much less, which reduces greatly aerodynamic heating. If it proves feasible to combine the advantages of laminar flow and low atmospheric density, the temperature limit of ordinary materials used in missile construction would not be exceeded, even on long flights at high Mach numbers.

Probing the hypersonic range

In certain types of long-range missiles, most effective performance is obtained by operation at high altitudes and Mach numbers in the range of 5 to 10. Exploratory research at even higher Mach numbers is being conducted in small ballistic-type facilities at both the Ames and Langley Laboratories.



11-inch hypersonic tunnel

At hypersonic speeds, it has been determined, shock waves are swept back close to the model, and the boundary layer becomes thick. Whereas at moderate angles of attack at subsonic speeds lift is derived largely from the upper surface of a wing, at hypersonic speeds the largest part of the lift is derived from the lower surface. At the same time, the influence of the three-dimensional tip flows becomes smaller until at hypersonic speeds this influence is so small that use of wings with extremely low aspect ratio appears to be practical. Even though lift-drag ratios are low, they are sufficient to permit horizontal flight at high altitude at hypersonic speeds. At these speeds more of the load can be carried by the lift derived from the body, as distinguished from the lift coming from the wings.

The boundary layer grows at a much faster rate at hypersonic than at lower speeds. The thick boundary layer changes the surface, thus altering the effective wing or body shape. This problem is of considerable importance at Mach numbers of 7 on slender shapes suitable for missile use, and will assume even greater importance as the Mach number is increased still further.

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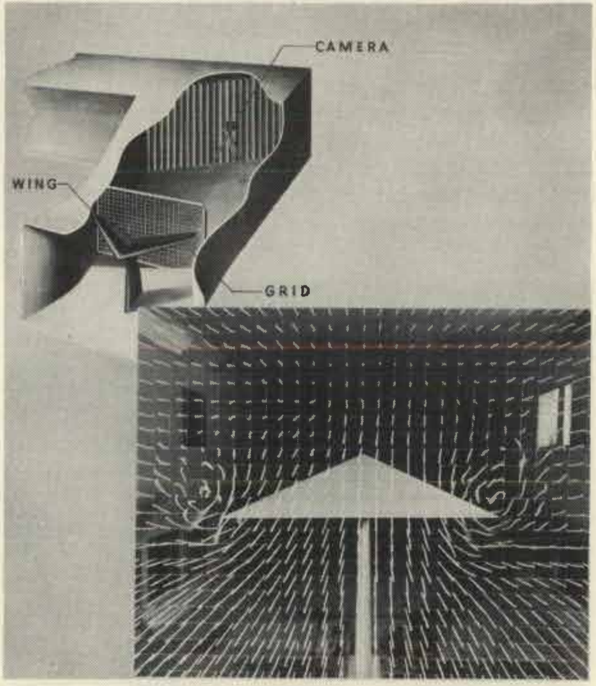
Wing-wake problems studied

The flight behavior of airplanes, particularly at high angles of attack, is complicated by the interaction of the various parts. A tail assembly located behind the wing, for example, is affected by the wing wake. For wings with high aspect ratios, the effect of the wing wake on the tail generally does not present a serious problem. When a tail assembly is used behind a low-aspect-ratio wing, however, the problem is more serious, because regions of highly disturbed air flow lie close to the tail. This condition effects not only the static stability of the airplane, but also the damping of oscillatory motion.

To aid in studying the air flow behind a wing, a tuft grid setup has been developed for use in one of the Langley 7 × 10-foot tunnels. Consisting of a steel framework on which fine wires are strung with equal spacing both vertically and horizontally, the grid has wool tufts attached to the intersections of the wires.

Cameras, either still or motion, are located far downstream in the tunnel to take pictures of the tufts in a vertical plane. In regions of un-



Wing-wake problems studied

disturbed flow, the tufts show in the pictures as small dots. In regions of downwash and sidewash, the flow pattern is clearly shown by the tufts.

Results of research conducted during the past 5 years in the NACA's full-scale tunnels at the Langley and Ames Laboratories on a broad range of high-speed, sweptback wing shapes now make possible reasonable prediction of the low-speed characteristics of such wings. With regard to the flow phenomena, the stalling of such wings may be grouped in two predominant types: those with round-nose airfoils and those with sharp-nose airfoils. The type of flow has an important effect on the pitching-moment characteristics of a wing.

Airfoil nose radius and sweep angle of the wings were found to influence importantly the maximum lift coefficient. Longitudinal instability due to tip stalling is a fundamental problem for a large number of swept wings. Various methods of achieving stability by controlling flow have been studied and data gathered to aid in the selection and design of devices to obtain stability.

Inlets for supersonic airplanes

As in the design of other airplane parts for efficient operation in the transonic speed range, serious new problems are introduced respecting the air inlet of a power plant for this speed range. Most important of these for the inlet are drag and pressure recovery.

Research has shown that an open-nose inlet can be designed for high subsonic speeds which will be useful through the transonic range to low supersonic speeds. At higher speeds, however, a strong detached shock develops ahead of the relatively blunt nose of the inlet, causing excessive loss in available engine pressure as well as excessive drag.

For flight at higher speeds, air inlets clearly must be designed especially for supersonic flow, and great emphasis is being placed on inlet research covering such speed ranges, with new problems present as well as the older ones. One of the most important problems is that of matching the area of the inlet with the air required by the engine through the supersonic range. At subsonic speeds, inlet size is not critical. An inlet can be designed to operate through a wide range of air flow rates without harmful effects.

At supersonic speeds, however, because of its shock pattern, an inlet may be too small to supply the air required by the engine at speeds other than in the relatively narrow range for which it was specifically designed. Decreased thrust and increased drag at off-design speeds may be the result. If, on the other hand, the inlet is too large at off-design speeds, external shocks are produced ahead of the inlet which increase drag. In either situation, the result is a serious loss in effective engine thrust.

One solution to the problem would be the development of an inlet which could be varied in opening to provide for the proper amount of air for the desired operating speed, thereby avoiding severe penalties in drag or thrust. Under some conditions, a movable-cone inlet offers promise, and other possible solutions are being studied.

Because of the intended use for an airplane, it may be impracticable to position the air inlet in the fuselage nose, where, aerodynamically, the design problems are simplest. Such nose space may be pre-empted by armament, electronic equipment, or photographic apparatus. The problem then becomes one of designing an efficient air inlet which will be located elsewhere. Inlets located on the side of the fuselage, in the wing root, or in the wing, or attached to the fuselage as scoops, are options.

One promising solution is the side inlet, to the study of which considerable research effort has been devoted. Utilizing the rather complete information which the NACA has acquired on supersonic nose inlet design, the approach has been to split the nose inlet for mounting in the sides of the fuselage. Unless a by-pass is provided so that a sufficient quantity of boundary-layer air can be removed, the ram pressure recovery losses are great. With such a by-pass, however, ram recovery can be restored to a value nearly as high as that for the nose inlet.

New Instruments for research

In the study of such problems as buffeting and flutter, instruments suitable for investigation of the phenomena under scrutiny must be developed. Until recently, the pressure recording instruments used in buffeting research have been mechanical in action. The pressure to be measured at some point, as on the wing, has been conducted through a long tube to a measuring instrument. Especially when there were rapid changes in pressure, the lag resulting from the long tube made accurate recordings impossible.

One solution has been development of a 30-cell pressure-distribution manometer, small enough to be placed in the wing of a fighter-type airplane. The manometer presents data as tiny spots of light, so arranged as to plot a conventional pressure distribution diagram which can be photographed by a motion-picture camera. This instrument has been used to obtain a visual representation of the way loads at a wing section of a fighter-type airplane were varying in flight and to determine the regions of oscillating pressures.

When buffeting is investigated using small models in a wind tunnel, the frequencies involved are very high, which requires the development of special electrical pressure gages for dynamic studies. These gages are particularly adapted to the measurement of oscillating and unsteady pressures both in flight and in wind-tunnel research. Another instrument now being used is an electrical pressure integrator which can condense as many as 40 pressures into a single data channel. Electrical pressure gages also are being used in some flutter studies, while in other investigations strain gages are mounted on the wing beams.

Recent design trends, particularly for very large aircraft, have indicated the need for flutter and vibration studies using completely scaled dynamic models. Such complex models, if properly designed, are capable of producing much useful information. They may be used to indicate good or bad effects of relatively minor changes in prototype design, a particularly desirable feature if the prototype is an unconventional type. They may indicate the significance of the various assumptions made in vibration analyses. They may be used to solve certain complex vibration problems which are difficult to formulate, let alone solve. Actually, such models are effective analog computing machines.

By the use of many techniques and by attacking such problems from many sides, it is hoped reliable experimental data can be compiled which will be useful in predicting buffeting and flutter more accurately, and in the alleviation or elimination of such troubles.

Aircraft loads investigated

Aircraft loads research is being conducted by means of theoretical investigations, wind-tunnel measurements of loads on airplane models, and flight measurement of loads on models as well as on full-scale airplanes. Still another method involves use of a machine which makes fatigue tests on full-scale aircraft structures.

In structures research on fatigue, mentioned elsewhere, the laboratory methods used have produced stresses which were uniform in size and were applied with regularity. In flight, however, stresses in the airplane's structure are imposed by gusts which are variable both in intensity and occurrence. To simulate such fatigue-inducing stresses in the laboratory, a testing machine has been developed which enables a study of full-scale aircraft structures.

First, the machine applies a steady load, corresponding to that imposed on an airplane in steady flight through smooth air. Then, oscillating loads of 16 different amplitudes are superimposed on the steady load. The sequence of the amplitudes and the number of oscillations at each amplitude are established in advance, enabling study of very complicated load patterns which can, for example, match the statistical distribution of rough air loads.

It is important that the size and distribution of the net loads experienced in flight be known to enable adequate structural design. These loads are caused by the interrelated action of aerodynamic, inertia and elastic forces which may be imposed on the airplane in steady or maneuvering flight, gusts, or in landings.

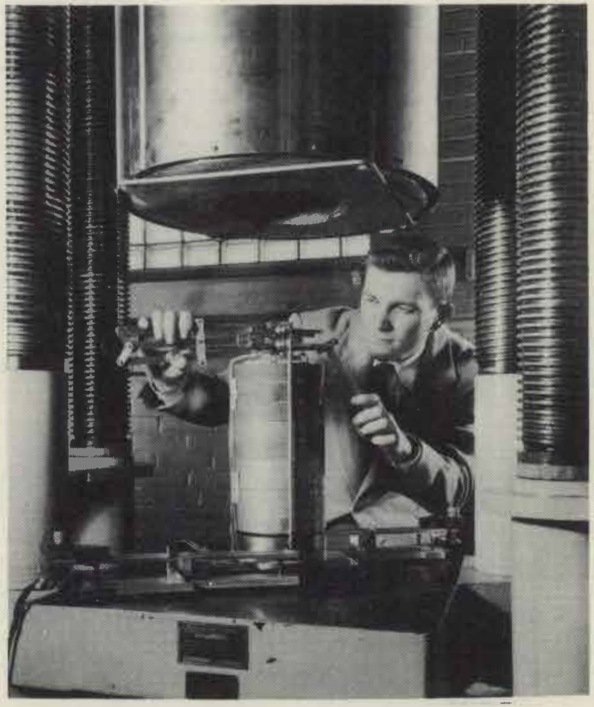
Loads may be determined by means of measurements of acceleration, pressure, and deflection. Accelerometers are useful in measuring the over-all airplane loads and inertia loads. Pressure distributions over the wing, tail, and fuselage determine not only the total load on the surface but the distribution of load over the surface. Deflection measurements by means of small electrical wire resistance strain gages help in determining the loads induced by elastic deformation.

Materials for high temperatures

Much research is being conducted on the suitability of materials for use in airplanes and missiles that will be subjected to the high temperatures associated with supersonic speeds. One criterion for such use is the ability of the material to withstand yielding, or stretching beyond permissible limits, at the higher temperatures which are experienced.

Aluminum alloys currently used in aircraft lose almost all their strength at 600^{o} F. Titanium alloy and stainless steel seem to hold up much better at such high temperatures, and stainless steel seems to be much better than titanium, although when compared on the basis of strength per unit of weight, the differences are less pronounced. Titanium is better on a strength basis for use where intermediate temperatures will be experienced.

In the bending of a compression structure like the plate elements in the upper skin of a wing,



Titanium under test in laboratory

the full material strength often cannot be realized because the skin tends to wrinkle when the skin is thin. This wrinkling can occur long before the material itself has been stressed to its capacity. After wrinkling occurs, the plate elements still can take load but their maximum strength no longer is directly related in a simple way to strength of the material. In order to provide a basis of material selection for such cases, research has been conducted to determine the correlations between the strength of the structural elements and the yield strength of the material.

If the consideration of weight is added to the above-mentioned factors, of the materials compared stainless steel is to be preferred at temperatures above 800° F, and the titanium alloy is superior in the intermediate temperature range. At lower temperatures, any one of the three materials might be most efficient, depending upon the particular design conditions. A general conclusion is that no one material is universally superior, but that the choice of a material depends not only on the temperature consideration but also on the structural use to which it will be put.

Another field of structures research is fatigue, where repeated stressing of material may eventually cause it to fail. Why materials fail by fatigue is not yet known, but many factors affecting the fatigue life of structures are now understood. For example, fatigue failure generally starts in the vicinity of so-called stress raisers such as holes, notches, or fillets which disrupt the uniform flow of stress. Such an increase over uniform stress is called the stress concentration factor. The relation between it and fatigue life is affected by the size of the specimen, an effect which has been evaluated for steel, and now is being studied with aluminum alloys.

....Research in flight

In addition to the use of full-scale airplanes for investigation of aerodynamic problems in the transonic range, discussed elsewhere, there are many other areas in which actual flight is a most effective, and sometimes the only, method of securing needed aeronautical information. For example, measurements on airplanes in flight provide virtually the entire basis for current design requirements as to the degree of stability and control an airplane needs for safe, precision flight.

Such flight work has been performed with respect to helicopters to the end that stability and control information could be made available to designers. To check the adequacy of "maneuver requirements," established by flight trials conducted with normal, every-day visibility, flying qualities are being assessed under blind flying conditions. These blind flying trials have also directed attention to a new problem, that of directional control. During instrument flight, holding a steady course becomes a difficult task. Possible changes in stability and control characteristics to lessen this difficulty are being investigated, and work also is being done to discover a better way to present flight information, via the instrument panel, to the pilot.

Measurements on airplanes in flight are a primary source of information about loads that will be imposed on an airplane by the pilot, or by atmospheric turbulence. One such study was made of a service airplane with strain gages being used to measure loads on the wing, horizontal tail, and vertical tail. The purpose of the flight program was to establish the degree of agreement between actual loads measured and those calculated by the engineer on the basis of information available at the time of design. During the flights, a series of abrupt push-down, pull-up maneuvers were made to compare measured and calculated tail loads in abrupt maneuvers. It was found that the flexibility of the rear fuselage and tail combination affected the calculation of tail loads. For large, flexible airplanes, this factor should be included in tail load calculations.

Nearly always flight tests are required to provide a final check on conclusions reached in the laboratory, where exact duplication of all the actual conditions of use seldom is possible.

Operating problems under attack

Operating problems of commercial aircraft are being studied at all three of the NACA's laboratories and include flight and wind-tunnel work, theoretical work, and the development of specialized instruments and new testing techniques. Among problems are effects of turbulence and meteorological conditions such as winds and temperatures at high altitudes. For the study of these, data from actual airplane operations are needed.

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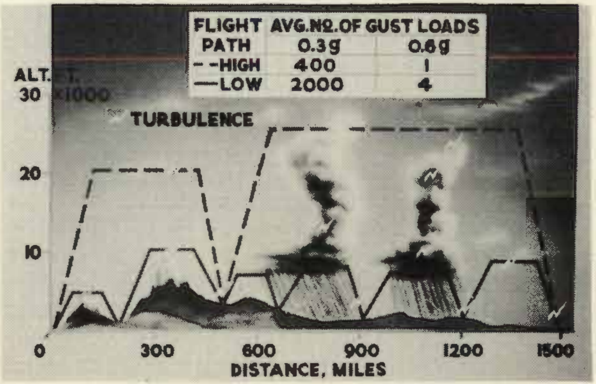
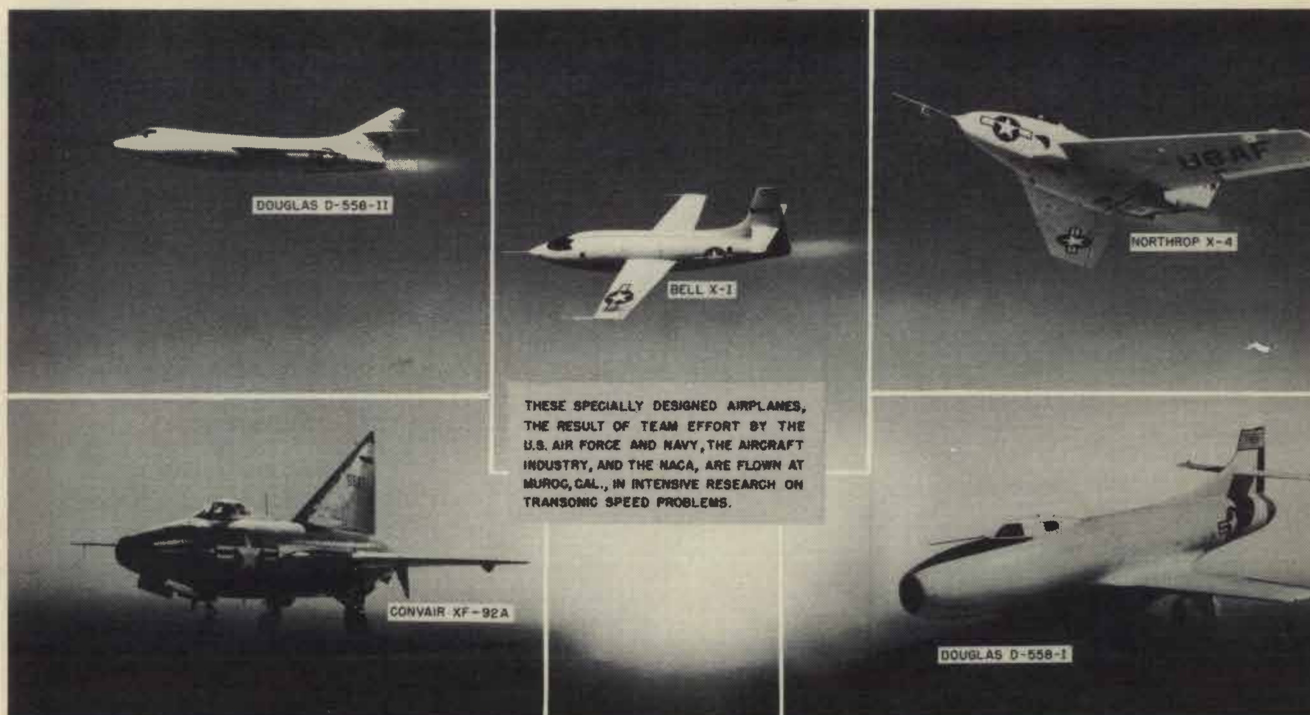
For a number of years, V-G recorders have been installed in commercial airplanes in routine operations, yielding pertinent information on maximum loads experienced, charted against airspeed. Unfortunately, these V-G recorders tell nothing about smaller loads which contribute to structural fatigue and passenger discomfort. A newer instrument being used currently is the V-G-H recorder which gives a time history of all the loads and the corresponding airspeed and altitude.

Preliminary statistical work has been done to determine the rough-air experience of airplanes operating below 10,000 feet and also at altitudes from 20,000 to 30,000 feet. Hardly 1/5 the number of accelerations corresponding to noticeable and moderate passenger discomfort were recorded in the higher altitude range, compared to low-altitude flight. The high-altitude airplane flies above many cumulus clouds, and is not subjected to as much rough air associated with mountainous terrain. Further, it has a better chance of avoiding the higher thunderstorms.

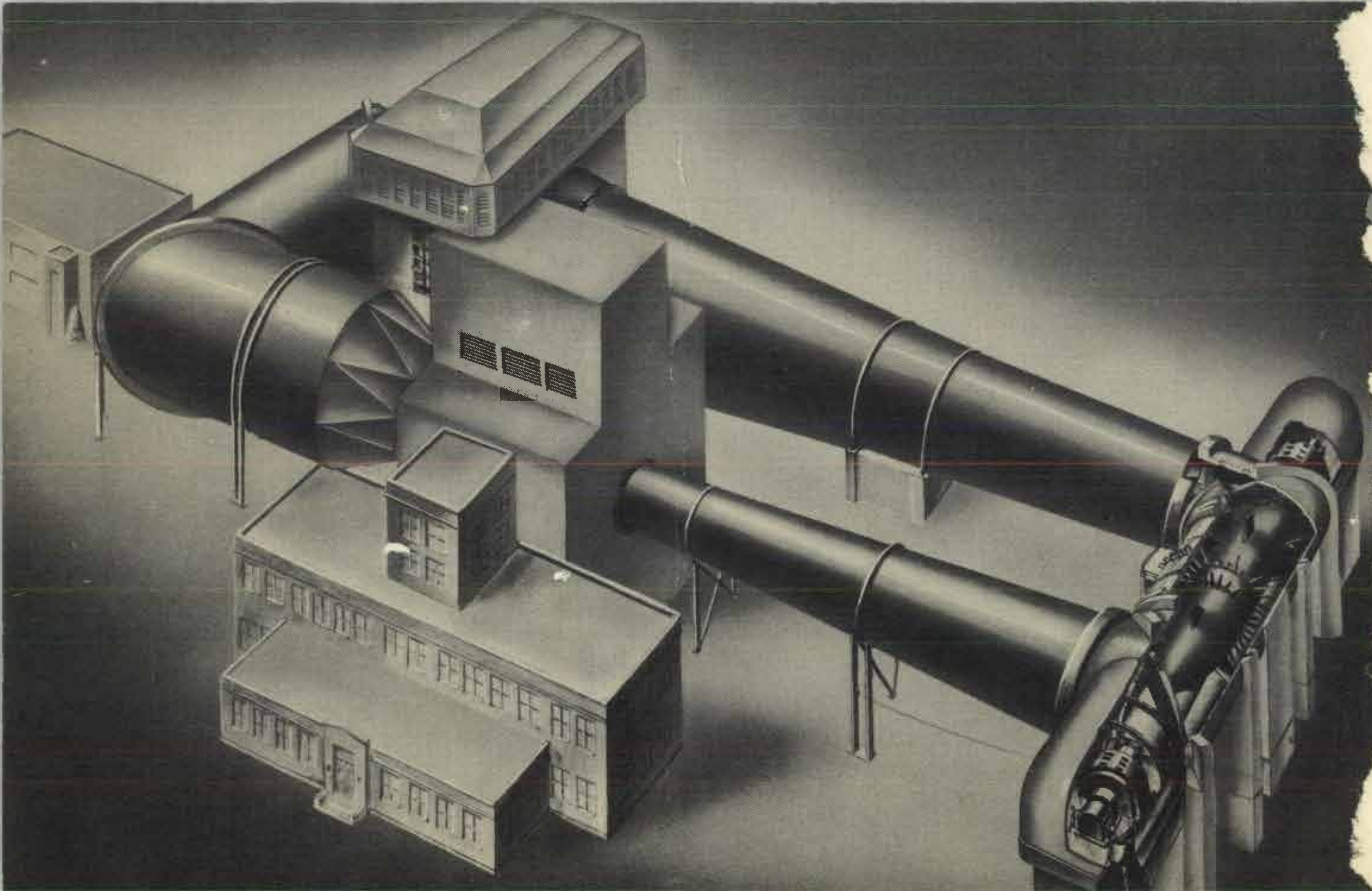
In the determination of reasonable safe speeds for airplanes, it is known that aircraft are limited by speeds and by Mach numbers which cause buffeting, adverse stability changes, and structural problems. The question becomes more serious with respect to jet airplanes, because they can be flown near their limiting speeds and Mach numbers in climbing and level flight, as well as descent. Further study is being given the problem, as well as possible methods to insure operation within safe speed and Mach number limits.



High flight avoids turbulence



THESE SPECIALLY DESIGNED AIRPLANES, THE RESULT OF TEAM EFFORT BY THE U.S. AIR FORCE AND NAVY, THE AIRCRAFT INDUSTRY, AND THE NACA, ARE FLOWN AT MUROC, CAL., IN INTENSIVE RESEARCH ON TRANSONIC SPEED PROBLEMS.



61967

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Guest List

1951 Biennial Inspection
NACA Laboratories
Langley Air Force Base, Virginia

May ~~17~~ 18, 1951

State Room	Name	Affiliation	Color Group
40	Abbott, Ira H	NACA	Red
	Adams, M. H	United Aircraft Corp	Red
117	Allen, Robert C.	Allis-Chalmers Mfg. Co.	Gold
103	Alquist, H. E.	NACA	Tan
104	Ames, Milton B.	NACA	Green
27	Anderson, Kenneth	The Austin Company	Gold
	Andrews, Allen	North American Aviation	Tan
1	Apanasewicz, Nellie	NACA	Tan
	Auyer Earl L.	General Electric Company	Gold
	~~Baker, C. F~~	~~United Aircraft Corp~~	~~Green~~
K	Baker, Paul S.	Chance Vought Aircraft	Green
	Barba, J. C	Beemer Engineering Co	White
130	Barlow, C. B.	Boeing Airplane Company	Gold
	Bartfield, J E.	Chase Aircraft Company	Tan
L	Beard, M. G.	American Airlines, Inc	Blue
	Beardsley, G. E	Pratt & Whitney Aircraft	Tan
137	Bell, Robert L	NACA	Red
	~~Bellanca, August~~	~~Bellanca Aircraft Corp~~	~~Tan~~
31	Blizzard, J E	Beemer Engineering Co	White
115	Boeke, F. L.	North American Aviation	Gray
3	Bogart, Grace	NACA	Tan
	Bollay, Dr. William	North American Aviation	Green
O	Bollinger, Dr. Lynn	Harvard Business School	Gray
	Bortner, Robert	Republic Aviation	Red
	~~Bowen, E M.~~	~~Atomic Energy Commission~~	~~Gold~~
111	Bowman, Richard G.	Republic Aviation	Green
D	Brady, George W.	Curtiss-Wright Corp.	Green
131	Bromberg, Dr. E.	Office of Naval Fesearch	Gold
	~~Bronk, Dr Detlev~~	~~NACA (Johns Hopkins Univ.)~~	~~Blue~~
139	Brown, Edmund D.	Pratt & Whitney Aircraft	Gray
119	Buck, Prof. N Lewis	University of Pittsburgh	Gold
	~~Brown, J. P.~~	~~Lear Incorporated~~	~~Tan~~

State Room	Name	Affiliation	Color Group
	Brown, Capt. Sheldon	BuAer, Dept. of Navy	Green
	Brown, W J	USAF Air Development Force	Gray
M	Buckley, O E	Office, Defense Mobilization	Blue
E	Buckwalter, John	Douglas Aircraft Company	Green
	Burden, Hon. W A M	Office of Sec. of Air Force	Blue
	Byrd, Harry Flood	U.S Senate	Blue
	Caleen, R L	Pratt & Whitney	Gold
43	Cannon, E. P.	General Accounting Office	White
128	Carlson, A.C	Boeing Airplane Company	Gold
59	Carran, John A.	CAA	Tan
R	Cassady Adm. J. H.	Deputy Chief, Naval Op.	Blue
24	Chamberlin, E H	NACA	White
	Clark, E. E	Glenn L Martin Company	Red
	Clark, J. D	BuAer, Dept. of Navy	White
	Conrad, Donald S	Pratt & Whitney Aircraft	Gray
	Constantino, C.S	Wright Aeronautical Corp.	White
130	Cook, W. H	Boeing Airplane Company	Green
141	Crane, J. D	National Airlines, Inc	Gray
36	Crowley, J W,	NACA	Green
133	Cushman, R. E	NACA	Gold
	Demler, Col. M C	Air Materiel Command	Green
71	Davis, F. W.	Consolidated Vultee	Green
114	Dearborn, C. H	NACA	Gold
	Deflorez, Dr. Luis	Deflorez Engineering Co	Blue
I	DeFrance, S. J.	NACA, Ames	Green
136	Desmond, J. J		Gray
	Dickman, P. R	Grumman Aircraft	Red
A	Diehl Capt. W. S.	USN	Blue
	Dineen, J	Fairchild Aircraft & Engine	Tan
	Dix, E. H., Jr.	Aluminum Co. of America	Gold
	Doll, Walter	Pratt & Whitney	Gray
	Doolittle, J H	Shell Oil Company	Blue
	Driggs, Ivan H.	BuAer, Dept. of Navy	Gold
M	Dryden, Dr. H.L.	NACA	Blue
138	Dunmire, R	Goodyear Aircraft	Red
R	Durgin, Vice Adm.	USN	Blue
123	Ebel, W K	Canadair, Ltd.	Green
	English, W. P	Fairchild Eng & Air. Co	White
111	Epstein, Albert	Republic Aviation	Red

State Room	Name	Affiliation	Color Group
10	Faas, C W., Jr.	Fairchild Eng. & Air.	Gray
D	Fairbanks, K J.	Sherman Fairchild & Assoc.	Green
128	Finlay, D W	Boeing Airplane Company	Gold
E	Fleming, Roger C.	General Motors Corp.	Brown
	Floor, A. P.	USAF Air Dev. Force	Red
	Freeman, H. R	General Electric Co.	Gold
	~~Freidman, S. N.~~	~~Lear, Inc.~~	~~Tan~~
9	Frischhertz. N. F.	General Electric Co.	Gray
139	Frocht, Dr. M. M.	Ill. Inst. of Tech.	Gold
	Gaillard, G R.	CAA	Tan
73	Gamble, A. O.	NACA	White
129	Gander, Wm.	Grumman Aircraft	Gray
	~~Gerstenberger, W~~	~~Sikorsky Aircraft~~	~~White~~
126	Gerteis, J H.	Cessna Aircraft	Gold
129	Geyer, Leo A.	Grumman Aircraft	Gray
124	Gibbons. H. B	Chance Vought	Tan
	~~Gillespie, E F~~	~~Jacobs Aircraft Eng. Co~~	~~Gray~~
	Ginder, Rear Adm. S.	Office, Sec. of Navy	Blue
	~~Goranson, R. F.~~	~~NACA~~	~~Red~~
75	Gordon, M. J.	Beech Aircraft	Gold
75	Gordon, Mrs. M. J	Beech Aircraft	Gold
	Gosselin, Hubert	Pratt & Whitney	Gray
	~~Gove, W D.~~	~~Pratt & Whitney~~	~~Gold~~
118	Greene, L P.		
	Gregor, M.	Chase Aircraft	Tan
	Gregory, A. T.	Fairchild Eng. & Air.	White
	Grove, R. K.	Atomic Energy Commission	Gold
	Gulliver, A. H.	General Motors Corp.	Tan
	Gurney, T.	Pratt & Whitney	Red
4	Gustafson, R. A.	Grumman Aircraft	Gray
134	Haiduck, A. F.	Lear. Inc.	Tan
	Hanson. A. S	BuAer, Dept. of Navy	Gold
	~~Hardy, Cmdr. D.~~	~~BuAer, Dept. of Navy~~	~~Gold~~
	Hartman, E C	Alum. Co. of America	Gold
	Hatcher, Capt. R S.	BuAer Dept. of Navy	Green
J	Haven, E. G.	General Electric Co.	Tan
K	Hibbard, Hall L.	Lockheed Aircraft	Blue
	Hignite, Lt. Com. D.	BuAer Dept. of Navy	White
	Hoff, Dr. N. J.	Poly. Inst. of Brooklyn	Green
35	Holtz, Walter W	Douglas Aircraft Company	Red
	Howald, Werner E	Wright Aero. Corp.	White
	Hoxton, Dr. L G.	Univ. of Virginia	Gold
138	Hunter, Willson	NACA, Lewis	Tan
32	Huntsberger, R. F	NACA, Ames	Tan

State Room	Name	Affiliation	Color Group
115	Jamouneau, W. C.	Piper Aircraft Company	Gray
	~~Jensen, H. T.~~	~~Sikorsky Aircraft~~	~~Tan~~
	Jewett, C. S.	Wright Aeron. Corp.	Green
125	Jewett, F. D.	Glenn L. Martin Company	Blue
106	~~Johns, J. M.~~	~~Libbey-Owens-Ford Glass~~	~~Red~~
118	Johnson, R. E.	Wright Aero Corp.	White
	~~Johnson, W. B.~~	~~Lear, Inc.~~	~~Green~~
A	Joyce, T N.	Wing Engineering Corp.	Green
	Kahn, F W.	Grumman Aircraft	Blue
	~~Karant, Max~~	~~AOPA~~	~~Brown~~
	Kartveli, Dr. A. A.	Republic Aviation	Blue
	~~Katzenberger, E. F.~~	~~Sikorsky Aircraft~~	~~Tan~~
	Kayan, Dr. Carl F.	Columbia University	Green
108	Kingham, H. G.	General Electric Co.	Red
	Kinney, R. W.	USAF Air Dev. Force	Red
	~~Kinnucan, J. E~~	~~Continental Motors Corp.~~	~~Gold~~
	Knowles, T A.	Goodyear Aircraft Corp.	Green
	Koch, C J	Glenn L. Martin Co.	Red
	Krentz, F. M.	Wright Aeronautical Corp.	White
C	Land, Adm. E S.	ATA	Blue
	Lang, Millard T.	Westinghouse Electric	White
G	Larson, L W.	Consolidated Vultee	White
	~~LeBaron, Robert~~	~~Atomic Energy Commission~~	~~Blue~~
	Ledbetter, R. E.	General Electric Co.	Tan
107	Leeson, E. E.	Fairchild Eng. & Air.	White
35	LeMonier, C R.	Fairchild Eng. & Air.	White
P	Lester, E M.	Fairchild Eng. & Air.	Green
	Libby, Dr. Paul	Poly. Inst. of Brooklyn	Gray
	~~Lieber, K.~~	~~Con. Western Steel Corp.~~	~~Gray~~
	~~Lightfoot, R B~~	~~Sikorsky Aircraft~~	~~White~~
102	Littell, R E	NACA	Tan
L	Littlewood, Wm.	American Airlines	Blue
23	Loos, R. A	Wright Aeronautical	White
6	Lowkrantz, G.	Link Aviation, Inc.	Gray
	Lundquist, W. G.	Wright Aeronautical	Green
	Luce, Henry III	Time	Brown
	McCarthy, C. J.	United Aircraft	Blue
	McCrea, Russell	RDB	Green
	McCrea, T S.	General Motors Corp.	Tan
	McCullough, H. A.	BuAer, Dept. of Navy	Gold

State Room	Name	Affiliation	Color Group
	McDowell, C.J.	General Motors Corp.	Tan
	McKenna, Lt. Com. C.	BuAer, Dept. of Navy	Gold
	~~MacCarter, H.L.~~	~~Westinghouse Electric~~	~~White~~
T	Mack, Clifton E.	Federal Supply Service	Blue
113	~~Magill, G.W.~~	~~Rotor-Craft Corp~~	~~Red~~
59	Maloy, R B	CAA	Green
141	Manganiello, E.	NACA Lewis	White
105	Martin, James S.	Republic Aviation	Red
122	Maske, E B., Jr.	Consolidated Vultee	White
	~~Mathews, Jerry A., Jr.~~	~~Edo Corporation~~	~~Red~~
	Mercer, Capt. W.	BuAer, Dept. of Navy	Gold
5	Merrill, J A.	Goodyear Tire & Rubber	Red
60	Metzel, Rear Adm.	USN	Blue
60	Metzel, Lt. jg., Jr.	USN	Blue
	Mevay, Francis	Republic Aviation	Red
	Miller, H.	A R O, Inc.	White
F	Mock, R M.	Lear, Inc.	Blue
10	~~Moeller, D.O.~~	~~Fairchild Eng. & Air.~~	~~White~~
27	Moles, Howard	Air Lifts, Inc.	Gold
5	Montgomery, Bruce	CAA	Tan
	Morrill, Carl	Pratt & Whitney Aircraft	Red
4	Munier, Albert	Grumman Aircraft	Gray
O	Murray, J.P.	Boeing Airplane	Gold
	Nay, Col. P.F	USAF Air Dev. Force	Red
	Newman, V O.	USAF Air Dev. Force	Red
43	Nolan, E T.	Gen Accounting Office	White
121	Nordlinger, S.G.		Green
	~~Norriss, F.H.~~	~~Westinghouse Electric~~	~~White~~
	Novak, A J.W	Brush Development Co.	White
	O'Donnell, Dr. W J	Republic Aviation	Red
	Oliver, G.H.	General Electric	Tan
113	Orr, Walter	NACA, Lewis	Brown
N	Osborn, E.D.	Edo Corporation	Blue
112	Osborn, R R.	McDonnell Aircraft	Tan
117	~~Palmer, S C.~~	~~Westinghouse Electric~~	~~White~~
	Pappas, C.E.	Republic Aviation	Green
Q	Parr, R.Adm. W S.	National Prod. Authority	Blue
32	Parsons, John	NACA, Ames	Green

State Room	Name	Affiliation	Color Group
Q	Peale, M.L.	Republic Aviation	Blue
135	Pearson, E O.	NACA	Tan
13	Pennell, M L.	Boeing Airplane Co.	Gold
112	Perkins, K.	McDonnell Aircraft	Tan
	Petaja, A.E	USAF Air Development Force	Gray
136	Petersen, A H.	Lockheed Aircraft	White
51	Pinkel, B.	NACA, Lewis	Red
127	Plant, A P.	Libby-Owens-Ford Glass	Red
108	Porter, Dr. R W.	General Electric	Green
119	Price, Prof L	Worcester Poly Inst.	Gold
	Purcell, Tom	Prewitt Aircraft	White
	Pusin, H.	Glenn L. Martin	Red
S	Putt, Maj. Gen. D L.	Office, Deputy Chief of Staff	Blue
120	Reade, R.S.	Consolidated Vultee	White
	Reaser W.W.	Douglas Aircraft	Red
	Redding, A.H	Westinghouse Electric	Green
123	Redding, J.D.	RDB	Blue
	Rhines, T.B.	Hamilton Standard	Green
104	Rhode, R V.	NACA	Green
122	Rice, J.S.	AIA	Red
107	Richardson R. Adm.	Fairchild Eng. & Airplane	Blue
	~~Richardson, R.W.~~	~~Goodyear Tire & Rubber~~	~~Red~~
	~~Richey, R.~~	~~Consolidated Western Steel~~	~~Gray~~
	~~Rogalski S~~	~~Chase Aircraft~~	~~Tan~~
	Rolle, S.	CAA	Green
137	Rosche, M.G	NACA	Tan
	Ross, Dr. R S.	Goodyear Aircraft	Red
	Ruffin, M.B.	Lear, Inc.	Tan
	~~Ryan, W.R~~	~~Edo Corporation~~	~~Red~~
	~~Salvadori, B.J.~~	~~Bellanca Aircraft~~	~~Tan~~
S	Saville, Maj. Gen.	Dep. Chief of Staff, Dev.	Blue
	~~Schaefer, R.G~~	~~Consolidated WesternSteel~~	~~Gray~~
13	Schairer, G.	Boeing Airplane	Blue
103	Schey, O.	NACA, Lewis	Gray
124	Schlieman, J.B	Chance Vought Aircraft	Tan
	Schneyer, R	A R O, Inc.	White
47	Schoolfield, W.C.	Chance Vought	Green
11	Shambach, H L.	General Electric	Red
F	Sharp, Dr. E R.	NACA, Lewis	Blue
133	Shea, W.M.	NACA	White
	Sheets, Dr H.E	Goodyear Aircraft	Red
	Shoults, D.Roy	A R O Inc.	Blue

State Room	Name	Affiliation	Color Group
	Shows, H.R.	USAF Air Development Force	Gray
	Sidebottom, J.H.	AIA	Red
51	Silverstein, A	NACA, Lewis	White
	Simon, Lt. H.	USAF Air Development Force	Gray
	~~Simpson, J.~~	~~Douglas Aircraft~~	~~Red~~
127	Sings, J.T.	Libby-Owens-Ford Glass	Red
	~~Sisto, F.J.~~	~~Jacobs Aircraft Eng. Co.~~	~~Gray~~
1	Smith, Mrs. Helen	NACA	Tan
	Smith, R.G.	Pratt & Whitney	Gray
114	Smull, T.L.K.	NACA	Gray
	Snow, Lorenzo	Pratt & Whitney	Red
	Sorte, Lt. Col. M.C.	USAF Air Development Force	Gray
	Spalding L.P.	North American Aviation	Gray
125	~~Spaulding, M.B , Jr.~~	~~ATA~~	~~Gray~~
~~121~~	~~Speas, R.D~~	~~A.V. Roe, Canada Ltd.~~	~~Green~~
39	Spiess, P.C.	CAA	Tan
109	Stevenson, C.H	Douglas Aircraft	Gold
73	Stocking, E J	Civil Service Commission	White
	~~Stoner, M.L~~	~~Society of Automotive Eng.~~	~~Gold~~
71	Stout, E.G.	Consolidated Vultee	Green
	~~Stowe, L.J.~~	~~Chase Aircraft~~	~~Gold~~
	~~Stowell, H.F.~~	~~Bellanca Aircraft~~	~~Tan~~
110	Strong, E F.	Consolidated Vultee	White
	~~Stroukoff, M.~~	~~Chase Aircraft~~	~~Gold~~
	Stroukoff, O.	Chase Aircraft	Gold
126	~~Strunk, K G.~~	~~Breeze Corporations, Inc~~	~~Gold~~
	~~Sullivan, J.E~~	~~BuAer Dept. of Navy~~	~~Gold~~
	Suydam, H B.	Grumman Aircraft	Gray
39	Szabo, E.G.	McDonnell Aircraft Corp.	Tan
47	Tafe, H.	Consolidated Vultee	White
135	Talmage, D B.	NACA	Gray
	Templin, R L.	Aluminum Co. of America	Green
105	Thieblot, A J.	A.J Thieblot Aircraft Eng. Co.	Green
	~~Thompson, J.C.~~	~~Consolidated Western Steel~~	~~Gray~~
102	Thompson, W M.	NACA	White
	Thornton, K F.	Aluminum Co. of America	Gold
110	Todd, J.M.	General Electric	Gray
11	Travers, W R.	General Electric	Gray
2	Tripp, R.L.	Grumman Aircraft	Gray
19	Vanderpool, Miss S.	NACA	Tan
T	Victory, Dr. J.F.	NACA	Blue

State Room	Name	Affiliation	Color Group
	Wallace, R	Pratt & Whitney Aircraft	Tan
19	Walrad, Miss Ruth	NACA	Tan
H	Webster, Hon. Wm.	RDB	Blue
H	Webster, Mrs. Wm.		Blue
109	Weise, C.A.	Douglas Aircraft	Gold
	Wenzinger, C. J.	Sverdrup & Parcel, Inc.	White
N	Wetmore, Dr. A.	Smithsonian Institution	Blue
	~~Wheeler, J. C.~~	~~General Electric~~	~~Gold~~
P	Whitney, E G	Fairchild Eng. & Airplane	White
120	~~Widmer, R. H.~~	~~Consolidated Vultee~~	~~Green~~
	~~Wieben, H. C.~~	~~Chase Aircraft~~	~~Tan~~
6	~~Williford, E. A.~~	~~Link Aviation, Inc.~~	~~Gray~~
134	~~Willis, C. E.~~	~~Lear, Inc.~~	~~Tan~~
	~~Winne, H. A.~~	~~General Electric~~	~~Blue~~
	Wolfe, Lt. F.C.	Air Development Force	Red
7	Wolfe, L.C	Aeronca Mfg. Co	Red
9	Woods, J. Jr.	General Electric Co.	Gold
8	Wood, W.W , Jr.	Link Aviation, Inc.	Gray
	Worley, Prof. W.J	University of Illinois	Gray
106	Zoll, F.B.	Libby-Owens-Ford Glass	Red
I	Zusi, J.A	Grumman Aircraft	Gray

GUEST LIST
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APPROVED BY NACA HEADQUARTERS
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1.	David Anderton	Aviation Week	Boat
2.	John Adams	U. S. News and World Report	Boat
3.	George Carroll	N.Y. Journal American	Boat
4.	Charles Corddry	U.P.	Plane
5.	Peter Edson	NEA	Boat
6.	James J. Haggerty	American Aviation	Plane
7.	Elton Fay	A.P.	Boat
8.	Dr. Arthur Monahan	Science Service	Boat
9.	Fred Hamlin	Aero Digest	Boat
10.	Robert McLarren	Aero Digest	Boat
11.	Fred Graham	N.Y. Times	Boat
12.	John Vandergrift	All Hands Mag.	Boat
13.	William Shippen	Washington Star	Boat
14.	Ben Lee	Aviation Week	Plane
15.	Alex McSurely	Aviation Week	Plane
16.	William Perrault	American Aviation	Boat
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18.	Hugh Harvey	Shell Aviation News	Boat
19.	Wellman Shrader	Aero. Eng. Review	Boat
20.	A. T. Hadley	Newsweek	Plane
21.	William Kerwin	INS	Boat
22.	C. B. Allen	N.Y. Herald Tribune	Plane
23.	Henry Luce III	Time	Boat
24.	Harlan Trott	Christian Science Monitor	Boat
25.	Elmer Thompson	Air Transport Assn.	Boat
26.	E. E. Miller	NACA	Boat
27.	Don Wiley	NACA	Boat
28.	Walt Bonney	NACA	Plane
29.	Max Karant	AOPA	Boat
30.	Art Clawson	Aero Digest	
~~31.~~	~~James Harris~~	~~Peninsula Enterprise~~	

NACA - Langley

ADDITIONAL GUESTS LIST MAY 18, 1951 BIENNIAL INSPECTION

APPROVED BY DIRECTOR

Group Color	Name	Affiliation
Red	Arnstein, Dr. Karl	Goodyear Aircraft Corp.
Blue	Barrett, James G.	USAF - WPAFB
~~Blue~~	~~Beckett, W. R., Maj.~~	~~Langley Liaison Office~~
Tan	Broad, Janet H.	NACA - Langley
White	Chapman, Col. W. F.	Commanding Officer, LAFB
Green	Chenoweth, O. C.	AAF - WPAFB
Blue	Condon, Dr. E. U.	National Bureau of Standards
Gray	Feldman, F. K.	North American
~~Brown~~	~~Franklin, Pete~~	~~Newport News Times Herald~~
~~Brown~~	~~Glasgow, Jesse~~	~~Norfolk Virginia-Pilot~~
Green	Hartman, E. P.	NACA Western Coordinator
Red	Hood, Manley J.	NACA - Ames
White	Jorgen, C. C.	Navy Department
Brown	Kinnier, J. T.	Newport News Daily Press
Tan	Klinefelter, Lois E.	NACA - Langley
White	Kroon, R. P.	Westinghouse
Green	Lonnquest, Rear Adm. T. C.	U.S. Navy
Gold	McKay, Capt. A. L.	Langley Liaison Office
Tan	Rice, Margaret	NACA - Langley
Tan	Richardson, Bernice	NACA - Langley
Tan	Riggins, L. Lee	NACA - Langley
Red	Roche, J. A.	Langley Liaison Office
Tan	Stovall, Vesta	NACA - Langley
Brown	Thompson, Elmer	Air Transport, ASSOC
White	Thoren, T. R.	Thompson Products, Cleveland, Ohio
Gray	Underwood, W. J.	NACA Liaison Office, Wright Field
White	Woodall, J. F.	Consolidated Vultee

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Guest List

1951 Biennial Inspection
NACA Laboratories
Langley Field, Virginia

May 21, 1951

Color Group	Name	Affiliation
Green	Albin, Lt. Col. J. B.	Fort Eustis, Virginia
Gold	Alexander, Comdr. R. T.	U.S.C.G., Washington
Brown	✓Allison, J. M.	Bureau of Ordnance
Tan	Alsher, D.	N.A.M.C., Philadelphia
Gray	Anderson, Maj. C. E.	ADF, Wright-Patterson AFB
Green	Anderson, Lt. Col. D. L.	ADF, Wright-Patterson AFB
Gold	Anderson, Capt. R. H.	TAC, Langley AFB
Brown	✓Angelone, Capt. Joseph	SWC, Kirtland AFB, N. M.
Tan	Antonatos, P. P.	ADF, Wright-Patterson AFB
Green	✓Appold, Lt. Col. N. C.	USAF, Washington
Gold	Ash, Lt. Comdr. L. R.	MATS, Andrews AFB
Brown	Bachman, J. L.	NAMC, Philadelphia
Tan	Baird, Lt. Comdr. W. D.	NATC, Patuxent, Md.
Gray	Ball, Lt. I. H.	NAS, Norfolk
Red	Barcus, Maj. Gen. G. O.	TAC, Langley AFB
Green	Barila, Lt. B. B.	NATC, Patuxent, Md.
White	Barnaby, Capt. R. S.	Franklin Institute
Gold	✓Barnett, W.	Taylor Model Basin
Brown	Bashark, N.	ADF, Wright-Patterson AFB
White	Basye, Col. W. E.	TAC, Langley AFB
Tan	✓Baum, C. P.	BuAer, Washington
Gray	Baumeister, Capt. C. E.	TAC, Langley AFB
Blue	Bayers, Comdr. E. H.	NATC, Patuxent, Md.
Green	✓Beaman, Lt. Col. H. C.	ADF, Wright-Patterson AFB
Gold	Beaver, Lt. Comdr. R. H.	NATC, Patuxent, Md.
Brown	Becker, Col. H. P.	Cherry Point, N. C.
Red	Beckett, Maj. W. R.	Langley Liaison
Blue	Beiser, George	RDB, Washington
Green	Bennett, T. C.	NADC, Johnsville, Pa.
Gold	Berk, Comdr. H. R.	NATC, Patuxent, Md.
Brown	Bertoni, Lt. Col. L.	AWS, Andrews AFB
Tan	Bitner, Lt. Col. R. O.	ADF, Wright-Patterson AFB
Gray	✓Blake, J. C.	Army, Washington
Green	Bloss, D.	Wright-Patterson AFB
Red	Bordon, A.	Taylor Model Basin
White	Bosee, Comdr. R. A.	NATC, Patuxent, Md.
Blue	✓Boyd, Col. R. K.	AAF, Fort Monroe
Green	✓Boyle, T. P.	NAS, Norfolk

Color Group	Name	Affiliation
Gold	✓Brake, N. E.	TAC, Langley AFB
Gold	Bremer, G. F.	ADF, Wright-Patterson AFB
Gold	✓Brenholtz, Capt. George	ADF, Wright-Patterson AFB
Brown	Brewer, Lt. Col. C. S.	Offutt AFB
Brown	Brewer, Lt. Col. R. M.	TAC, Langley AFB
Blue	Briggs, Comdr. C. A.	NAMC, Philadelphia
Brown	✓Brinckley, E. P.	ADF, Wright-Patterson AFB
Gold	✓Briscoe, Maj. A. S.	TAC, Langley AFB
Tan	Broudo, S.	NAMC, Philadelphia
Gray	Brown, Lt. Col. C. E.	ADF, Wright-Patterson AFB
Green	Brown, Capt. H. O.	TAC, Langley AFB
Blue	✓Brown, Comdr. H. S.	NAS, Norfolk
Gray	Brown, W. J.	ADF, Wright-Patterson AFB
Red	✓Brownell, W. F.	Taylor Model Basin
White	Browning, Col. L. M.	Bolling AFB
Green	✓Brumfiel, Maj. O. M.	USAF, Washington
Gold	Buck, Maj. A. B.	AWS, Andrews AFB
Brown	Buckholtz, Capt. E. H.	TAC, Langley AFB
Tan	Bunker, Lt. Col. W.	Fort Eustis, Virginia
Gray	Burgner, Maj. N. M.	AWS, Andrews AFB
Red	✓Burwell, C. L.	Navy, Washington
Green	Bynum, Capt. R.	USAF, Washington
Red	Callahan, Lt. Col. G. P.	ADF, Wright-Patterson AFB
Blue	Campbell, Lt. Col. S. W.	ADF, Wright-Patterson AFB
Red	Cannon, Lt. Gen. J. K.	TAC, Langley AFB
Tan	Cantwell, R.	ADF, Wright-Patterson AFB
Tan	Carey, A.	NATC, Patuxent, Md.
Green	Carlson, R. C.	ADF, Wright-Patterson AFB
Blue	Carroll, Maj. Gen. F. O.	C.G., AEDD, Tullahoma
Red	Carter, Lt. Comdr. A. M., Jr.	NAMC, Philadelphia
White	Carter, Col. J. H.	USAF, Washington
Tan	Casey, Maj. J. B.	TAC, Langley AFB
Gray	Cenesbaugh, Lt. Comdr. T. K.	NATC, Patuxent, Md.
Red	✓Chambers, Comdr. L. S.	BuAer, Washington
Red	Chapman, Col. W. F.	C.O., Langley AFB
Green	Chenoweth, Opie	ADF, Wright-Patterson AFB
Gold	Cherney, Maj. M. R.	TAC, Langley AFB
Brown	✓Clark, E. A.	NAS, Norfolk
Green	Clausen, Lt. Col. L. C.	ADF, Wright-Patterson AFB
Gold	✓Clayton, W. L., Jr.	TAC, Langley AFB
White	✓Coates, Capt. L. D.	BuAer, Washington
Blue	Cocklin, H.S.	USCG, Washington
Red	Coffin, Capt. P. R.	NAMC, Philadelphia
Tan	Coley, Comdr. V. J., Jr.	NATC, Patuxent, Md.
Gray	Collins, Col. R. B.	Bolling AFB
Red	Collins, Comdr. T. W.	NADC, Johnsville, Pa.
Red	✓Combs, Rear Adm. T. S.	BuAer, Washington

Color Group	Name	Affiliation
White	Conlon, E. W.	AEDC, Tullahoma, Tenn.
Blue	✓Conner, Col. C. P.	ATC, Scott AFB, Ill.
Green	Cook, R. E.	TAC, Langley AFB
Gold	Corsaw, L. H.	ADF, Wright-Patterson AFB
Brown	Couch, R. B.	Taylor Model Basin
Tan	✓Covington, Lt. Col. F. S.	TAC, Langley AFB
Gray	✓Creel, R. L.	BuAer, Washington
Green	Croom, Lt. Col. W. C.	TAC, Langley AFB
Red	Cross, Capt. G.	NATC, Patuxent, Md.
Gold	Crotwell, Lt. L. L.	NATC, Patuxent, Md.
Blue	Crow, Col. R. M.	Bolling AFB
Brown	Culbertson, Col. A. T.	ADF, Wright-Patterson AFB
Gold	✓Curry, J. H.	Taylor Model Basin
Tan	Curtiss, Lt. Col. G. S.	ADF, Wright-Patterson AFB
Gray	Dale, Maj. J. R.	Offutt AFB
Green	Dalehite, T. H.	APG, Eglin AFB
Gold	Dallman, Capt. H. M	TAC, Langley AFB
Brown	Dallow, T.	NATC, Patuxent, Md.
Tan	Dana, Lt. Comdr. M. L.	NAS, Norfolk
Gray	D'Andera, J. B.	ADF, Wright-Patterson AFB
Red	Davis, Comdr. E. W.	Ind. College, Wash. D. C.
White	Davis, Lt. Comdr. J. A.	NADC, Johnsville, Pa.
Blue	De Crescente, C.	NATC, Patuxent, Md.
Green	Degavre, Col. C. B.	Army, Washington
Gold	De Lalio, Lt. Col. A. H.	NATC, Patuxent, Md.
Brown	Delgiorno, Capt. A. M.	TAC, Langley AFB
White	Dent, Brig. Gen. F. R., Jr.	ADF, Wright-Patterson AFB
Tan	Dernbach, A. F.	ADF, Wright-Patterson AFB
Gray	Diehl, Col. D. B.	Ind. College, Wash. D. C.
Green	Doner, J.	NATC, Patuxent, Md.
Gold	Dooley, Lt. R. J.	NATC, Patuxent, Md.
Brown	✓Driscoll, B. J.	Hdqrts, USAF, Washington
Tan	Drubek, Maj. G. G.	AWS, Andrews AFB
Red	Dryden, Hugh L.	NACA
Gray	✓Duncan, Maj. C. O.	Signal Corps, Wash. D. C.
Green	Duncan, B.	NATC, Patuxent, Md.
Blue	✓Duncan, Comdr. R. L.	O.N.R., Washington
Gold	Durup, Lt. P.	NATC, Patuxent, Md.
Brown	Duval, George	NADC, Johnsville, Pa.
Red	Echols, C. G.	NAS, Norfolk
Brown	✓Edwards, Maj. W. H.	TAC, Langley AFB
Tan	Ellis, Col. R. H.	TAC, Langley AFB
Gray	Ellison, Lt. Col. M. E.	Fort Belvoir, Va.
Green	Elvin, Lt. Col. M. P.	ADF, Wright-Patterson AFB
Gold	England, J.	ADF, Wright-Patterson AFB
Brown	✓Engoron, E. J.	USAF, Washington

Color Group	Name	Affiliation
Blue	Erickson, Comdr. F. A.	NATC, Patuxent, Md.
White	Erickson, Lt. Comdr. W. A.	NADC, Johnsville, Pa.
Tan	Evans, Lt. Comdr. H., Jr.	NATC, Patuxent, Md.
Gray	✓ Evans, J. C.	USAF, Washington
Green	✓ Everett, Lt. W. H.	NAS, Anacostia
Brown	Fitzpatrick, D.	NATC, Patuxent, Md.
Red	✓ Floberg, J. F.	Navy, Washington
Gold	Floor, A. P.	ADF, Wright-Patterson AFB
Green	Floyd, Lt. D. S.	Wright-Patterson AFB
Red	✓ Folk, H.	NAS, Norfolk
Brown	✓ Follensbee, Capt. E. R.	SWC, Kirtland AFB
Blue	Ford, Comdr. W. W.	NAMC, Philadelphia
Tan	✓ Forsht, Lt. E. R.	NAS, Anacostia
Gray	Forster, Lt. Col. B. F.	AWS, Andrews AFB
Green	✓ Freeman, Lt. R. G.	NAS, Norfolk
Gold	✓ Fresh, J. N.	Taylor Model Basin
Brown	✓ Frisbie, W. Z.	BuAer, Washington
Tan	Funderburg, A. B.	ADF, Wright-Patterson AFB
Gray	Gaboury, Comdr. W. D.	NATC, Patuxent, Md.
Green	✓ Gaetani, R. A.	NAS, Norfolk
Gold	✓ Gaffney, Capt. J. H.	TAC, Langley AFB
Brown	✓ Galbreath, Lt. Col. S. C.	SWC, Kirtland AFB
Tan	Garofalo, Lt. (jg) P. C.	NATC, Patuxent, Md.
Gray	✓ Garrison, C. C.	ONR, Washington
Red	Gartsu, G.	NATC, Patuxent, Md.
White	Geary, R. H.	MATS, Andrews AFB
Blue	✓ Getting, I. A.	USAF, Washington
Green	✓ Givan, Lt. Col. D. K.	ATC, Scott AFB, Ill.
Gold	✓ Glass, E. M.	ADF, Wright-Patterson AFB
Brown	Gloeckler, F. M.	NADC, Johnsville, Pa.
Tan	Gold, A.	NADC, Johnsville, Pa.
Gray	Goldberg, J. H.	NADC, Johnsville, Pa.
Green	Goldman, G. M.	ADF, Wright-Patterson AFB
Gold	✓ Gomer, Capt. J. P.	TAC, Langley AFB
Brown	✓ Goode, Col. R. E.	Fort Eustis, Virginia
Green	✓ Gossner, Capt. J. E.	TAC, Langley AFB
Gold	Greichen, R. R.	AEDC, Tullahoma, Tenn.
White	✓ Grant, Rear Adm. L. M.	BuAer, Washington
Blue	Graul, Col. D. P.	USAF, Washington
Brown	Greenland, M. G.	NAMC, Philadelphia
Red	✓ Gregory, Col. H. F.	USAF, Washington
Tan	Gridley, Capt. A. H., Jr.	TAC, Langley AFB
Gray	Griffin, Col. R. W.	TAC, Langley AFB
Green	✓ Griffing, Lt. Comdr. C. W.	Taylor Model Basin
Gold	✓ Gruendyke, Maj. R. N.	TAC, Langley AFB
Brown	✓ Guarino, L. W.	NAMC, Philadelphia
Tan	Gulledge, Lt. Comdr. K. E.	NADC, Johnsville, Pa.

Color Group	Name	Affiliation
Gray	Haberman, W.	Taylor Model Basin
~~Red~~	~~Hackanson, H. G.~~	~~ADF, Wright-Patterson AFB~~
White	Hagen, G. R.	Taylor Model Basin
~~Blue~~	~~Hairston, Lt.Col. F. B.~~	~~Bolling AFB~~
~~Red~~	~~Haley, Capt. T. B.~~	~~NAS, Norfolk~~
~~Green~~	~~Hampton, Col. E. W.~~	~~TAC, Langley AFB~~
Gold	Hanes, Col. H. A.	USAF, Washington
Brown	Hannan, Lt. J. M., Jr.	TAC, Langley AFB
~~Blue~~	~~Hardin, Brig. Gen. T. O.~~	~~Norton AFB~~
Tan	Harding, Col. J. G.	Army, Washington
Gray	Hargis, C. B.	ADF, Wright-Patterson AFB
Blue	Harrison, Lt. Col. C. E.	Signal Corps, Washington
~~White~~	~~Harrison, Comdr. H. W.~~	~~NATC, Patuxent, Md.~~
Green	Harvey, R. C.	TAC, Langley AFB
Gold	Hasert, C. N.	USAF, Washington
Brown	Haskin, Col. M. L.	USAF, Washington
~~White~~	~~Haueter, P.~~	~~ADF, Wright-Patterson AFB~~
Tan	Haugen, Col. V. R.	USAF, Washington
~~Blue~~	~~Haydock, Maj. C. E., Jr.~~	~~Army, Washington~~
~~Green~~	~~Haynes, B.~~	~~Army Ordnance Research~~
~~Gold~~	~~Hays, E. L.~~	~~NAMC, Philadelphia~~
~~Brown~~	~~Heacox, Lt. W. J.~~	~~NATC, Patuxent, Md.~~
~~Gray~~	~~Henderson, Lt. T. F.~~	~~TAC, Langley AFB~~
~~Tan~~	~~Herring, T. G.~~	~~NADC, Johnsville, Pa.~~
~~Gray~~	~~Hill, Lt. C. A.~~	~~NAMC, Philadelphia~~
Tan	Hill, J. G.	Taylor Model Basin
~~Gray~~	~~Hoffman, R. E.~~	~~ADF, Wright-Patterson AFB~~
~~Tan~~	~~Holbrook, Lt. Col. C. C.~~	~~Fort Belvoir, Va.~~
~~Gray~~	~~Holmes, Col. W. W.~~	~~USAF, Washington~~
~~Green~~	~~Horne, C. L.~~	~~TAC, Langley AFB~~
~~Gold~~	~~Horsman, Lt. H. M.~~	~~NATC, Patuxent, Md.~~
~~Brown~~	~~Horton, Maj. Peter~~	~~USAF, Washington~~
Tan	Howell, Capt. D. L.	TAC, Langley AFB
~~Gray~~	~~Hrebec, Capt. G. M.~~	~~Offutt AFB~~
~~Tan~~	~~Hueners, Maj. G. W.~~	~~TAC, Langley AFB~~
~~Gray~~	~~Hume, Capt. G. B.~~	~~TAC, Langley AFB~~
Red	Hunt, Comdr. L. ~~H.~~ J.	BuAer, Navy
~~White~~	~~Hunter, H. N.~~	~~NAMC, Philadelphia~~
Green	Hyatt, Abraham	BuAer, Navy
Gold	Inn, E. C. Y.	Cambridge Laboratories
~~Brown~~	~~Insalata, I. A.~~	~~NADC, Johnsville, Pa~~
Tan	Irvin, Lt. Col. M. H.	TAC, Langley AFB
~~Gray~~	~~Jablonsky, Lt. Col. H. J.~~	~~USAF, Washington~~
~~Red~~	~~Jacobs, W. C.~~	~~AWS, Andrews AFB~~
~~White~~	~~Jamison, Lt. Col. M. V.~~	~~AWS, Andrews AFB~~
~~Blue~~	~~Jankiewicz, E.~~	~~NAMC, Philadelphia~~
~~Green~~	~~Jehl, Lt. Col. R. R.~~	~~Bolling AFB~~

Color Group	Name	Affiliation
~~Gold~~	~~Jelks, Lt. C. R., Jr.~~	~~TAC, Langley AFB~~
~~Brown~~	~~Johns, Lt. Comdr. R. L.~~	~~NATC, Patuxent, Md.~~
~~Tan~~	~~Johnson, Comdr. N. D.~~	~~NATC, Patuxent, Md.~~
Gray	✓Johnson, Maj. R. E.	First Army, N. Y.
~~Red~~	~~Johnson, Col. R. L.~~	~~ADF, Wright-Patterson AFB~~
~~White~~	~~Johnson, Lt. Col. W. L.~~	~~TAC, Langley AFB~~
~~Blue~~	~~Johnston, Comdr. R. K.~~	~~NATC, Patuxent, Md.~~
~~Green~~	~~Johnstone, D.~~	~~NAS, Norfolk~~
Gold	✓Jones, Maj. C. H.	TAC, Langley AFB
Brown	✓Joynt, H. M.	NAS, Norfolk
~~Tan~~	~~Kabase, Maj. F.~~	~~APG, Eglin AFB~~
~~Gray~~	~~Kamm, R. W.~~	~~Air Eng. Dev., Wash. D.C.~~
~~Red~~	~~Keator, Lt. Col. R. D.~~	~~ADF, Wright-Patterson AFB~~
Green	✓Keith, Capt. E. T.	TAC, Langley AFB
~~Gold~~	~~Kemp, Lt. Col. R. D.~~	~~Fort Belvoir, Va.~~
~~Brown~~	~~Kinney, R. W.~~	~~ADF, Wright-Patterson AFB~~
~~Tan~~	~~Kirkpatrick, Lt. H. J.~~	~~NATC, Patuxent, Md.~~
~~Gray~~	~~Kleff, Lt. Col. P. A.~~	~~Ind. College, Wash. D.C.~~
~~Green~~	~~Klein, Maj. P. L.~~	~~Fort Eustis, Virginia~~
~~Gold~~	~~Kline, P.~~	~~NATC, Patuxent, Md.~~
Brown	✓Klise, Lt. Col. K. W.	TAC, Langley AFB
Tan	✓Kolletty, Lt. Col. J.	Fort Eustis, Virginia
~~Gray~~	~~Lamache, A.~~	~~NATC, Patuxent, Md.~~
Red	✓Lamplin, P. A.	NAS, Norfolk
~~Green~~	~~Larkin, Lt.(jg) J. C., Jr.~~	~~NATC, Patuxent, Md.~~
Blue	✓Larkin, Lt. Gen. T. B.	Army, Washington
White	✓Latham, Lt. Col. J. C.	ADF, Wright-Patterson AFB
~~Tan~~	~~Lawson, Lt. Col. T. O., Jr.~~	~~USAF, Washington~~
~~Gray~~	~~Lenahan, Maj. G. W.~~	~~ATC, Scott AFB, Ill.~~
~~Green~~	~~Lentz, Maj. J. C. H.~~	~~TAC, Langley AFB~~
White	✓Leon, Comdr. H. L.	USN, Res. and Dev.
~~Gold~~	~~Levy, W. W.~~	~~NADC, Johnsville, Pa.~~
~~Brown~~	~~Lichtenstein, L. J.~~	~~NAMC, Philadelphia~~
Tan	✓Lindenbaum, B.	ADF, Wright-Patterson AFB
~~Gray~~	~~Lindtner, Lt. Col. F. L.~~	~~TAC, Langley AFB~~
~~Green~~	~~Little, A. A., III~~	~~NAMC, Philadelphia~~
~~Gold~~	~~Little, Lt. J.~~	~~NATC, Patuxent, Md.~~
~~Brown~~	~~Lohmann, Comdr. E. A.~~	~~USN, Res. and Dev.~~
Red	✓Lombard, A. E., Jr.	USAF, Washington
~~Tan~~	~~Lott, M. A.~~	~~NAMC, Philadelphia~~
Gray	✓Louden, F. A.	BuAer, Washington
~~Green~~	~~Lovegrove, Lt. H. C.~~	~~NATC, Patuxent, Md.~~
~~Red~~	~~Lunney, E. J.~~	~~Wright-Patterson AFB~~
Gold	✓Maier, Maj. M. P.	USAF, Washington
~~Brown~~	~~Mansfield, Maj. C. D.~~	~~Bolling AFB~~

Color Group	Name	Affiliation
~~Tan~~	~~Mapp, R.~~	~~ADF, Wright-Patterson AFB~~
Grey	Marinelli, Lt. Col. J. L.	AFF, Fort Monroe
Green	Marshall, Lt.(jg) J. T.	ONR, Washington
~~Gold~~	~~Martin, Lt.Col. G. P.~~	~~Bolling AFB~~
~~Brown~~	~~Marx, J.~~	~~NATC, Patuxent, Md.~~
~~Tan~~	~~Maurer, Lt. Comdr. T. E.~~	~~NATC, Patuxent, Md.~~
Red	Maxwell, Brig. Gen. A. R.	USAF. Washington
~~Gray~~	~~Mayfield, Lt. Col. L. W.~~	~~Fort Eustis, Virginia~~
~~Green~~	~~Mayo, Lt. Comdr. R. C.~~	~~NAS, Anacostia~~
~~Gold~~	~~Mazur, J.~~	~~NATC, Patuxent, Md.~~
Brown	McCauley, J.W.	Air Eng. Dev., Washington
~~Tan~~	~~McClanahan, Capt. H. C.~~	~~ADF, Wright-Patterson AFB~~
Gray	McConnaughhay, Comdr. J. W.	Naval Air, Washington
Green	McCourt, Capt. F. P.	Fort Eustis, Virginia
~~Gold~~	~~McCoy, Maj. C. E.~~	~~Bolling AFB~~
~~Brown~~	~~McCrackin, Comdr. O. E.~~	~~NADC, Johnsville, Pa.~~
~~Tan~~	~~McCrary, Lt. S. W.~~	~~NATC, Patuxent, Md.~~
Gray	McDaniel, R. J.	NAS, Norfolk
~~Blue~~	~~McKay, Capt. A. L.~~	~~Langley Liaison~~
~~Green~~	~~McKeown, Lt. Col. C. W.~~	~~Fort Eustis, Virginia~~
~~Gold~~	~~McKinley, R. V.~~	~~TAC, Langley AFB~~
~~Brown~~	~~McLennan, M. A.~~	~~ADF, Wright-Patterson AFB~~
Red	McKechnie, Capt. A. W.	Navy, Washington
~~Tan~~	~~McNickle, Col. M. L.~~	~~ADF, Wright-Patterson AFB~~
Gray	McNaulty, Maj. G. M.	TAC, Langley AFB
Red	McRee, Comdr. W. H.	BuAer, Washington
~~Green~~	~~Medici, Lt. J. J.~~	~~ADF, Wright-Patterson AFB~~
~~Gold~~	~~Mester, C. H.~~	~~NAMC, Philadelphia~~
~~White~~	~~Meyer, Col. R. D.~~	~~Fort Eustis, Virginia~~
~~Brown~~	~~Meyers, Maj. R.~~	~~Fort Eustis, Virginia~~
~~Gray~~	~~Miller, Capt. F.~~	~~ADC, Ent AFB~~
~~Green~~	~~Monroe, E.~~	~~NATC, Patuxent, Md.~~
White	Monroe, Brig. Gen. H. McD.	CG VII Corps., Fort Meade
~~Tan~~	~~Moody, T.~~	~~NATC, Patuxent, Md.~~
~~Green~~	~~Morat, Capt. A. T., Jr.~~	~~Cherry Point, N. C.~~
~~Gold~~	~~Morgan, Capt. C. S.~~	~~Cherry Point, N. C.~~
Brown	Morton, J. W.	BuAer, Washington
~~Tan~~	~~Muche, Lt. C. C.~~	~~NATC, Patuxent, Md.~~
~~Gray~~	~~Mulford, Lt. W. W.~~	~~TAC, Langley AFB~~
Gray	Muse, T. C.	USAF, Washington
~~Red~~	~~Nay, Col. P. F.~~	~~Wright-Patterson AFB~~
~~White~~	~~Nehf, Maj. A. N.~~	~~NATC, Patuxent, Md.~~
~~Blue~~	~~Nelson, Maj. Gen. M. R.~~	~~USAF, Washington~~
~~Gold~~	~~Nesbitt, Lt. W. E.~~	~~TAC, Langley AFB~~
~~Brown~~	~~Ness, A.~~	~~NATC, Patuxent, Md.~~
~~Green~~	~~Newman, V. E.~~	~~ADF, Wright-Patterson AFB~~
~~Tan~~	~~Nial, J.~~	~~NATC, Patuxent, Md.~~
Gray	Niederer, O.	Taylor Model Basin

Color Group	Name	Affiliation
Red	Null, C. R.	NATC, Patuxent, Md.
White	Nunneley, Maj. C. M.	TAC, Langley AFB
Blue	✓Nunziato, Maj. R. J.	USAF, Washington
Green	Nutter, R. D.	NADC, Johnsville, Pa.
Gold	✓Oder, Lt. Col. F. C.	Cambridge Laboratories
Brown	✓Olfson, Maj. J. W.	ATC, Scott AFB, Ill.
White	Olsen, Capt. C. B.	USCG, Washington
Tan	✓Ormsby, R. B.	Taylor Model Basin
Gray	✓Palmer, Maj. B. A.	TAC, Langley AFB
Green	Paradis, J.	NATC, Patuxent, Md.
Gold	✓Parthum, Maj. A. H.	Army, Washington
Brown	Pasch, Lt. A. E.	NATC, Patuxent, Md.
Tan	Patzig, H.	NATC, Patuxent, Md.
Gray	Paul, Lt. D. R.	NAMC, Philadelphia
Red	Pearch, Col. L. D.	TAC, Langley AFB
White	✓Perry, Lt. Col. L. D.	TAC, Langley AFB
Brown	Petaja, A. E.	ADF, Wright-Patterson AFB
Blue	Petzing, Col. E. R.	Signal Corps, Washington
Gold	Pfieifer, H. H.	NADC, Johnsville, Pa.
Tan	Pieper, F. W.	TAC, Langley AFB
Gray	Pierce, Col. P. P.	TAC, Langley AFB
Red	Pond, H. L.	Taylor Model Basin
White	Pooler, Comdr. L. G.	Buord, Washington
Blue	✓Porter, Lt. Col. R. A.	USAF, Washington
Gold	Potter, C. F., Jr.	NAMC, Philadelphia
Brown	✓Powers, J. O.	BuAer, Washington
Tan	Prickett, Comdr. R. H.	NAMC, Philadelphia
White	✓Proschan, A.	Office Asst. Secy. Def.
Gray	✓Prouty, Maj. L. F.	ADC, Ent AFB
Gold	Provost, Comdr. T. C.	NATC, Patuxent, Md.
Brown	✓Quillinan, J. H.	Taylor Model Basin
Tan	Quinlan, W.	NATC, Patuxent, Md.
Gray	✓Rapp, R.	Taylor Model Basin
Blue	✓Raschke, Capt. Henry	ADF, Wright-Patterson AFB
Red	Reed, Maj. D. M.	TAC, Langley AFB
White	✓Reed, T. G.	Taylor Model Basin
Green	Rice, Maj. L. C., Jr.	TAC, Langley AFB
Gold	Richert, Maj. W. K.	ADF, Wright-Patterson AFB
Brown	Ricketts, Lt. Comdr. O. J.	NADC, Johnsville, Pa.
Tan	✓Ridenour, L. N.	USAF, Washington
Gray	Robbins, Maj. H. W.	ADF, Wright-Patterson AFB
Red	Robinson, Lt. B.	NATC, Patuxent, Md.
White	Roche, J. A.	Langley Liaison
Blue	Roessel, Lt. Col. J.	Wright-Patterson AFB

Color Group	Name	Affiliation
Red	Rogers, Col. N. E., Jr.	TAC, Langley AFB
Red	Rose, Brig. Gen. F.	TAC, Langley AFB
Green	Rosenfeld, M. S.	NAMC, Philadelphia
Gold	Rosenfield, Lt. Col. W. A.	ADF, Wright-Patterson AFB
Blue	✓Roth, Brig. Gen. M. S.	USAF, Washington
Red	Rothrock, Col. J. H.	ADF, Wright-Patterson AFB
Red	✓Sager, Comdr. J. P.	BuAer, Wright-Patterson AFB
Blue	Salter, Maj. R. D.	ADC, Ent AFB
Blue	✓Saltzman, Maj. E. C., Jr.	SWC, Kirtland AFB, N. M.
Blue	Sanwald, G. L.	NAMC, Philadelphia
Green	Schaefer, E. S.	Cherry Point, N. C.
White	Schlatter, Maj. Gen. D. M.	ARDC, Wright-Patterson AFB
Blue	Schlech, Lt. Col. R. E.	Wright-Patterson AFB
Gold	Schlieben, E. W.	NADC, Johnsville, Pa.
Brown	Schoech, H.	NATC, Patuxent, Md.
Tan	Schoeni, Lt. Comdr. A. L.	Ed., N. A. Aviation News
Gray	Schriever, Col. B.	USAF, Washington
Red	Schumacher, L. E.	ADF, Wright-Patterson AFB
Green	Schwartz, Lt. W. E.	NAS, Anacostia
Gold	✓Schwarzbach, J.	NATC, Patuxent, Md.
Brown	Seay, J.	NATC, Patuxent, Md.
Blue	Seeger, Comdr. L. H.	USCG, Washington
Red	✓Senter, Brig. Gen. W. O.	Chief, AWS, Andrews AFB
White	Sessums, Brig. Gen. J. W.	ARDC, Wright-Patterson AFB
Blue	Shadow, Lt. Comdr. R. A.	NAMC, Philadelphia
Tan	Shaker, Capt. E. E.	Fort Belvoir, Va.
Gray	Sheidow, Capt. R. G.	TAC, Langley AFB
Red	Shinabarger, A.	ADF, Wright-Patterson AFB
White	Short, Comdr. W. C., Jr.	NATC, Patuxent, Md.
Blue	Shows, H. R.	ADF, Wright-Patterson AFB
Green	Shtogran, Col. A. T.	AWS, Andrews AFB
Gold	Shunske, Lt. Col. G. E.	Bolling AFB
Brown	Shuman, Maj. P. L.	Cherry Point, N. C.
Blue	Sievers, Col. R. H.	Ind. College, Wash. D. C.
White	Sims, Lt. Col. R. D.	Bolling AFB
Tan	Sinclair, Lt. Comdr. A. M.	NAMC, Philadelphia
Red	Sintic, Comdr. A. J., Jr.	NAS, Norfolk
White	✓Sisson, Capt. T. U.	Office Ch., Naval Op.
Blue	✓Slason, Comdr. F. K.	NAS, Norfolk
Green	Smith, A.	NATC, Patuxent, Md.
Gold	✓Smith, B. G.	NAS, Norfolk
Brown	✓Smith, Col. E. E.	Army, Washington
Tan	Smith, R. H.	Offutt AFB
Gray	Snodgrass, Lt. J. C.	NATC, Patuxent, Md.
White	Snow, O. J.	NADC, Johnsville, Pa.
Blue	Snyder, Col. I. D.	TAC, Langley AFB
White	✓Sollenberger, Lt. Comdr. H. D.	NAMC, Philadelphia

Color Group	Name	Affiliation
~~Blue~~	~~Sollenberger, Lt. Comdr. R. L.~~	~~Taylor Model Basin~~
~~Gold~~	~~Spangler, Capt. S. B.~~	~~Comdr., NADC, Johnsville, Pa.~~
~~White~~	~~Speltz, Lt. Comdr. P. H.~~	~~NATC, Patuxent, Md.~~
~~Brown~~	~~Spivey, Lt. V. M.~~	~~TAC, Langley AFB~~
~~Tan~~	~~Sponenbergh, Maj. M. C.~~	~~TAC, Langley AFB~~
~~Gray~~	~~Stevens, Capt. J. A.~~	~~TAC, Langley AFB~~
~~White~~	~~Stevens, Lt. Comdr. P. F.~~	~~NATC, Patuxent, Md.~~
~~Blue~~	~~Stim, C.~~	~~NATC, Patuxent, Md.~~
Gold	✓ Stirling, Comdr. C. W.	Taylor Model Basin
~~Brown~~	~~Steckebrand, Lt. A.P.~~	~~NATC, Patuxent, Md.~~
~~White~~	~~Stough, J.~~	~~ADF, Wright-Patterson AFB~~
~~Tan~~	~~Stuber, B.~~	~~NATC, Patuxent, Md.~~
~~Gray~~	~~Sweet, R. A.~~	~~NATC, Patuxent, Md.~~
~~Red~~	~~Swofford, Brig. Gen. R. P.~~	~~ARDC, Wright-Patterson AFB~~
~~Blue~~	~~Tara, Lt. Col. H. B.~~	~~TAC, Langley AFB~~
~~Brown~~	~~Terry, Capt. M. F., Jr.~~	~~ADF, Wright-Patterson AFB~~
~~Tan~~	~~Thomas, Lt. H. R., Jr.~~	~~NAS, Anacostia~~
~~Blue~~	~~Thomas, J.~~	~~NADC, Johnsville, Pa.~~
~~White~~	~~Thompson, Capt. G. G.~~	~~AWS, Andrews AFB~~
~~Tan~~	~~Thompson, Lt. J. C., Jr.~~	~~NAS, Anacostia~~
~~Blue~~	~~Tillon, Lt. F. J.~~	~~NATC, Patuxent, Md.~~
~~White~~	~~Tillinghast, N.~~	~~NATC, Patuxent, Md.~~
White	✓ Valz, F. M.	BuAer, Washington
~~Brown~~	~~Vandayburg, Maj. K. D.~~	~~Wright-Patterson AFB~~
White	✓ Van Zandt, J. P.	Office Secy. of A. F.
Red	✓ Wagoner, Lt. Comdr. L. H.	NAS, Anacostia
~~White~~	~~Walker, E. A.~~	~~RDB, Washington~~
Blue	✓ Walkowicz, Lt. Col. T. F.	USAF, Washington
Green	✓ Ward, Capt. K. G.	First Army, New York
~~Green~~	~~Warren, Capt. R. F.~~	~~Fort Belvoir, Virginia~~
Gold	✓ Wattendorf, F. L.	Air Eng. Dev., Washington
White	✓ Weart, Comdr. H. C.	Navy, Washington
Blue	✓ Weinberger, R. A.	BuAer, Washington
Brown	✓ Welch, H. C.	Taylor Model Basin
~~Green~~	~~White, Maj. Floyd~~	~~TAC, Langley AFB~~
White	✓ White, Comdr. M. W.	BuAer, Washington
Blue	✓ Wilber, Capt. A. W.	ADC, Ent AFB
~~White~~	~~Wilkinson, T. P.~~	~~BuAer, Washington~~
~~Green~~	~~Williams, Capt. J.E.~~	~~TAC, Langley AFB~~
Tan	✓ Wilson, Lt. Col. K. S.	USAF, Washington
~~White~~	~~Wiseman, H. E.~~	~~Offutt AFB~~
~~Brown~~	~~Wolfe, E. A.~~	~~ADF, Wright-Patterson AFB~~
~~Gray~~	~~Wolfe, Lt. F. C.~~	~~ADF, Wright-Patterson AFB~~
Gray	✓ Wolfe, Maj. Fred	ADF, Wright-Patterson AFB
~~Gray~~	~~Wood, Col. F. B.~~	~~ADF, Wright-Patterson AFB~~
Red	✓ Woodard, R. C.	NAS, Norfolk

Color Group	Name	Affiliation
Red	✓ Woods, S. R.	TAC, Langley AFB
Red	✓ Wooton, Comdr. J. C.	BuAer, Navy
Blue	✓ Wyatt, Lt. Comdr. J. R.	NAS, Anacostia
Tan	✓ Young, R. A.	BuAer, Navy
~~Blue~~	~~Zahringer, J.~~	~~NATC, Patuxent, Md.~~
Red	✓ Zelubowski, A. E.	NAS, Norfolk
~~White~~	~~Zepke, W. W.~~	~~NAMC, Philadelphia~~

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

ADDITIONAL GUESTS LIST

MAY 21, 1951

APPROVED BY DIRECTOR

Color Group	Name	Affiliation
Green	Blanchard, Ulysse J.	NACA - Langley
Red	Brewer, Jack D.	NACA - Washington
Blue	Burbank, P. B.	NACA - Langley
Tan	Bursnall, William J.	NACA - Langley
Blue	Byrne, Robert	NACA - Langley
Gray	Campbell, Lt. A. B.	NAS, Norfolk
Gold	Charak, Mason T.	NACA - Langley
Blue	Cunningham, H. J.	NACA - Langley
Green	Daley, Bernard	NACA - Langley
Green	Day, William	OSAF, Washington
Gray	Delano, James B.	NACA - Langley
Blue	Dickey, Daniel A.	ADF, Wright-Patterson AFB
Red	Fickes, Lt. L. R.	NAS, Anacostia, Wash. D.C.
Tan	Fisher, Lloyd J.	NACA - Langley
Green	Fitspatrick, J. E.	NACA - Langley
Gray	Foland, Douglas H.	NACA - Langley
White	Fralich, Robert W.	NACA - Langley
Tan	Gammal, Abraham	NACA - Langley
Red	Gardiner, Robert A.	NACA - Langley
White	Gilman, Jean	NACA - Langley
Green	Harrin, E. N.	NACA - Langley
White	Hedgepeth, John M.	NACA - Langley
Brown	Humphreys, M. D.	NACA - Langley
Brown	Kagels, Edward P.	NACA - Lewis
Brown	Kapryan, W. J.	NACA - Langley
Tan	Kennedy, Robert M.	NACA - Langley
Red	King, Lt.(jg) M. H.	NAS, Anacostia, Wash. D.C.
White	Klunker, E. B.	NACA - Langley
Gold	Lord, Douglas R.	NACA - Langley
Red	Libove, Charles	NACA - Langley
Brown	Lina, L. J.	NACA - Langley
Brown	Lovell, P. M.	NACA - Langley
Red	Margolis, Kenneth	NACA - Langley
Red	Mayers, J.	NACA - Langley
Gold	Mayo, W. L.	NACA - Langley
Gray	McBride, Ellis E.	NACA - Langley

Color Group	Name	Affiliation
Gold	Milwitzky, Benjamin	NACA - Langley
Gold	Morris, G. J.	NACA - Langley
Brown	Morrison, Lt. Comdr. F. P.	O and R, NAS, Norfolk
Gray	Moseley, William C., Jr.	NACA - Langley
Blue	Nelson, Herbert	NACA - Langley
Gold	Nelson, Robert L.	NACA - Langley
Red	Oswalt, Maj. J. W.	R and D, OCAFF, Ft. Monroe
Gold	Pacharzina, Capt. Carl A.	R and D, USAF, Wash. D.C.
Brown	Petynia, William W.	NACA - Langley
Gold	Pratt, Kermit G.	NACA - Langley
White	Queijo, M. J.	NACA - Langley
Green	Ramser, John A.	NACA - Langley
White	Ramsey, Capt. Paul H.	BuAero, Navy, Wash. D.C.
Tan	Roberts, Lt. (jg) G. M.	Naval Air Station, Anacostia
Brown	Sanders, Elmer C.	NACA - Langley
White	Sanders, J. L.	NACA - Langley
Red	Seide, Paul	NACA - Langley
Green	Sellers, Thomas B.	NACA - Langley
Gray	Siesby, Norman S.	NACA - Langley
Tan	Strass, H. Kurt	NACA - Langley
White	Sullivan, J. E.	BuAero, Wash. D. C.
Gray	Trant, James P., Jr.	NACA - Langley
Tan	Trimpi, Robert L.	NACA - Langley
Blue	Wardell, Capt. Patrick G.	R and D, OCAFF, Ft. Monroe
Brown	Weil, J.	NACA - Langley
White	Williams, Walter	NACA - Muroc, Calif.
Tan	Woods, Col. George E.	Chief, Transportation, Wash.
Gold	Wright, Ray H.	NACA - Langley

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Guest List

1951 Biennial Inspection
NACA Laboratories
Langley Field, Virginia

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May 22, 1951

Color Group	Name	Affiliation
Brown	Barranco, Magalyn M.	NACA - Langley
~~Red~~	~~Beckett, Maj. W. R.~~	~~Langley Liaison~~
~~Gold~~	~~Berdahl, E. O.~~	~~Offutt AFB~~
~~Gold~~	~~Brewer, Lt. Col. G. S.~~	~~Offutt AFB~~
Brown	Butler, Frances L.	NACA - Langley
Brown	Cartwright, Lucy T.	NACA - Langley
~~Red~~	~~Chapman, Col. W. F.~~	~~C.O., Langley AFB~~
Brown	Hoback, Frances	NACA - Langley
Tan	Hogge, Shirley	NACA - Langley
Gold	Hrebec, Capt. G. M.	Offutt AFB
~~Green~~	~~Kagels, Edward~~	~~NACA - Lewis~~
~~Tan~~	~~Lublin, A. M.~~	~~Norfolk~~
~~Blue~~	~~McKay, Capt. A. L.~~	~~Langley Liaison~~
Brown	Moreland, Frances B.	NACA - Langley
Brown	Mulcahy, Helen B.	NACA - Langley
~~Green~~	~~Roche, J. A.~~	~~Langley Liaison~~
Brown	Sale, W. Antionette	NACA - Langley
~~Tan~~	~~Shumaker, Adm. J. M.~~	~~Norfolk~~
Brown	Smith, Margaret E.	NACA - Langley
Gold	Taub, W. M.	NACA - Langley
Brown	Topping, Doris R.	NACA - Langley
Brown	Tucker, Eleanor H.	NACA - Langley
Green	Willment, D. A.	NACA - Langley
Gold	Wiseman, H. E.	Offutt AFB

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

1951 Biennial Inspection

Additional Guests Approved by Director

May 22, 1951

Color Group	Name	Affiliation
Gold	Berdahl, E. O.	Hq. SAC, Offutt AFB
Brown	Bisplinghoff, Raymond	MIT
Blue	Coe, R. Adm. C. F.	Office Chief Naval Oper., Wash.
Tan	Evans, A. J.	NACA - Langley
Tan	Haynes, E.	Office Chief Ordnance, Wash.
Green	Kurzweg, Hermann	Naval Ordnance
Blue	Le Baron, Peggy	
Blue	Le Baron, Robert	Deputy Sec. of Defense for Atomic Energy
Tan	Meissner, C. E.	Budd Co., Wash.
Red	Rieger, D. H.	Piedmont Airlines
Green	Saunders, H. K.	Piedmont Airlines
Blue	Stevenson, Andrew A.	U. S. House of Representatives
Green	Theodorsen, T.	Air Dev. Force, Wash.
Red	Tompkins, A. W.	Piedmont Airlines
Green	Wasserman, Lee S.	Air Dev. Force, Wright Field
Green	Wentzel, Howard	Fairchild Aircraft Corp.

NACA

1951 BIENNIAL INSPECTION

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of the

LANGLEY AERONAUTICAL LABORATORY
LANGLEY FIELD, VIRGINIA

May 22, 1951

State Room	Name	Affiliation	Color Group
135	~~Anderson, R. A.~~	~~NACA Headquarters~~	~~Tan~~
77	Arthur, John	Research Development Board	Green
	Babberger, Carl W.	Hughes Aircraft	Red
	Bachle, C. F	Continental Aviation Corp.	Tan
	~~Bain, Gordon~~	~~Civil Aeronautics Board~~	Gold
39	Baker W L	Socony-Vacuum Oil Co.	Gold
28	~~Barnett, C. A.~~	~~Kellett Aircraft Corp.~~	~~Tan~~
138	Beach, James	Civil Aeronautics Administration	Tan
	Beall, Dr. Paul	Research & Development Board	Green
71	Belinn, Clarence M.	Los Angeles Airways, Inc.	Green
2	Bensen, Igor	Kaman Aircraft Corp.	Brown
	Bergman, Arthur J.	Fairchild Engine & Airplane	Green
H	Biermann, David	Hartzell Propeller Co.	Gold
H	Biermann, Mrs. David		Gold
10	Bissell, Thomas A	Society of Automotive Engs.	Red
32	Blackwood, A. J.	Standard Oil Dev. Co.	Green
138	Blount, T E,	Fairchild Camera & Inst.	Brown
52	Blumenthal, Leon	Civil Service Commission	Brown
	~~Borger, John G.~~	~~Pan American Airways~~	~~Red~~
S	Borland, William R	Port of New York Authority	Blue
136	Boudwin, J. E.	Civil Aeronautics Adm.	Brown
107	Bowe, D D.	General Motors Corp.	Green
117	Bowers, H. L.	Central Intelligence Agency	Red
47	Bowie, Dr. R M.	Sylvania Electric Products	Brown
103	Braig, Eugene	NACA, Lewis Lab.	Brown
52	Braithwaite, Howard	NACA, Headquarters	Tan
103	Brenner, Melvin A	Bureau of the Budget	Green
27	Briant, Raymond	Carbide Company	Tan
	~~Brown, Francis W.~~	~~Civil Aeronautics Board~~	~~Red~~
137	Brown, Harvey H.	NACA Headquarters	Tan
129	Bryan, Samuel	Civil Aeronautics Adm.	Red
119	Burton, E W	Civil Aeronautics Adm.	Red

State Room	Name	Affiliation	Color Group
129	Carlson, John	Civil Aeronautics Adm.	Green
B	~~Case, Sen. Francis~~	~~U. S. Senate~~	~~Blue~~
139	Cesaro, Richard S.	NACA Headquarters	Gold
102	Chamberlain, J.M.	Civil Aeronautics Board	Red
N	Chenoweth, Hon. J. E.	U. S. House of Representatives	Blue
P	Chester, Stanford	NACA Headquarters	Blue
116	Childress, G. D.	Civil Aeronautics Adm.	Tan
O	Cleveland, W. I.	American Automobile Assn.	Blue
24	~~Cohn, Benedict~~	~~Boeing Airplane Company~~	~~Green~~
73	Collins, John H.	NACA - Lewis	Red
13	Conlon, Dr. E. W.	Arnold Eng'g. and Dev. Center	Blue
	Cook, Ernshaw	Fairchild Eng. & Airplane	Red
19	Cook, Col. Frank R.	Minneapolis-Honeywell Co.	Gold
	Coughlin, Cregg	Fairchild Eng. & Airplane	Red
125	Cox, Dr. William E.	Northrop Aircraft, Inc.	Green
77	Crane, Neal	Research & Develop. Board	Green
115	Cudworth, Dr. James R.	University of Alabama	Green
122	Curtiss, Dr. J. H.	National Bureau of Standards	Green
106	Dallas, Allen W.	Air Transport Association	Red
35	Davies, W. W.	United Air Lines, Inc.	Red
105	Davis, F. E.	Eastern Air Lines, Inc.	Gold
108	Davis, Halford G.	United States Senate	Blue
	Davis, T. H.	Piedmont Airlines	Green
	Devers, Lt. Gen. J. (Ret.)	Fairchild Eng. & Airplane	Blue
M	Dolliver, Hon. J. I.	U. S. House of Representatives	Blue
143	Ebert, John W.	NACA Headquarters	Brown
126	~~Erdoss, B. K.~~	~~Stevens Inst. of Technology~~	~~Brown~~
	~~Emmerson, J. Q.~~	~~Kaman Aircraft Corp.~~	~~Brown~~
	~~Enos, Louis H.~~	~~Curtiss-Wright Corp.~~	~~Tan~~
	Enter, Ted E.	Office, Dep. Chief of Staff, Dev.	Green
	~~Everest, Maj. Gen. F.F.~~	~~Dep. Chief of Staff, Operations~~	Blue
131	Fagin, Irving	Civil Aeronautics Adm.	Green
36	Flesh, E. M.	McDonnell Aircraft Corp.	Brown
133	Florer, H. S.	Civil Aeronautics Adm.	Gold
	Fonda, Col. A. Paul	Fairchild Eng. & Airplane	Red
27	Fraas, Arthur P.	Carbide & Carbon Chem. Co.	Green
105	Froesch, Charles	Eastern Air Lines, Inc.	Gold
115	Furnas, Dr. C. C.	Cornell Aeronautical Lab.	Green

State Room	Name	Affiliation	Color Group
104	Garber, Paul E	Smithsonian Institution	Gold
130	Garrelts, Prof. Jewell	Columbia University	Green
142	Garrick, I. E.	NACA, Langley	Gold
114	George, J. J.	Eastern Air Lines	Gold
19	Gerrich, David C.	Minneapolis-Honeywell Reg.	Gold
44	Gerstenberger, Walter	Sikorsky Aircraft	Red
P	Gildersleeve, Clifford	Cleveland Chamber of Commerce	Blue
114	Girard, P. E.	Ryan Aeronautical Co	Green
132	Godfrey, Linwood H.	Department of Justice	Tan
128	Goland, Martin	Midwest Research Institute	Gold
9	Gosney, Mrs. Mary Lou	NACA, Lewis	Brown
140	Green, John C.	Department of Commerce	Brown
N	Green, Hon. Wm. J., Jr.	House of Representatives	Blue
	~~Greene, William L~~	~~Engineering & Research Corp.~~	~~Brown~~
6	Gross, Prof. Donald	University of Maryland	Red
31	Gunther, C. A.	Radio Corp. of America	Tan
111	Haldeman, George	Civil Aero. Adm.	Brown
60	Hall, Jesse F.	NACA, Lewis	Gold
109	Harper, Carl		Green
9	Harris, Miss Blanche	NACA Headquarters	Brown
	Haynes, B. C.	U.S. Weather Bureau	Tan
118	Heckert, Jackson S.	Civil Aeronautics Board	Brown
J	Heppe, Richard	Lockheed Aircraft Corp.	Tan
59	Herrmann, Charles A	NACA, Lewis Laboratory	Brown
M	Hinshaw, Hon. Carl	House of Representatives	Blue
106	Hoekstra, Harold D.	Civil Aeronautics Adm.	Blue
132	Hootman, James A	NACA Headquarters	Tan
A	Hoskinson, R L.	Douglas Aircraft Company	Green
75	~~Hovgard, P. E.~~	~~Pennsylvania Aircraft Syndicate~~	~~Red~~
110	Hubbard, N A.	Engineering & Research Corp.	Brown
13	~~Huglin, Col. H. P., USAF~~	~~Arnold Eng. & Dev Center~~	~~Red~~
120	Hutton, A. C.	National Bureau of Standards	Red
134	Jackson, Eugene B	NACA Headquarters	Brown
127	Janes, C. J.	Civil Aeronautics Adm	Gold
D	~~Jarrett, Edward~~	~~Interstate & For. Commerce~~ Committee	~~Blue~~
123	~~Jensen, Harry T.~~	~~Sikorsky Aircraft~~	~~Red~~
Q	~~Johnson, Hon. LeRoy~~	~~House of Representatives~~	Blue
J	S. Paul Johnston	Institute of the Aeronautical Sciences	Blue

State Room	Name	Affiliation	Color Group
	~~Kaman, Charles H.~~	~~Kaman Aircraft Corp.~~	~~Brown~~
123	Katzenberger, E. F.	Sikorsky Aircraft	Tan
20	Keane, Richard C.	American Bosch Corp.	Tan
108	Kelly, J. J., Jr.	U. S. Senate	Blue
31	Knapp, H. D.	Radio Corp. of America	Tan
48	Kent, W. T.	Douglas Aircraft	Green
	Knox, Thomas B.	Kellex Corporation	Tan
111	Koneczny, W. E.	Civil Aeronautics Board	Brown
130	Krefeld, W. J.	Columbia University	Green
R	Kyle, John M.	Port of N. Y. Authority	Blue
109	Lacklen, Robert J.	NACA Headquarters	Brown
107	LaMotte, Ralph R.	General Motors Corp.	Green
122	Laufer, John	National Bureau of Standards	Green
71	Lawrence, Wm. C.	American Airlines	Green
	Lee, F. B.	Civil Aeronautics Adm.	Tan
F	~~Lee, Hon. Josh~~	~~Civil Aeronautics Board~~	~~Blue~~
126	Lehman, William	Stevens Inst. of Technology	Gold
124	Levy, Samuel	National Bureau of Standards	Green
125	Lightfoot, R. B.	Sikorsky Aircraft	Tan
	Little, D. M.	U. S. Weather Bureau	Tan
48	Lodge, Richard S.	Minneapolis-Honeywell Co.	Gold
75	~~Lucker, Larry~~	~~Penna. Aircraft Syndicate~~	Red
35	McBrien, R. L.	United Airlines, Inc.	Red
73	McCann, W. J.	NACA - Lewis	Tan
	~~McGregor, Douglas~~	~~American Bosch Corp.~~	~~Tan~~
127	McMillen, Chas. H.	Civil Aeronautics Adm.	Gold
135	Maggin, Bernard	NACA Headquarters	Brown
	~~Magrath, Howard A.~~	~~USAF Air Development Force~~	~~Green~~
40	Manson, Sam	NACA - Lewis	Red
43	~~Marquardt, Dr. Roy~~	~~Marquardt Aircraft Co.~~	~~Tan~~
43	Martin, George	Prewitt Aircraft Co.	Tan
	Martin, Ross J.	University of Illinois	Tan
	Mentzer, W. C.	United Airlines, Inc.	Red
	~~Mickelson, Brig. Gen. S. R.~~	~~Office, Asst. Chief of Staff~~	~~Blue~~
113	Micotti, A. D.	Bureau of Aeronautics, Navy	Red
36	Miller, R. W.	McDonnell Aircraft Corp.	Red
12	Milne, W. W.	Soc. of Automotive Engrs.	Red

State Room	Name	Affiliation	Color Group
120	Mitchell, Nolan D.	National Bureau of Standards	Green
	~~Mitterling, Lt. Col. R. O~~	~~Assistant for Atomic Energy~~	~~Blue~~
11	Moor, Miss Mildred	NACA Headquarters	Brown
131	Morris, Judson W	Civil Aeronautics Adm	Brown
51	Morse, John C.	Civil Aeronautics Adm.	Red
E	~~Murphy, John~~	~~House of Representatives~~	~~Blue~~
128	~~Murray, Allan B.~~	~~Stevens Inst. of Technology~~	~~Gold~~
134	Myers, Boyd C., II	NACA Headquarters	Brown
S	Myers, James F.	Port of New York Authority	Blue
11	Nixon, Miss Connie	NACA Headquarters	Brown
116	Notley, A. F.	Civil Aeronautics Adm.	Tan
40	Nye, B. E.	Cleveland Pneumatic Tool	Brown
2	Odlum, Edward J.	Kaman Aircraft Corp.	Brown
44	O'Leary, F. R.	Curtiss-Wright Corp.	Green
	~~Orlando, H. E.~~	~~Northeast Airlines~~	~~Green~~
102	~~Pahl, John~~	~~Civil Aeronautics Board~~	~~Gold~~
	Palmer, Richard C	Fairchild Eng & Airplane	Green
	~~Parker, N. A.~~	~~University of Illinois~~	~~Tan~~
47	Parker, T D.	Climax Molybdenum Co of Michigan	Gold
	~~Peach, Robert E.~~	~~Robinson Airlines Corp.~~	~~Gold~~
143	Phillips, Franklyn W.	NACA Headquarters	Gold
	~~Piasecki, F. N.~~	~~Piasecki Helicopter Corp.~~	~~Green~~
110	Poth, John	Engineering & Research Corp.	Brown
117	Priebe, Paul D	Central Intelligence Agency	Red
140	Ramberg, Dr. Walter	National Bureau of Standards	Red
	Reber, Carl	U S Weather Bureau	Tan
142	Regier, A. A.	NACA Langley	Red
I	Reynolds Walter L	United States Senate	Blue
Q	Riley, Prof. John	University of Maryland	Red
8	Riley, Hon, John J	House of Representatives	Blue
F	Rodert, L. A	NACA, Lewis Laboratory	Brown
N	Rogers, Hon. Dwight L.	House of Representatives	Blue
	Roper, Col. H. M., USA	Office of Secretary of Defense	Blue
	Ross, Morwick	Department of Commerce	Brown
138	Rubinstein, Bernard	Munitions Board	Gold
	~~Rummel, R. W~~	~~Transworld Airlines~~	Green
112	Rutz, Fred	American Bosch Corp	Tan

State Room	Name	Affiliation	Color Group
121	Sanders, Richard	Sanders Aviation, Inc.	Brown
121	Sanders, Robert	Sanders Aviation, Inc.	Brown
23	Schmill, W. C.	Fairchild Eng. & Airplane	Gold
28	~~Schneck, Curtis E.~~	~~Kellett Aircraft Corp.~~	~~Tan~~
	Schneiter, L. E.	NACA Headquarters	Gold
141	Schreiber, Carl	NACA Headquarters	Gold
124	Schubauer, G. B.	National Bureau of Standards	Red
	Schuette, Evan H.	Dow Chemical Co.	Tan
	Schuette, Prof. O.F.,Jr.	College of Wm. and Mary	Tan
60	Sessions, Robt. C.	NACA - Lewis	Brown
T	Shapley, Willis S.	Bureau of the Budget	Green
	Sheehy, Wm. J.	Joint Com. of Atomic Energy	Blue
6	Sherwood, Dr. A. W.	University of Maryland	Red
E	~~Sieminski, Hon. A. D.~~	~~U. S. House of Representatives~~	~~Blue~~
32	~~Splaine, E. J.~~	~~Northeast Airlines~~	~~Green~~
119	Sprague, W. B.	Civil Aeronautics Adm.	Gold
A	Stanford, J. N.	Douglas Aircraft	Gold
	Stathers, G. D.	Civil Aeronautics Adm.	Brown
	~~Stefano, N. M.~~	~~Hughes Aircraft Co.~~	~~Red~~
L	Stockburger, Dr. A.E.	U.S. House of Representatives	Blue
76	Stoebe, R. W.	Munitions Board	Gold
10	Stoner, LeRoy	Soc. of Automotive Engrs.	Red
104	Strobell, R. C.	Smithsonian Institution	Gold
R	Sullivan, Thos. M.	Port of N.Y. Authority	Blue
I	~~Sweeney, Edw. C.~~	~~U. S. Senate~~	~~Blue~~
	Thompson, F. L.	NACA - Langley	Gold
59	Tousignant, John	NACA - Lewis	Brown
24	Trotter, Herbert	Eastman Kodak Co.	Brown
23	Trussel, J. I.	Fairchild Eng. & Airplane	Green
T	Ulmer, Ralph E.	NACA Headquarters	Green
	~~Underwood, E. Victor~~	~~Robinson Airlines Corp.~~	~~Gold~~
39	Van Dyck, L. H.	Socony-Vacuum Oil Co.	Gold
	~~Verner, James M.~~	~~Civil Aeronautics Board~~	~~Red~~
113	Verville, Alfred	Bureau of Aeronautics, Navy	Red
O	Victory, Dr. J. F.	NACA Headquarters	Blue
76	Walker, Samuel A.	Munitions Board	Gold
118	Welch, R. R.	Radio Corp. of America	Tan
51	White, Ralph S.	Civil Aeronautics Adm.	Green
	Wilson, Maj. Gen. R.C.	Assistant for Atomic Energy	Blue
137	Wood, Clotaire	NACA Headquarters	Tan
133	Woodward, R. C.	Civil Aeronautics Adm.	Red
112	Wrede, B. A.	Lockheed Aircraft	Gold
141	Yates, Chas. R.	NACA Headquarters	Gold

NACA

1951 BIENNIAL INSPECTION

of the

LANGLEY AERONAUTICAL LABORATORY
LANGLEY FIELD, VIRGINIA

May 22, 1951

State Room	Name	Affiliation	Color Group
135	Anderson, R. A.	NACA Headquarters	Tan
77	Arthur, John	Research Development Board	Green
	Babberger, Carl W.	Hughes Aircraft	Red
	Bachle, C. F	Continental Aviation Corp.	Tan
	Bain Gordon	Civil Aeronautics Board	Gold
39	Baker W L	Socony-Vacuum Oil Co.	Gold
28	Barnett, C A.	Kellett Aircraft Corp.	Tan
138	Beach, James	Civil Aeronautics Administration	Tan
	Beall, Dr. Paul	Research & Development Board	Green
71	Belinn, Clarence M.	Los Angeles Airways, Inc.	Green
2	Bensen, Igor	Kaman Aircraft Corp.	Brown
	Bergman Arthur J.	Fairchild Engine & Airplane	Green
H	Biermann, David	Hartzell Propeller Co.	Gold
H	Biermann, Mrs. David		Gold
10	Bissell, Thomas A	Society of Automotive Engs.	Red
32	Blackwood, A. J.	Standard Oil Dev. Co.	Green
138	Blount, T E.	Fairchild Camera & Inst.	Brown
52	Blumenthal, Leon	Civil Service Commission	Brown
	Borger, John G.	Pan American Airways	Red
S	Borland, William R	Port of New York Authority	Blue
136	Boudwin, J. E.	Civil Aeronautics Adm.	Brown
107	Bowe, D D.	General Motors Corp.	Green
117	Bowers, H. L.	Central Intelligence Agency	Red
47	Bowie, Dr. R M.	Sylvania Electric Products	Brown
103	Braig, Eugene	NACA, Lewis Lab.	Brown
52	Braithwaite, Howard	NACA, Headquarters	Tan
103	Brenner, Melvin A	Bureau of the Budget	Green
27	Briant, Raymond	Carbide Company	Tan
	Brown, Francis W	Civil Aeronautics Board	Red
137	Brown, Harvey H.	NACA Headquarters	Tan
129	Bryan, Samuel	Civil Aeronautics Adm.	Red
119	Burton, E W	Civil Aeronautics Adm.	Red

State Room	Name	Affiliation	Color Group
129	Carlson, John	Civil Aeronautics Adm.	Green
B	Case, Sen. Francis	U. S. Senate	Blue
139	Cesaro, Richard S.	NACA Headquarters	Gold
102	Chamberlain, J.M.	Civil Aeronautics Board	Red
N	Chenoweth, Hon. J. E.	U. S. House of Representatives	Blue
P	Chester, Stanford	NACA Headquarters	Blue
116	Childress, G. D.	Civil Aeronautics Adm.	Tan
O	Cleveland, W. I.	American Automobile Assn.	Blue
24	Cohn, Benedict	Boeing Airplane Company	Green
73	Collins, John H.	NACA - Lewis	Red
13	Conlon, Dr. E. W.	Arnold Eng'g. and Dev. Center	Blue
	Cook, Ernshaw	Fairchild Eng. & Airplane	Red
19	Cook, Col. Frank R.	Minneapolis-Honeywell Co.	Gold
	Coughlin, Cregg	Fairchild Eng. & Airplane	Red
125	Cox, Dr. William E.	Northrop Aircraft, Inc.	Green
77	Crane, Neal	Research & Develop. Board	Green
115	Cudworth, Dr. James R.	University of Alabama	Green
122	Curtiss, Dr. J. H.	National Bureau of Standards	Green
106	Dallas, Allen W.	Air Transport Association	Red
35	Davies, W. W.	United Air Lines, Inc.	Red
105	Davis, F. E.	Eastern Air Lines, Inc.	Gold
108	Davis, Halford G.	United States Senate	Blue
	Davis, T. H.	Piedmont Airlines	Green
	Devers, Lt. Gen. J. (Ret.)	Fairchild Eng. & Airplane	Blue
M	Dolliver, Hon. J. I.	U. S. House of Representatives	Blue
143	Ebert, John W.	NACA Headquarters	Brown
126	Erdoss, B. K.	Stevens Inst. of Technology	Brown
	Emmerson, J. O.	Kaman Aircraft Corp.	Brown
	Enos, Louis H.	Curtiss-Wright Corp.	Tan
	Enter, Ted E.	Office, Dep. Chief of Staff, Dev.	Green
	Everest, Maj. Gen. F.F.	Dep. Chief of Staff, Operations	Blue
131	Fagin, Irving	Civil Aeronautics Adm.	Green
36	Flesh, E. M.	McDonnell Aircraft Corp.	Brown
133	Florer, H. S.	Civil Aeronautics Adm.	Gold
	Fonda, Col. A. Paul	Fairchild Eng. & Airplane	Red
27	Fraas, Arthur P.	Carbide & Carbon Chem. Co.	Green
105	Froesch, Charles	Eastern Air Lines, Inc.	Gold
115	Furnas, Dr. C. C.	Cornell Aeronautical Lab.	Green

State Room	Name	Affiliation	Color Group
104	Garber, Paul E	Smithsonian Institution	Gold
130	Garrelts, Prof. Jewell	Columbia University	Green
142	Garrick, I. E.	NACA, Langley	Gold
114	George, J. J.	Eastern Air Lines	Gold
19	Gerrich, David C.	Minneapolis-Honeywell Reg.	Gold
44	Gerstenberger, Walter	Sikorsky Aircraft	Red
P	Gildersleeve, Clifford	Cleveland Chamber of Commerce	Blue
114	Girard, P. E.	Ryan Aeronautical Co	Green
132	Godfrey, Linwood H.	Department of Justice	Tan
128	Goland, Martin	Midwest Research Institute	Gold
9	Gosney, Mrs. Mary Lou	NACA, Lewis	Brown
140	Green, John C.	Department of Commerce	Brown
N	Green, Hon. Wm. J., Jr.	House of Representatives	Blue
	Greene, William L	Engineering & Research Corp.	Brown
6	Gross, Prof. Donald	University of Maryland	Red
31	Gunther, C A.	Radio Corp. of America	Tan
111	Haldeman, George	Civil Aero. Adm.	Brown
60	Hall, Jesse F.	NACA, Lewis	Gold
109	Harper, Carl		Green
9	Harris, Miss Blanche	NACA Headquarters	Brown
	Haynes, B.C.	U.S. Weather Bureau	Tan
118	Heckert, Jackson S.	Civil Aeronautics Board	Brown
J	Heppe, Richard	Lockheed Aircraft Corp.	Tan
59	Herrmann, Charles A	NACA, Lewis Laboratory	Brown
M	Hinshaw, Hon. Carl	House of Representatives	Blue
106	Hoekstra, Harold D.	Civil Aeronautics Adm.	Blue
132	Hootman, James A	NACA Headquarters	Tan
A	Hoskinson, R L.	Douglas Aircraft Company	Green
75	Hovgard, P.E.	Pennsylvania Aircraft Syndicate	Red
110	Hubbard, N A.	Engineering & Research Corp.	Brown
13	Huglin, Col. H. P., USAF	Arnold Eng. & Dev Center	Red
120	Hutton, A.C.	National Bureau of Standards	Red
134	Jackson, Eugene B	NACA Headquarters	Brown
127	Janes, C.J.	Civil Aeronautics Adm	Gold
D	Jarrett Edward	Interstate & For. Commerce Committee	Blue
123	Jensen, Harry T.	Sikorsky Aircraft	Red
Q	Johnson, Hon. LeRoy	House of Representatives	Blue
J	S. Paul Johnston	Institute of the Aeronautical Sciences	Blue

State Room	Name	Affiliation	Color Group
	Kaman, Charles H.	Kaman Aircraft Corp.	Brown
123	Katzenberger, E. F.	Sikorsky Aircraft	Tan
20	Keane, Richard C.	American Bosch Corp.	Tan
108	Kelly, J. J., Jr.	U. S. Senate	Blue
31	Knapp, H. D.	Radio Corp. of America	Tan
48	Kent, W. T.	Douglas Aircraft	Green
	Knox, Thomas B.	Kellex Corporation	Tan
111	Koneczny, W. E.	Civil Aeronautics Board	Brown
130	Krefeld, W. J.	Columbia University	Green
R	Kyle, John M.	Port of N. Y. Authority	Blue
109	Lacklen, Robert J.	NACA Headquarters	Brown
107	LaMotte, Ralph R.	General Motors Corp.	Green
122	Laufer, John	National Bureau of Standards	Green
71	Lawrence, Wm. C.	American Airlines	Green
	Lee, F. B.	Civil Aeronautics Adm.	Tan
F	Lee, Hon. Josh	Civil Aeronautics Board	Blue
126	Lehman, William	Stevens Inst. of Technology	Gold
124	Levy, Samuel	National Bureau of Standards	Green
125	Lightfoot, R. B.	Sikorsky Aircraft	Tan
	Little, D. M.	U. S. Weather Bureau	Tan
48	Lodge, Richard S.	Minneapolis-Honeywell Co.	Gold
75	Lucker, Larry	Penna. Aircraft Syndicate	Red
35	McBrien, R. L.	United Airlines, Inc.	Red
73	McCann, W. J.	NACA - Lewis	Tan
	McGregor, Douglas	American Bosch Corp.	Tan
127	McMillen, Chas. H.	Civil Aeronautics Adm.	Gold
135	Maggin, Bernard	NACA Headquarters	Brown
	Magrath, Howard A.	USAF Air Development Force	Green
40	Manson, Sam	NACA - Lewis	Red
43	Marquardt, Dr. Roy	Marquardt Aircraft Co.	Tan
43	Martin, George	Prewitt Aircraft Co.	Tan
	Martin, Ross J.	University of Illinois	Tan
	Mentzer, W. C.	United Airlines, Inc.	Red
	Mickelson, Brig. Gen. S. R.	Office, Asst. Chief of Staff	Blue
113	Micotti, A. D.	Bureau of Aeronautics, Navy	Red
36	Miller, R. W.	McDonnell Aircraft Corp.	Red
12	Milne, W. W.	Soc. of Automotive Engrs.	Red

State Room	Name	Affiliation	Color Group
120	Mitchell, Nolan D.	National Bureau of Standards	Green
	Mitterling, Lt. Col. R. O.	Assistant for Atomic Energy	Blue
11	Moor, Miss Mildred	NACA Headquarters	Brown
131	Morris, Judson W	Civil Aeronautics Adm	Brown
51	Morse John C.	Civil Aeronautics Adm.	Red
E	Murphy, John	House of Representatives	Blue
128	Murray, Allan B.	Stevens Inst. of Technology	Gold
134	Myers, Boyd C., II	NACA Headquarters	Brown
S	Myers, James F.	Port of New York Authority	Blue
11	Nixon, Miss Connie	NACA Headquarters	Brown
116	Notley, A. F.	Civil Aeronautics Adm.	Tan
40	Nye, B. E.	Cleveland Pneumatic Tool	Brown
2	Odlum, Edward J.	Kaman Aircraft Corp.	Brown
44	O'Leary, F.R.	Curtiss-Wright Corp.	Green
	Orlando, H E.	Northeast Airlines	Green
102	Pahl, John	Civil Aeronautics Board	Gold
	Palmer, Richard C	Fairchild Eng & Airplane	Green
	Parker, N. A.	University of Illinois	Tan
47	Parker, T D.	Climax Molybdenum Co of Michigan	Gold
	Peach, Robert E.	Robinson Airlines Corp.	Gold
143	Phillips, Franklyn W.	NACA Headquarters	Gold
	Piasecki, F. N.	Piasecki Helicopter Corp.	Green
110	Poth, John	Engineering & Research Corp.	Brown
117	Priebe, Paul D	Central Intelligence Agency	Red
140	Ramberg, Dr. Walter	National Bureau of Standards	Red
	Reber, Carl	U S Weather Bureau	Tan
142	Regier, A. A.	NACA Langley	Red
I	Reynolds Walter L	United States Senate	Blue
Q	Riley, Prof. John	University of Maryland	Red
8	Riley, Hon, John J	House of Representatives	Blue
F	Rodert, L. A	NACA, Lewis Laboratory	Brown
N	Rogers, Hon. Dwight L.	House of Representatives	Blue
	Roper, Col. H. M., USA	Office of Secretary of Defense	Blue
	Ross, Morwick	Department of Commerce	Brown
138	Rubinstein, Bernard	Munitions Board	Gold
	Rummel, R. W	Transworld Airlines	Green
112	Rutz, Fred	American Bosch Corp	Tan

State Room	Name	Affiliation	Color Group
121	Sanders, Richard	Sanders Aviation, Inc.	Brown
121	Sanders, Robert	Sanders Aviation, Inc.	Brown
23	Schmill, W. C.	Fairchild Eng. & Airplane	Gold
28	Schneck, Curtis E.	Kellett Aircraft Corp.	Tan
	Schneiter, L. E.	NACA Headquarters	Gold
141	Schreiber, Carl	NACA Headquarters	Gold
124	Schubauer, G. B.	National Bureau of Standards	Red
	Schuette, Evan H.	Dow Chemical Co.	Tan
	Schuette, Prof. O.F.,Jr.	College of Wm. and Mary	Tan
60	Sessions, Robt. C.	NACA - Lewis	Brown
T	Shapley, Willis S.	Bureau of the Budget	Green
	Sheehy, Wm. J.	Joint Com. of Atomic Energy	Blue
6	Sherwood, Dr. A. W.	University of Maryland	Red
E	Sieminski, Hon. A. D.	U. S. House of Representatives	Blue
32	Splaine, E. J.	Northeast Airlines	Green
119	Sprague, W. B.	Civil Aeronautics Adm.	Gold
A	Stanford, J. N.	Douglas Aircraft	Gold
	Stathers, G. D.	Civil Aeronautics Adm.	Brown
	Stefano, N. M.	Hughes Aircraft Co.	Red
L	Stockburger, Dr. A.E.	U.S. House of Representatives	Blue
76	Stoebe, R. W.	Munitions Board	Gold
10	Stoner, LeRoy	Soc. of Automotive Engrs.	Red
104	Strobell, R. C.	Smithsonian Institution	Gold
R	Sullivan, Thos. M.	Port of N.Y. Authority	Blue
I	Sweeney, Edw. C.	U. S. Senate	Blue
	Thompson, F. L.	NACA - Langley	Gold
59	Tousignant, John	NACA - Lewis	Brown
24	Trotter, Herbert	Eastman Kodak Co.	Brown
23	Trussel, J. I.	Fairchild Eng. & Airplane	Green
T	Ulmer, Ralph E.	NACA Headquarters	Green
	Underwood, E. Victor	Robinson Airlines Corp.	Gold
39	Van Dyck, L. H.	Socony-Vacuum Oil Co.	Gold
	Verner, James M.	Civil Aeronautics Board	Red
113	Verville, Alfred	Bureau of Aeronautics, Navy	Red
O	Victory, Dr. J. F.	NACA Headquarters	Blue
76	Walker, Samuel A.	Munitions Board	Gold
118	Welch, R. R.	Radio Corp. of America	Tan
51	White, Ralph S.	Civil Aeronautics Adm.	Green
	Wilson, Maj. Gen. R.C.	Assistant for Atomic Energy	Blue
137	Wood, Clotaire	NACA Headquarters	Tan
133	Woodward, R. C.	Civil Aeronautics Adm.	Red
112	Wrede, B. A.	Lockheed Aircraft	Gold
141	Yates, Chas. R.	NACA Headquarters	Gold

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

1951 Biennial Inspection

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Additional Guests Approved by Director

May 23, 1951

Color Group	Name	Affiliation
Gold	Bagnato, Lt. N.	Langley AFB
Green	Calmer, Steven	NACA - Lewis
Brown	Duce, Capt. Jack A.	Langley AFB
Blue	Kagels, Ed	NACA - Lewis
Tan	Kuchta, F. J.	NACA - Lewis
Tan	Lown, Maj. F. D.	Langley AFB
Blue	Mayo, W. B.	NACA - Langley
Green	McGaughy, John B.	Lublin McGaughy and Assoc.
Green	Stovall, Col. A. S. J.	OCAFF, Ft. Monroe
Red	Thomson, Capt. L. E.	Langley AFB
Green	Tobey, Lt. Richard N.	Langley AFB
Brown	Wilson, S/Sgt. Paul R.	Langley AFB

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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Guest List

1951 Biennial Inspection
NACA Laboratories
Langley Field, Virginia

May 23, 1951

Color Group	Name	Affiliation
Red	Abernathy, G. T.	Newport News Shipyard
~~Blue~~	~~Alber, Maj. G. D.~~	~~Langley AFB~~
Brown	Algrante, Joe	NACA - Lewis
~~Gold~~	~~Alpaugh, Lt. E. S.~~	~~Langley AFB~~
Brown	Amsberry, Capt. W. I.	Langley AFB
Brown	Andrews, M/Sgt. L. W.	Langley AFB
Red	Antonatos, P. P.	ADF, Wright-Patterson AFB
Red	Ashby, Chester	Warwick County, Va.
Green	Askey, Maj. A. W.	Langley AFB
Blue	Auerbach, John	NACA - Lewis
Green	Bailey, Maj. J. R.	Langley AFB
Gold	Baker, M/Sgt. F. F.	Langley AFB
~~Brown~~	~~Banton, Capt. H. L.~~	~~Langley AFB~~
Tan	Barger, Maj. T. J.	Langley AFB
Blue	Barney, Capt. J. E.	Langley AFB
Red	Barth, Maj. M. O.	Langley AFB
Tan	Bartlett, WOJG J. S.	Langley AFB
Red	Beckett, Maj. W. P.	Langley Liaison
~~Red~~	~~Benedict, Lt. Col. James~~	~~Langley AFB~~
~~Tan~~	~~Bennett, Lt. R. E.~~	~~Langley AFB~~
~~Brown~~	~~Bennett, Lt. S. W.~~	~~Langley AFB~~
Gold	Berdami, Capt. R. J.	Langley AFB
Blue	Berryman, W. T.	NACA - Langley
Red	Bitner, Lt. Col. R. O.	ADF, Wright-Patterson AFB
Red	Boehmer, Al	NACA - Lewis
~~Red~~	~~Bottom, R. B.~~	~~Pres., Daily Press, Inc.~~
~~Green~~	~~Boutwell, Capt. O. V.~~	~~Langley AFB~~
Gold	Boyles, Capt. D. R., Jr.	Langley AFB
Green	Bracy, B.	NACA - Lewis
Tan	Brandt, M/Sgt. J. J.	Langley AFB
~~Brown~~	~~Brannen, Capt. S., Jr.~~	~~Langley AFB~~
Green	Bremer, G. F.	ADF, Wright-Patterson AFB
Red	Brooks, C. T., Jr.	Pres. NN Merchants Assoc.
Tan	Brown, Lt. Col. G. E.	ADF, Wright-Patterson AFB
Blue	Brown, R. G.	Brown and Grist
Red	Brydon, Capt. G. M.	Norfolk Naval Shipyard
Gold	Budnik, Capt. E. J.	Langley AFB
Blue	Burgess, W. C.	NACA - Lewis
Blue	Burkle, Andy	NACA - Lewis
~~Tan~~	~~Butler, Maj. H. F.~~	~~Langley AFB~~

Color Group	Name	Affiliation
Red	Caldwell, Maj. G. P.	Langley AFB
Red	Callahan, Lt. Col. G. P.	ADF, Wright-Patterson AFB
Red	Campbell, Col. F. W.	ADF, Wright-Patterson AFB
Blue	Cantwell, R.	ADF, Wright-Patterson AFB
Green	Carnahan, Capt. D. E.	Langley AFB
Green	Cartwright, Ed	NACA, Lewis
Gold	Carver, Capt. C. E.	Langley AFB
Brown	Clark, Capt. Robert	Langley AFB
Blue	Clausen, Lt. Col. C. L.	Wright-Patterson AFB
Tan	Coffey, Warrant Officer M. E.	Langley AFB
Blue	Collings, G. B.	Gen. Mgr., PAC
Tan	Collings, Capt. O. B.	Langley AFB
Red	Colonna, G. B.	Hampton, Va.
Red	Conant, Lt. Comdr. J. E.	Norfolk Naval Shipyard
Red	Cope, Maj. S. J.	Langley AFB
Blue	Cosley, Maj. Jack	Fleet Marine Force LANT
Brown	Cremer, Lt. G. D.	Langley AFB
Tan	Crichton, Frank	NACA, Lewis
Brown	Crim, Maj. H. C., Jr.	Langley AFB
Red	Crocker, Lt. Col. J. P.	Langley AFB
Blue	Cummings, Lt. Col. E. W.	Langley AFB
Green	Dailey, R. E.	Langley AFB
Blue	D'Amore, Lt. Col. A. A. S.	Langley AFB
Tan	D'Andera, J. B.	ADF, Wright-Patterson AFB
~~Blue~~	✓~~Daugherty, Capt. R. J.~~	~~Langley AFB~~
Red	Dawson, Maj. V. B.	Langley AFB
Gold	Deakin, Capt. B. K.	Langley AFB
~~Blue~~	✓~~Deppe, Lt. Col. H. W.~~	~~Langley AFB~~
Tan	DeVille, M/Sgt. A. J.	Langley AFB
~~Brown~~	✓~~Dewey, William~~	~~NACA, Lewis~~
Tan	Dillon, Lt. W. B.	Langley AFB
Brown	Doile, Capt. J. E.	Langley AFB
Blue	Donaldson, R. M.	Newport News Shipyard
~~Green~~	✓~~Donohue, Capt. W. F.~~	~~Langley AFB~~
Gold	Downey, Maj. R. J.	Langley AFB
Brown	Earhart, Capt. C. A.	Langley AFB
~~Red~~	✓~~Eason, Lt. Comdr. V. V.~~	~~Hq., Fifth Naval District~~
~~Red~~	✓~~Ellerton, Comdr. G. C., Jr.~~	~~Mine Depot, Yorktown, Va.~~
Green	Elvin, Lt. Col. M. P.	ADF, Wright-Patterson AFB
Tan	England, M/Sgt. O. L.	Langley AFB
Tan	Everett, John	NACA, Lewis
Red	Evvard, J. C.	NACA, Lewis
~~Green~~	✓~~Fausnaught, Maj. W. J.~~	~~Langley AFB~~
Gold	Felker, Capt. C. W.	Langley AFB
Blue	Fitzgerald, Maj. R. L.	Langley AFB
Green	Fitzwater, Maj. C. E.	Langley AFB
Red	Forbes, Lt. Comdr. S. G., Jr.	Mine Depot, Yorktown, Va.

Color Group	Name	Affiliation
~~Green~~	~~Friddel, Capt. A. F.~~	~~Langley AFB~~
Red	Funderburg, A. B.	ADF, Wright-Patterson AFB
~~Blue~~	~~Garrett, Lt. Col. S. N.~~	~~Langley AFB~~
~~Blue~~	~~Gilchrist, Comdr. N. S.~~	~~Norfolk Naval Shipyard~~
~~Tan~~	~~Gillings, Lt. R. L.~~	~~Langley AFB~~
Tan	Goldman, G. M.	ADF, Wright-Patterson AFB
Gold	Gordon, Vic	NACA, Lewis
Brown	Greco, M/Sgt. M. A.	Langley AFB
Blue	Greffett, Lt. Col. C. V.	Langley AFB
Blue	Griffith, L. M.	Hampton, Va.
Green	Hamilton, Capt. G. K.	Langley AFB
Red	Hamilton, Capt. W. H.	Comdr., NAB, Fifth Naval Dist.
Green	Hammers, Capt. B. N.	Langley AFB
~~Red~~	~~Harcos, Col. B. A.~~	~~Langley AFB~~
Green	Harley, Maj.	Wright-Patterson AFB
Blue	Harlow, Lt. Comdr. L. C.	Norfolk Naval Shipyard
Blue	Harris, Maj. R. A.	Langley AFB
~~Green~~	~~Hendry, Maj. A. N.~~	~~Langley AFB~~
Gold	Hooper, Capt. W. D.	Langley AFB
~~Brown~~	~~Hoover, H. L.~~	~~NACA, Lewis~~
Red	Horn, W. M.	Newport News Shipyard
~~Tan~~	~~Hornbaker, Maj. J. O.~~	~~Langley AFB~~
Tan	Huskins, M/Sgt. Joe	Langley AFB
Green	Inloes, Maj. B. H., Jr.	Langley AFB
~~Gold~~	~~Insalaco, Capt. Vincenzo~~	~~Langley AFB~~
Brown	Isles, Lt. T. W.	Langley AFB
~~Gold~~	~~Jackson, Lt. C. W.~~	~~Langley AFB~~
Brown	Johnston, Capt. M. N.	Langley AFB
Tan	Johnston, Capt. R. O.	Langley AFB
Gold	Joyner, U. T.	NACA, Langley
Red	Kale, Lt. Col. J. S.	Langley AFB
Blue	Kane, J. R.	Newport News Shipyard
Red	Keator, Lt. Col. R. D.	ADF, Wright-Patterson AFB
Green	Kehrer, Maj. Kenneth	Langley AFB
Gold	Kelly, Capt. J. W.	Langley AFB
Brown	Kendall, Capt. R. B.	Langley AFB
Tan	Kinney, M/Sgt. J. L.	Langley AFB
Tan	Knapp, Maj. F. A.	Langley AFB
Brown	Kopit, Capt. A. L.	Langley AFB
~~Green~~	~~Kramer, S.~~	~~NACA, Lewis~~
~~Blue~~	~~Lamerdin, W. L.~~	~~Newport News Shipyard~~
~~Green~~	~~Lancaster, Capt. LeRoy M.~~	~~Langley AFB~~
~~Gold~~	~~Lawn, Maj. F. D., Jr.~~	~~Langley AFB~~
Brown	Lazzarini, Lt. H. F.	Langley AFB
Red	Leahy, Capt. W. H.	Norfolk Naval Shipyard
Red	Leclaire, Maj. W. B.	Langley AFB
Green	Lee, Dana	NACA, Lewis

Color Group	Name	Affiliation
~~Gold~~	~~Leese, Capt. F. M.~~	Langley AFB
~~Brown~~	~~Lively, WOJG M.W.~~	~~Langley AFB~~
Tan	Logan, Maj. R. B.	Langley AFB
Blue	Lovewell, Comdr. H. D.	Hq., Fifth N. D.
Green	Lowe, Capt. J. G.	Langley AFB
Green	Lublin, A. M.	Norfolk
Gold	Lunney, E. J.	Wright-Patterson AFB
Green	Maas, Lt. C. P.	Langley AFB
Red	Mapp, R.	ADF, Wright-Patterson AFB
Gold	Martin, Capt. C. L.	Langley AFB
Blue	Martin, E. W.	Hampton, Va.
Red	Martin, Col. F. B.	U. S. Army, Richmond
Brown	Martinez, Capt. C. J.	Langley AFB
~~Tan~~	~~Maslowsky, Lt. M. W.~~	~~Langley AFB~~
Green	McBride, Lt. B. R.	Langley AFB
Blue	McClanahan, Capt. H. C.	ADF, Wright-Patterson AFB
Green	McLennan, M. A.	Wright-Patterson AFB
Red	McCord, Col. L. B.	Langley AFB
Gold	McGee, Capt. H. J.	Langley AFB
~~Green~~	~~McKay, Capt. A. L.~~	~~Langley~~ Liaison
Gold	Medici, Lt. J. J.	ADF, Wright-Patterson AFB
Red	Miller, E. W.	Hampton, Va.
~~Gold~~	~~Miller, Maj. W. E.~~	~~Langley AFB~~
Brown	Mills, Maj. F. N.	Langley AFB
Brown	Mitchell, Maj. R. W., Jr.	Langley AFB
Green	Modarelli, Jim	NACA - Lewis
~~Tan~~	~~Monroe, Capt. P. B., Jr.~~	~~Langley AFB~~
Blue	Monsted, Lt. Col. R. M.	Langley AFB
~~Brown~~	~~Moore, Capt. D. G.~~	~~Langley AFB~~
~~Gold~~	~~Moore, M/Sgt. W. J.~~	~~Langley AFB~~
Green	Morris, D. P.	NACA, Langley
Gold	Mulcahy, Burt	NACA, Lewis
Gold	Mykica, Lt. J. H.	Langley AFB
Green	Neyhard, Capt. A. L.	Langley AFB
Tan	North, Warren	NACA, Lewis
Blue	Oakes, Lt. Col. W. R. T.	Langley AFB
Blue	O'Hara, L. R.	President, PAC
Blue	Olson, W. T.	NACA, Lewis
Blue	Pawley, Comdr. L. P.	Norfolk Naval Shipyard
Green	Pedersen, Maj. E. K.	Fleet Marine Force LANT
Tan	Petersen, Capt. W. J.	Langley AFB
~~Green~~	~~Prade, Lt. Comdr. N. H.~~	~~Mine Depot, Yorktown,~~ Va.
Brown	Prado, Lt. I. L.	Langley AFB
~~Blue~~	~~Price, Lt. Col. G. B.~~	~~Langley AFB~~
Gold	Prochoroff, Capt. George	Langley AFB
Green	Puttkamer, Capt. Kenneth	Langley AFB

Color Group	Name	Affiliation
~~Blue~~	~~Raley, Maj. A. C.~~	~~Langley AFB~~
~~Green~~	~~Rattig, Lt. W. O.~~	~~Langley AFB~~
Blue	Reader, A. F.	NACA - Lewis
Green	Reynolds, Lt. Billy M.	Langley AFB
Gold	Reynolds, Lt. S. F.	Langley AFB
~~Brown~~	~~Rhoades, Capt. M. R.~~	~~Langley AFB~~
~~Tan~~	~~Rhoden, Lt. C. D.~~	~~Langley AFB~~
~~Tan~~	~~Rivenbark, Lt. T. H.~~	~~Langley AFB~~
Brown	Robbins, Maj. H. W.	ADF, Wright-Patterson AFB
~~Blue~~	~~Roberts, Lt. Col. G. S.~~	~~Langley AFB~~
~~Green~~	~~Roche, J. A.~~	~~Langley Liaison~~
~~Blue~~	~~Rogers, Maj. W. B.~~	~~Langley AFB~~
Gold	Rokke, Donald	Boeing Airplane Co.
~~Gold~~	~~Ryan, Lt. W. B.~~	~~Langley AFB~~
~~Red~~	~~Sampson, Lt. Col. R. D.~~	~~Langley AFB~~
Gold	Sanders, N. D.	NACA - Lewis
Tan	Sanderson, Capt. E. J.	Langley AFB
~~Brown~~	~~Sanford, Capt. M. B.~~	~~Langley AFB~~
Gold	Sanford, Lt. R. L.	Langley AFB
Gold	Schueller, C. F.	NACA - Lewis
~~Red~~ Green	Schulke, R. G.	NACA - Lewis
Brown	Sena, Lt. Col. J. M.	Langley AFB
~~Red~~	~~Serrett, George~~	~~Mgr., Hotel Chamberlin~~
Brown	Shinabarger, E.	ADF, Wright-Patterson AFB
Gold	Shrauger, Lt. G. W.	Langley AFB
Green	Shoemaker, Adm. J. M.	Norfolk
Gold	Siebenaler, Lt. Col. F. J.	Langley AFB
Gold	Skinner, Maj. John, Jr.	Fleet Marine Force Lant.
Tan	Sleeth, Capt. K. R.	Langley AFB
Brown	Slider, Capt. Harry	Langley AFB
Gold	Smith, Capt. C. A. A.	Langley AFB
~~Blue~~	~~Smith, Capt. M. S.~~	~~Langley AFB~~
Tan	Smith, Maj. W. B., Jr.	Langley AFB
Brown	Soultaire, WOJG W. G.	Langley AFB
Gold	Stanhope, Capt. J.	Langley AFB
Blue	Stewart, Maj. D. W., Jr.	Langley AFB
~~Green~~	~~Stinson, R. W.~~	~~Boeing Airplane Co.~~
Tan	Storts, Capt. G. E.	Langley AFB
Green	Storwick, E. M.	Boeing Airplane Co.
Tan	Stowe, Capt. J. M.	Langley AFB
~~Brown~~	~~Strange, Lt. G. H.~~	~~Langley AFB~~
~~Gold~~	~~Sumner, Capt. C.A.~~	~~Langley AFB~~
Tan	Szafranski, Capt. M. L.	Langley AFB
Tan	Terrel, M/Sgt. B. J.	Langley AFB
Red	Thomas, Maj. H. M.	Langley AFB
Gold	Thomas, Lt. J. C., Jr.	Langley AFB
Brown	Timmermans, Capt. H. L.	Langley AFB
Blue	Tregea, Maj. Ruth E.	Langley AFB
~~Brown~~	~~Trimble, Sgt. R. C.~~	~~Wright-Patterson AFB~~
Tan	Turner, Capt. L. P.	Langley AFB

Color Group	Name	Affiliation
Tan	Vaccaro, M. J.	NACA, Lewis
Brown	VanHorn, Capt. R. E.	Langley AFB
Red	VanLiew, Comdr. R. E.	Norfolk Naval Shipyard
Brown	Wakefield, Lt. B. P.	Mine Depot, Yorktown, Va.
Tan	Wallace, Capt. R. B., Jr.	Langley AFB
Blue	Walther, C. A.	Hampton, Va.
Blue	Wasielewski, E. W.	NACA, Lewis
~~Red~~	✓~~Watkins, Lt. Col. H. J.~~	~~Langley AFB~~
~~Brown~~	✓~~Webber, Capt. J. W.~~	~~Langley AFB~~
Brown	Whitmire, Capt. W. T.	Langley AFB
~~Red~~	✓~~Wight, Maj. C. H.~~	~~Langley AFB~~
~~Brown~~	✓~~Willcox, Lt. L. S.~~	~~Langley AFB~~
Tan	Winchester, Capt. C. W.	Langley AFB
Red	Winrick, W/O (jg) R. J.	Langley AFB
Green	Womack, Lt. James	Langley AFB
Red	Woodward, Lt. Col. E. F., Jr.	Langley AFB
Tan	Yeats, Capt. R. H.	Langley AFB
Brown	Young, Lt. W. W.	Langley AFB
Gold	Zarate, Lt. R. C.	Langley AFB

Langley Air Force Base, Va.
Date **May 24, 1951**

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116.2-64

From Langley
To ~~XXX~~ **Lewis**

Subject: **Transmittal of guest lists for 1951 Biennial Inspection**

Reference:

Please take the action indicated below:

A Advise status.
X B For your information, proper action, and files.
C For reply by your office.
D Forward (on loan) (for our files).
X E There (~~is~~) (are) transmitted herewith the following:
F Hold for further information.
G Copy of this letter enclosed with shipment.
H Advise whether order will be placed soon.
I Billing received. Submit purchase request and/or advise status.
J Information received indicates material shipped ____________. Advise if received and accepted.
K Two (2) copies of subject addendum. Copies forwarded all bidders.

Remarks:

Guest lists for 1951 Biennial Inspection at the Langley Laboratory - May 18, 22, and 23, 1951

W. Kemble Johnson
W. Kemble Johnson
Administrative Management Officer

jsr

DIRECTOR
Exec Off
Eng Plan
P & M
RES
Edit
Lib
F & C
C & T
M & T
E-R
Physics
S-P
Res Rpt
ADM
Clear Off
Pers
Fiscal
Adm. Serv
Proc
SERV
C & CA
Serv Sch
Saf & Sec
Mech Eng
Draft
Elec Eng
Fab
Mech Serv
Mech Oper
Contr Adm
Fac Eng
Plant Oper
Elec Oper

62203

NACA

1951 BIENNIAL INSPECTION

of the

LANGLEY AERONAUTICAL LABORATORY
LANGLEY FIELD, VIRGINIA

May 24, 1951

State Room	Name	Affiliation	Color Group
27	Aherne, Eugene	Civil Aeronautics Adm.	Brown
108	Aldrin, Edwin E	Atlas Supply Company	Blue
126	Alford, J.S.	General Electric Company	Tan
40	Arnold, E.K.	All-American Airways	Green
48	Ashley, Holt	M.I.T.	Red
24	Baird John W.	Civil Aeronautics Adm.	Red
36	Baker, John H.	Solar Aircraft Company	Brown
137	Barkey, Herman D.	McDonnell Aircraft Corp.	Tan
139	Barnett, C.A.	Kellett Aircraft Corp.	Green
L	Barrow, Dr. W.L.	Sperry Gyroscope Company	Gold
12	Bates, George P., Jr.	NACA Headquarters	Red
	✓~~Beams, Prof. Jesse W.~~	~~University of Virginia~~	~~Red~~
48	Beckley, Dr. L. E	M.I.T.	Red
	Bell, William H.	U. S. Steel Corp. Subsidiaries	~~Gold~~ Red
113	Berboth, N.	Calif. Eastern Airways	Green
~~131~~	✓~~Berkowitz, S.M.~~	~~Franklin Institute~~	~~Red~~
88	Bernardo, James	Civil Aeronautics Adm	Gold
102	Borges, Louis J	Civil Aeronautics Adm.	Brown
	Bowen, E.N.	Atomic Energy Commission	Tan
	Boyd, Hunter	Nat'l. Bureau of Standards	Tan
~~32~~	✓~~Boynton, F. W.~~	~~Reynolds Metals Company~~	~~Tan~~
32	Brandt, P.E.	Reynolds Metals Company	Tan
106	Brown, Mrs. M.F.	National Aeronautics Assn.	Brown
120	Brusca, J.L.	S K F Industries	Brown
121	Buracker, William H.	Jackson & Moreland	Green
3	Burkett, Mrs. Virginia	NACA Headquarters	Brown

State Room	Name	Affiliation	Color Group
125	Cahill, Martin B.	Northwest Airlines, Inc.	Green
	Carr, Dr. A. R.	Wayne University	Red
117	Chilton, Dr. Thos. H.	E. I. du Pont de Nemours & Co.	Blue
107	Cotton, Robert B.	All American Airways, Inc.	Green
	Craver, J. K.	Monsanto Chemical Co.	Brown
117	Creelman, G. D.	M. A. Hanna Co.	Brown
~~43~~	~~Cudhea, G.~~	~~Kaiser Metal Products, Inc.~~	~~Brown~~ Tan
92	Curry, R. B.	Applied Physics Laboratory	Red
140	Cushman, M. E.	Curtiss-Wright Propeller Div.	Tan
H	Dandrow, C. G.	Johns Manville Sales Corp.	Blue
G	Davidson, Joseph	Public Relations Counselor	Blue
124	Davidson, Dr. K.S.M.	Stevens Inst. of Technology	Red
	Davis, W.	Babcock & Wilcox Tube Co.	Gold
88	Davis, William B.	Civil Aeronautics Adm.	Gold
51	Dean, Hazen	NACA Headquarters	Gold
	~~Deeds, Chas. W.~~		~~Blue~~
114	DeNyse, T. L.	Western Electric Co., Inc.	Green
129	Desmond, E. A.	Ethyl Corporation	Green
F	Dexter, Robert R.	Institute of the Aero. Sciences	Blue
103	Disler, Maurice	Civil Aeronautics Adm.	Red
107	Doolittle, D. B.	All-American Airways, Inc.	Green
I	Drake, Howard	Washington Board of Trade	Blue
	Driggers, W. A.	Aircraft Development Co.	Tan
B	Driscoll, Harmon	Rockefeller Bros., Inc.	Blue
31	DuBois, Prof. G. B.	Cornell University	Red
106	Dugan, Mrs. F. F.	National Aeronautic Assn.	Brown
~~N~~	~~Dutton, Dr. D. W.~~	~~Georgia Inst. of Technology~~	~~Brown~~ Tan
122	DuVal, Herbert, Jr.	Airborne Instruments Lab.,Inc.	Gold
	Eichleay, J. W.	Babcock & Wilcox Tube Co.	~~Tan~~ Green
135	Eickmann, E. M.	Goodyear Tire & Rubber Co.	Brown
108	Ellis, R. E.	Standard Oil Company	Blue
	~~English, J. B.~~	~~Reynolds Metals Company~~	~~Gold~~
76	Erdoss, Prof. B. K.	Stevens Inst. of Technology	Red
128	Eustis, R.	Thermal Res. and Eng'g. Corp.	Tan

State Room	Name	Affiliation	Color Group
103	Fales, Elisha N.	Civil Aeronautics Assn.	Green
T	Fenske, Dr. M.R.	Pennsylvania State College	Red
	Fitzgerald, Mr.		Green
	~~Flinsch, Dean Harold~~	~~Mississippi State College~~	~~Red~~
110	Fortner, Prof. M.J	Alabama Polytechnic Institute	Red
	Frankhouser, W.	Babcock & Wilcox Tube Co.	~~Brown~~ Tan
~~13~~	~~Frazer, C.D.~~	~~National Air Council~~	~~Blue~~
90	Freeman, Dr. J.W.	University of Michigan	Gold
	Fritzlen, T.L.	Reynolds Metals Company	Gold
~~Q~~	~~Gagg, R.F.~~	~~Air Associates, Inc.~~	~~Gold~~
	Gamson, Dr. B.W	Great Lakes Carbon Corp.	Gold
	~~Gelly, George B.~~	~~Douglas Aircraft Company~~	~~Gold~~
	Gerard, G.	New York University	Red
116	Glodeck, Edward	Research & Development Bd.	Green
	Golladay, Arthur Derr	Golladay Aeronautical Lab.	Brown
105	Goodwin, R.P.	Aluminum Co. of America	Tan
138	Guerke, Ralph M	Curtiss-Wright Propeller	Gold
~~119~~	~~Hadley, Jesse M.~~	~~Bendix Aviation Corp.~~	~~Blue~~
76	Halfman, Prof. R.L.	M.I.T.	Red
	~~Hallam, George W.~~	~~Minneapolis-Honeywell~~	~~Tan~~
59	Hammill, Irving J.	Walter Kidde & Company	Gold
	Handy, Jamison	Jam Handy Organization	Blue
	Harcum, William M.		Tan
35	Harrington, Prof. Paul	R.P.I	Red
D	Harris, J.S	Shell Oil Company, Inc	Green
	~~Harter, I., Jr.~~	~~Babcock & Wilcox Tube Co.~~	~~Tan~~
104	Hatch, E. Franklin	Solar Aircraft Company	Brown
	Hayes, Robert E.	Jam Handy Organization	Blue
S	Hazeltine, Lt. Col. C.B.	Joint Chiefs of Staff	Blue
123	Heigis, H.E.	Walter Kidde & Company	Tan
127	Henshaw, R.C.	Lord Manufacturing Company	Gold
115	Herd, R.G.	General Electric Company	Tan
111	Hinmon, Don L.	Johns Manville Sales Corp	Tan
123	Hobelmann, A H.	Walter Kidde & Company	Gold
24	Hook, W. Byron	Civil Aeronautics Adm.	Red
124	Hugli, Dr. W.C., Jr.	Stevens Inst. of Technology	Red
	Hummel, Fred E.	Division of Aeronautics Commonwealth of Virginia	Green

State Room	Name	Affiliation	Color Group
132	Jaklitsch, J. J., Jr.	American Soc. of Auto. Eng'rs.	Gold
20	Jarrell, Wm. W., Jr.	Civil Aeronautics Adm.	Brown
111	Jobe, John B.	Johns Manville Sales Corp.	Tan
D	Johnson, C. R.	Shell Oil Co., Inc.	Green
128	Johnson, J. A.	Thermal Res. and Eng'g. Corp.	Tan
114	Johnson, W. B.	Lear, Inc.	Green
4	Johnston, Mrs. A.M.	NACA Headquarters	Brown
36	Johnston, Dr. H. L.	Ohio State University	Red
~~78~~	✓~~Jones, B. F.~~	~~B. F. Goodrich Co.~~	~~Tan~~
A	Jones, Dr. C. S.	Casey Jones School of Aero.	Blue
	Jones, Cdr. R. C.	Office, Chief of Naval Opera.	Blue
8	Kauffman, W. M.	NACA Headquarters	Tan
129	Kerley, Robert V.	Ethyl Corporation	Green
43	Kincaid, A. E.	Owens-Corning Fiberglas Corp.	Brown
28	King, Dr. Barry G.	Civil Aeronautics Adm.	Gold
104	Klauber, P. M.	Solar Aircraft Co.	Brown
105	Kraft, Ned O.	Aluminum Co. of America	Tan
9	Krebs, Chas. V.	NACA Headquarters	Green
133	Lamm, R. A.	National Bureau of Standards	Gold
122	Lathbury, B. K.	S K F Industries	Gold
O	Latimer, J. Austin	U. S. Senate	Blue
5	Lazar, James	NACA Headquarters	Brown
19	Leaphart, M. W.	Civil Aeronautics Adm.	Green
73	Lederer, Jerome	Flight Safety Foundation, Inc.	Gold
M	Legatski, Ted W.	Phillips Petroleum Co.	Green
44	Lessen, Martin	Penna. State College	Red
	Locke, Prof. A. A.	Wayne University	Red
	✓~~Loening, Grover~~	~~Aircraft Consultant~~	~~Blue~~
K	Lord, Thomas	Lord Manufacturing Co.	Blue
Q	Love, R. M.	All-American Airways, Inc.	Green
28	Lovelace, W. T.	Civil Aeronautics Adm.	Brown
1	Luckritz, Miss B. K.	NACA Headquarters	Brown
	Maas, Brig. Gen. M. J.	Office, Sec'y. of Defense	Blue

State Room	Name	Affiliation	Color Group
	McDonnell, J. S.	McDonnell Aircraft Company	Blue
109	McMullen, Col. A. B.	Nat'l. Assoc. of State Aviation Officials	Blue
47	Magee, S L.	U. S. Steel Subsidiaries	Brown
	Maloney, Phillip R.	University of Texas	Brown
	Maloney, Ruth W.	University of Texas	Brown
23	Marsh, Edward C.	Civil Aeronautics Adm.	Tan
	Martin, Samuel W.	Great Lakes Carbon Corp.	Gold
N	Mason, Dr. J. W.	Georgia Inst. of Techology	Brown
23	Matulaitis, Joseph	Civil Aeronautics Adm.	Tan
6	May, Ralph W.	NACA Headquarters	Tan
7	Mecutchen, E. T.	NACA Headquarters	Gold
59	Mellen, E. R.	Weston Electrical Inst. Corp.	Gold
138	Mergen, J. M.	Curtiss-Wright Propeller Corp.	Gold
	Michel, P. L.	North Carolina State College	Red
T	Miller, F. L.	Standard Oil Company	Green
~~11~~	~~Murphy, Maurice F.~~	~~NACA Headquarters~~	~~Gold~~
	Neale, O. A.	Babcock & Wilcox Tube Co.	Tan
10	Neill, T. T.	NACA Headquarters	Red
	Newell, H. D.	Babcock & Wilcox Tube Co	~~Brown~~ Tan
118	Newton, W S.	Metallurgical Res. & Dev Co.	Gold
6	Niewald, Roy J.	NACA Headquarters	Gold
	Noxon, Paul A.	Eclipse-Pioneer Div., Bendix Aviation Corp.	Green
132	O'Brien, Robert A.	American Society of Mechanical Engineers	Gold
31	Ocvirk, Prof. Fred	Cornell University	Red
	Ogden, F. F.	Monsanto Chemical Co.	Brown
O	Overby, Edward J.	Department of Agriculture	Blue

State Room	Name	Affiliation	Color Group
115	Paine, John P.	Aircraft Armaments, Inc.	Tan
10	Palmer, C. B.	NACA Headquarters	Red
~~77~~	✓~~Parks, M. J.~~	~~Air Associates, Inc.~~	~~Gold~~
	Pearson, Rear Adm. J.B.	Office, Chief of Naval Ops.	Blue
	Pengelley, C. D.	Southwest Research Institute	Brown
1	Percival, Miss P. E.	NACA Headquarters	Brown
35	Perkins, Prof. C. D.	Princeton University	Red
	Pilling, N. B.	International Nickel Co.	Green
110	Pitts, Prof. R. G.	Alabama Polytechnic Institute	Red
	✓~~Poteet, Fred G.~~	~~Va. State Dept. of Education~~	~~Tan~~
I	Press, Col. Wm. H.	Washington Board of Trade	Blue
	Prewitt, Richard H.	Prewitt Aircraft Co.	Gold
S	Purvis, Capt. R.S., USN	Joint Chiefs of Staff	Blue
	Quinsey, W. E.	University of Michigan	Red
137	Ramey, M. L.	McDonnell Aircraft Corp.	Tan
	Ratcliffe, T. W.	Babcock & Wilcox Tube Co.	Gold
13	Ray, J. G.	Ray and Ray	Blue
F	Raymond, Col. C. S.	National Production Agency	Green
	✓~~Reynolds, J. Louis~~	~~Reynolds Metals Co.~~	~~Tan~~
135	Richardson, R. W.	Goodyear Tire & Rubber Co.	Brown
51	Ricks, Hubert M.	Weston Elec. Instrument Corp.	Gold
	✓~~Rooney, J. H.~~	~~U. S. Steel Corp. Subsidiaries~~	~~Gold~~
P	Rothrock, A. M.	NACA Headquarters	Green
	✓~~Ryan, W. V.~~	~~Stewart-Warner Corp.~~	~~Gold~~
J	Saint, Samuel	Air Transport Assn.	Blue
80	Sartore, S. R.	McDonnell Aircraft Corp.	Tan
44	Sauer, John A.	Penna. State College	Red
	✓~~Schaaf, S. A.~~	~~University of California~~	~~Red~~
80	Schippel, H. F.	B. F. Goodrich Company	Tan
139	Schneck, C. E.	Kellett Aircraft	Tan
78	Seaton, J. H.	B. F. Goodrich Co.	Tan
52	Seidman, Oscar	Navy Bureau of Aeronautics	Brown
~~77~~	✓~~Sereno, C. A.~~	~~Air Associates, Inc.~~	~~Gold~~
	Shattuck, H. F.	Monsanto Chemical Co.	Brown
119	Shepherd, J. R.	Westinghouse Electric Corp.	Green
112	Sherling, Prof. W. G.	Alabama Polytechnic Inst.	Red
R	Simpson, T. P.	Socony-Vacuum Oil Co, Inc.	Green

State Room	Name	Affiliation	Color Group
E	Smith, Beauchamp E.	S Morgan Smith Company	Blue
~~126~~	✓~~Smith, Dr. G. P.~~	~~Corning Glass Works~~	~~Gold~~
	✓~~Smith, W. Donald~~	~~Golladay Aeronautical Lab.~~	~~Brown~~ Tan
47	Smoot, E. L.	U.S. Steel Corp. Subsidiaries	Brown
109	Snow, Crocker	Nat'l. Assn. of State Aviation Officials	Blue
R	Snyder, G.H.S.	Socony-Vacuum Oil Co.	Green
~~143~~	✓~~Snyder, Prof. M., Jr.~~	~~University of Wichita~~	~~Red~~
130	Soller, Walter	University of Cincinnati	Red
20	South, George E.	✓Civil Aeronautics Adm.	Brown
E	Sperry, Elmer A., Jr.		Blue
	Stevens, Robert T.	J. P. Stevens & Co.	Blue
102	Stevenson, David B	Civil Aeronautics Adm.	Brown
142	Stifel, David	Calif. Eastern Airways	Green
134	Stinson, Miss Katherine	Civil Aeronautics Adm.	Brown
	Styri, Dr. Haakon	S K F Industries	Gold
	✓~~Swicegood, Dewey~~	~~Division of Aeronautics~~ Commonwealth of Virginia	~~Tan~~
	Sylvander, R.C.	Bendix Aviation Corporation	Green
~~131~~	✓~~Tabor, Lewis P.~~	~~Franklin Institute~~	~~Red~~
71	Tatnall, Francis G	Baldwin Locomotive Works	Green
118	Taylor, Maurice E	Metallurgical Res. & Dev. Co.	Gold
40	Theodorides, Dr. Phrixos	Harvard University	Red
J	Thompson, C.C.	Airport Council	Blue
121	Thompson, Dr. R.J., Jr.	M.W Kellogg Company	Tan
	✓~~Tifford, Prof. Arthur~~	~~Ohio State University~~	~~Red~~
M	Trimble, Harold M.	Phillips Petroleum Co.	Green
127	Tubb, George E.	Lord Manufacturing Co.	Gold
A	Turner, Col. Roscoe	Turner Airlines Corp.	Blue
143	Turner, Dr. Howard	Pittsburgh Consolidated Coal Co.	Green
5	Ullman, Guy N.	NACA Headquarters	Brown
60	Victory, John F	NACA Headquarters	Blue
	✓~~Von Eschen, Dr G. L.~~	~~Ohio State University~~	~~Red~~

State Room	Name	Affiliation	Color Group
27	Wallsten, A. W.	Civil Aeronautics Adm.	Tan
	~~Ward, J. Carlton, Jr.~~		~~Blue~~
2	Ward, Miss Mateel A.	NACA Headquarters	Brown
71	Warden, H. H.	Curtiss-Wright Corp.	Gold
39	Washburn, S. H.	Bell Telephone Labs.	Green
	Weldon, Joseph M.	International Nickel Co.	Green
19	Welling, Omer	Civil Aeronautics Adm.	Green
120	Wellons, F. W.	S K F Industries	Brown
130	Wells, Dr. H. W.	Carnegie Inst. of Washington	Tan
2	Wheeler, Catherine	NACA Headquarters	Brown
	~~White, Dr. A. E.~~	~~University of Michigan~~	~~Red~~
	White, Walter	Department of Commerce	Blue
P	White, W. W.	Esso Export Corp.	Green
133	Wildhack, W. A.	National Bureau of Standards	Tan
39	Willets, H. N.	Western Electric Co.	Green
112	Williams, Prof. M. O.	Alabama Polytechnic Institute	Red
113	Williamson, C. G.	California Eastern Airways	Green
36	Woodham, R. M.	Guggenheim Avia. Safety Center	Tan
9	Woodward, W. H.	NACA Headquarters	Tan
140	Woolf, D. R.	Curtiss-Wright Propeller Div.	Tan
141	Wunner, G. W.	Curtiss-Wright Propeller Div.	Tan
	Young, Edwin C.	University of Texas	Brown
52	Zakhartchenko, C. L.	National Bureau of Standards	Gold
K	Zand, S. J.	Lord Manufacturing Co.	Blue
125	Zeek, Elwood	Walter Kidde & Co., Inc.	Tan

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS 62203

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Additional Guests Approved by Director

May 24, 1951

Color Group	Name	Affiliation
Tan	Bauserman, C. R.	University of Virginia
Gold	Brown, R. A.	University of Virginia
Blue	Dalton, Grady W.	Va. Advisory Comm. on Aviation
Red	Eldridge, J. W.	University of Virginia
Tan	Gamble, H. W.	University of Virginia
Tan	Gantt, Wyatt	University of Virginia
Gold	Gowin, Hamilton B.	Civil Aeronautics Adm.
Red	Hayes, A. W.	Cornell University
Blue	Jordan, Lt.(jg) W. E.	NARTU, Anacostia
Red	Killoren, Robert A.	Parks College, St. Louis Univ.
Tan	Kirby, R. H.	University of Virginia
Gold	Lebsack, A. J.	University of Virginia
Gold	Marshall, E. S.	University of Virginia
Tan	Marshall, W. T.	University of Virginia
Red	May, J. E.	University of Virginia
Red	Morse, Prof. F. T.	University of Virginia
Red	Poehle, Herbert F.	University of Michigan
Blue	Powell, R. D.	University of Virginia
Blue	Reid, H. J.	Capitor Airlines
Blue	Robertson, P. H.	University of Virginia
Tan	Stephens, C. C.	University of Virginia
Blue	Winsbro, W. R.	University of Virginia

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Guest List

1951 Biennial Inspection
NACA Laboratories
Langley Field, Virginia

May 24, 1951

Color Group	Name	Affiliation
Red	Beckett, Maj. W. P.	Langley Liaison
Brown	Belle, R. T.	NACA - Langley
Green	Birch, L. T.	NACA - Langley
Brown	Bloch, Freda N.	NACA - Langley
Brown	Briel, Lucy	NACA - Langley
Red	Cannon, Mrs. J. F.	Langley AFB
Red	Chapman, Col. W. F.	Langley AFB
Red	Chapman, Mrs. W. F.	Langley AFB
Brown	Coulson, C. Jane	NACA - Langley
Gold	Dellinger, D.	Minneapolis-Honeywell
Blue	Fenner, J. J.	NACA - Wallops
Brown	Gilman, Elizabeth R.	NACA - Langley
~~Green~~	~~Hallett, R. L., Jr.~~	~~NACA - Wallops~~
Gold	Helton, E. H.	NACA - Wallops
Blue	Hulcher, C. A.	NACA - Langley
Green	Krieger, R. L.	NACA - Wallops
Gold	Lawson, G. W.	General Electric
Tan	Levy, Isadore	NACA - Wallops
Green	McKay, Capt. A. L.	Langley Liaison
Tan	Palmer, J. C.	NACA - Wallops
Brown	Rapp, Betty J. A.	NACA - Langley
~~Blue~~	~~Ridley, K. F.~~	~~Kaiser Metal Products~~
Blue	Roche, J. A.	Langley Liaison

Color Group	Name	Affiliation
~~Gold~~	~~Scholt, R. S.~~	~~NACA - Langley~~
Tan	Spinak, A. D.	NACA - Wallops
Brown	Wiseman, Annie B.	NACA - Langley
Brown	Young, Ida	NACA - Langley

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Guest List

1951 Biennial Inspection
NACA Laboratories
Langley Field, Virginia

May 25, 1951

Color Group	Name	Affiliation
~~Brown~~	~~Alford, John~~	~~NACA - Langley~~
Green	Ammon, Capt. R. H.	AF Inst. of Technology
Gold	Anderson, Lt. Col. H.	AF Inst. of Technology
Brown	Anderson, Capt. J. J.	AF Inst. of Technology
~~Brown~~	~~Apt, Lt. M. G.~~	~~AF Inst. of Technology~~
~~Tan~~	~~Archambault, R. G.~~	~~Georgia Tech.~~
Red	Archer, Capt. R. J.	Staff College, Norfolk
Tan	Badgett, Cadet C. S., III	VMI
Green	Baird, Lt. Comdr. W. D.	NATC, Patuxent, Md.
Brown	Baker, Capt. E. E.	AF Inst. of Technology
Gold	Bardshar, Comdr. F. A.	NATC, Patuxent, Md.
~~Green~~	~~Barila, Lt. D. B.~~	~~NATC, Patuxent, Md.~~
Gold	Barton, Lt. F. C.	NATC, Patuxent, Md.
Brown	Bascom, Lt. W. R.	NATC, Patuxent, Md.
Tan	Baxter, Lt. W. D.	AF Inst. of Technology
~~Gold~~	~~Bayers, Comdr. E. H.~~	~~NATC, Patuxent, Md.~~
~~Gold~~	~~Beaver, Lt. Comdr. R. H.~~	~~NATC, Patuxent, Md.~~
~~Red~~	~~Beckett, Maj. W. R.~~	~~Langley Liaison~~
Blue	Bell, Comdr. C. E., Jr.	Staff College, Norfolk
Brown	Bennett, Capt. W. D.	AF Inst. of Technology
Gold	Bennett, Lt. W. L.	NATC, Patuxent, Md.
Green	Benoy, Capt. H. H.	AF Inst. of Technology
~~Red~~	~~Berk, Comdr. H. R.~~	~~NATC, Patuxent, Md.~~
Brown	Biles, Capt. H. K.	AF Inst. of Technology
Tan	Blake, Capt. R. J.	AF Inst. of Technology
Green	Blue, Maj. E. A.	AF Inst. of Technology
~~Red~~	~~Bosee, Comdr. R. A.~~	~~NATC, Patuxent, Md.~~
Tan	Brendza, E. L.	North American Aviation
Green	Bright, Capt. R. P.	AF Inst. of Technology
Red	Brown, Col. J. K.	National War College
Red	Brown, Capt. W. P., Jr.	NATC, Patuxent, Md.
Tan	Brummer, Mr.	American Tobacco Co.
Tan	Buchanan, Lt. R. S.	AF Inst. of Technology
Blue	Busemann, A.	NACA - Langley
Tan	Cagna, B. A.	MIT
Brown	Carey, A.	NATC, Patuxent, Md.
Blue	Carr, Lt. Comdr. D. E.	NATC, Patuxent, Md.
~~Blue~~	~~Carson, A. B.~~	~~USAFIT, Wright-Patterson~~
~~Blue~~	~~Ceneebaugh, Lt. Comdr. T. K.~~	~~NATC, Patuxent, Md.~~
~~Red~~	~~Chapman, Col. W. F.~~	~~C.O., Langley AFB~~

Color Group	Name	Affiliation
Brown	Chase, Lt. N. B.	AF Institute of Technology
Gold	Chatfield, Lt. J. D. L.	AF Institute of Technology
Blue	Chin, C.	University of Rhode Island
Green	Ciulis, Lt. (jg) E.	NATC, Patuxent, Md.
Red	Coley, Comdr. V. J., Jr.	NATC, Patuxent, Md.
Blue	Conner, Lt. Comdr. A. B.	NATC, Patuxent, Md.
Brown	Coutant, N. J.	NATC, Patuxent, Md.
Gold	Cox, Lt. (jg) J. W.	NATC, Patuxent, Md.
Tan	Craven, Cadet J. H., Jr.	VMI
~~Brown~~	~~Crawford, Lt. F. S.~~	~~NATC, Patuxent, Md.~~
~~Red~~	~~Cross, Capt. G.~~	~~NATC, Patuxent, Md.~~
~~Gold~~	~~Crotwell, Lt. L. L.~~	~~NATC, Patuxent, Md.~~
Tan	Cure, Cadet J. W.	VMI
~~Brown~~	~~Dallow, T.~~	~~NATC, Patuxent, Md.~~
Blue	Davis, Comdr. E. W.	Ind. College, Washington
Red	Davis, Col. L. I.	Commandant, USAFIT
Red	Day, Capt. C. N.	Staff College, Norfolk
Brown	D'Azzo, J. J.	USAFIT, Wright-Patterson
~~Blue~~	~~DeCrescente, C.~~	~~NATC, Patuxent, Md.~~
~~Gold~~	~~DeLalio, Lt. Col. A. H.~~	~~NATC, Patuxent, Md.~~
Blue	Diehl, Col. D. B.	Ind. College, Washington
~~Brown~~	~~Dommasch, D. O.~~	~~NATC, Patuxent, Md.~~
Green	Doner, J.	NATC, Patuxent, Md.
~~Gold~~	~~Dooley, Lt. R. J.~~	~~NATC, Patuxent, Md.~~
Tan	Duncan, E.	NATC, Patuxent, Md.
~~Brown~~	~~Durup, Lt. P.~~	~~NATC, Patuxent, Md.~~
Blue	England, Lt. Col. S. P.	Headquarters, Air University
Blue	Erickson, Comdr. F. A.	NATC, Patuxent, Md.
~~Green~~	~~Evans, Lt. Comdr. H., Jr.~~	~~NATC, Patuxent, Md.~~
~~Blue~~	~~Ferri, A.~~	~~NACA, Langley~~
Tan	Fetty, Lt. R. L.	AF Inst. of Technology
Tan	Fink, M. R.	MIT
Brown	Fitzpatrick, D.	NATC, Patuxent, Md.
Red	Fowler, Capt. R. B.	AF Inst. of Technology
Blue	Frisbee, Lt. Col. J. L.	USMA, West Point
~~Red~~	~~Gaboury, Comdr. W. D.~~	~~NATC, Patuxent, Md.~~
Tan	Galt, Lt. R. R.	AF Inst. of Technology
~~Tan~~	~~Garofalo, Lt. (jg) R. C.~~	~~NATC, Patuxent, Md.~~
Blue	Garrett, Capt. E. T.	USAFIT, Wright-Patterson
Green	Garrett, Maj. T. S., III	AF Inst. of Technology
Red	Gartsu, G.	NATC, Patuxent, Md.
Gold	Gates, Capt. T. M.	AF Inst. of Technology
Blue	Glasgow, R. S.	USN Postgraduate School
Tan	Goodloe, Cadet T. W., Jr.	VMI
Brown	Gould, Lt. A. H.	AF Inst. of Technology
Green	Grandmaison, R. A.	General Electric

Color Group	Name	Affiliation
Gold	Graule, Capt. E. G.	AF Inst. of Technology
Tan	Greenwood, Capt. L. P.	AF Inst. of Technology
Green	Grove, Maj. J. C.	AF Inst. of Technology
Tan	Hagen, Maj. A. D.	AF Inst. of Technology
Tan	Harris, Maj. T. G.	Hq., Air University
Gold	Harris, Maj. W. F.	AF Inst. of Technology
~~Green~~	~~Harrison, Comdr. H. W.~~	~~NATC, Patuxent, Md.~~
Gold	Harward, Lt. P. S.	NATC, Patuxent, Md.
~~Brown~~	~~Heacox, Lt. W. J.~~	NATC, Patuxent, Md.
Green	Hepburn, Lt.(jg) W. J.	NATC, Patuxent, Md.
~~Tan~~	~~Hesse, W. J.~~	~~NATC, Patuxent, Md.~~
Red	Higgins, G. J.	USN Postgraduate School
Brown	Hilovsky, Lt. S. E.	AF Inst. of Technology
Green	Hood, Capt. G. M.	AF Inst. of Technology
Blue	Hoover, R. A.	NATC, Patuxent, Md.
~~Gold~~	~~Horsman, Lt. H. M.~~	~~NATC, Patuxent, Md.~~
~~Brown~~	~~Housel, R. P.~~	~~NATC, Patuxent, Md.~~
Gold	Howard, Capt. H. C.	AF Inst. of Technology
~~Green~~	~~Howe, Lt. A. W., III~~	~~NATC, Patuxent, Md.~~
Green	Howell, Capt. H. H., Jr.	AF Inst. of Technology
Gold	Hucy, Lt. J. W.	AF Inst. of Technology
Green	Hull, Lt. Col. A. R.	AF Inst. of Technology
Red	Jensen, Maj. R. S.	AF Inst. of Technology
Green	Jobanek, Lt. Col. W. L.	AF Inst. of Technology
~~Brown~~	~~Johns, Lt. Comdr. R. L.~~	~~NATC, Patuxent, Md.~~
~~Green~~	~~Johnson, Lt. M. O., Jr.~~	~~AF Inst. of Technology~~
~~Gold~~	~~Johnson, Comdr. N. D.~~	~~NATC, Patuxent, Md.~~
Gold	Johnston, Lt. F. A.	AF Inst. of Technology
Blue	Johnston, Comdr. R. K.	NATC, Patuxent, Md.
~~Tan~~	~~Jones, D. D.~~	~~Georgia Tech.~~
Green	Junghans, Capt. E. A.	Staff College, Norfolk
Green	Kahr, C. H., Jr.	USN Postgraduate School
~~Red~~	~~Kenney, Gen. G. C.~~	~~Hq., Air University~~
Gold	Kieffer, Lt. R. W.	NATC, Patuxent, Md.
~~Red~~	~~Kilburg, R. F.~~	~~Georgia Tech.~~
Blue	Kimball, K. D.	General Electric
Green	King, Capt. L. R.	AF Inst. of Technology
Red	Kirchner, O. E.	American Airlines, Inc.
~~Tan~~	~~Kirkpatrick, Lt. H. J.~~	~~NATC, Patuxent, Md.~~
Brown	Kleff, Lt. Col. P. A.	Ind. College, Wash. D.C.
Gold	Kline, P.	NATC, Patuxent, Md.
Gold	Knoche, Lt. Comdr. E. J.	NATC, Patuxent, Md.
Brown	Kohler, H. L.	USN Postgraduate School
Green	Koontz, Capt. O. L.	AF Inst. of Technology
~~Red~~	~~Kotcher, Ezra~~	~~Director, USAFIT~~
~~Tan~~	~~Lamache, A.~~	~~NATC, Patuxent, Md.~~
Brown	Lamprecht, Lt. Richard	AF Inst. of Technology

Color Group	Name	Affiliation
Green	Lanham, Comdr. H. P.	NATC, Patuxent, Md.
Green	Larkin, Lt. (jg) J. C., Jr.	NATC, Patuxent, Md.
~~Blue~~	~~LaRocca, Lt. Col. G. A.~~	~~AF Inst. of Technology~~
Red	Latham, Maj. W. R., Jr.	AF Inst. of Technology
Tan	Latimer, Capt. C. B.	AF Inst. of Technology
Brown	Learmonth, Lt. A. F.	AF Inst. of Technology
Brown	Lee, Comdr. E. S., Jr.	USN Postgraduate School
Tan	Leese, Charles	USAFIT, Wright-Patterson
~~Brown~~	~~Lewis, Capt. C. H.~~	~~USAFIT, Wright-Patterson~~
Green	Limmer, T. H.	NATC, Patuxent, Md.
Blue	Lingemann, W. L.	Allison Div. of Gen. Motors
Gold	Linnekin, Lt. R. B.	NATC, Patuxent, Md.
~~Gold~~	~~Little, Lt. J.~~	~~NATC, Patuxent, Md.~~
Blue	Little, Maj. W. E.	AF Inst. of Technology
Brown	Long, Lt. Col. R. F.	AF Inst. of Technology
Green	Lovegrove, Lt. H. C.	NATC, Patuxent, Md.
Red	Luckett, Col. J. S.	Headquarters, Air University
Tan	Lytle, Capt. W. J.	NATC, Patuxent, Md.
Tan	McCrary, Lt. S. W.	NATC, Patuxent, Md.
~~Green~~	~~McKay, Capt. A. L.~~	~~Langley Liaison~~
Blue	MacCartney, Lt. G.	AF Inst. of Technology
~~Red~~	~~Mahler, Capt. Joseph~~	~~USAFIT, Wright-Patterson~~
Blue	Major, Capt. S. T.	AF Inst. of Technology
Red	Mangum, R. E.	NATC, Patuxent, Md
Red	Manley, Maj. T. M.	USAFIT, Wright-Patterson
Brown	Marx, J.	NATC, Patuxent, Md.
~~Tan~~	~~Maurer, Lt. Comdr. T. E.~~	~~NATC, Patuxent, Md.~~
Blue	Mays, Lt. Col. I. K.	AF Inst. of Technology
~~Tan~~	~~Mazur, J.~~	~~NATC, Patuxent, Md.~~
Gold	Melucas, Capt. P. J.	AF Inst. of Technology
~~Gold~~	~~Moe, Capt. W. S., Jr.~~	~~AF Inst. of Technology~~
~~Green~~	~~Monroe, D.~~	~~NATC, Patuxent, Md.~~
Tan	Moody, T.	NATC, Patuxent, Md.
Blue	Moranville, Capt. B. H.	AF Inst. of Technology
Blue	Morris, Lt. J. D. M.	AF Inst. of Technology
Gold	Morris, Lt. R. L.	NATC, Patuxent, Md.
~~Tan~~	~~Muehe, Lt. C. C.~~	~~NATC, Patuxent, Md.~~
Gold	Murphy, Maj. P. C.	AF Inst. of Technology
~~Red~~	~~Naughton, T. C.~~	~~Georgia Tech.~~
~~Blue~~	~~Nehf, Maj. A. N.~~	~~NATC, Patuxent, Md.~~
Tan	Nelson, Capt. C. E.	AF Inst. of Technology
Blue	Nelson, Lt. Col. R. E.	AF Inst. of Technology
~~Brown~~	~~Ness, A.~~	~~NATC, Patuxent, Md.~~
~~Tan~~	~~Nial, J.~~	~~NATC, Patuxent, Md.~~
Gold	Nicholson, Capt. T. M.	USMA, West Point
Red	Null, C. R.	NATC, Patuxent, Md.
Gold	Page, Capt. C. G.	AF Inst. of Technology
Tan	Papadopoulos, J. G.	MIT

Color Group	Name	Affiliation
~~Green~~	~~Paradis, J.~~	~~NATC, Patuxent,~~ Md.
Tan	Parkins, Capt. C. C.	VMI
Tan	Paschall, Lt. J. E.	AF Inst. of Technology
Brown	Patch, Lt. A. E.	NATC, Patuxent, Md.
~~Tan~~	~~Patzig, H.~~	~~NATC, Patuxent,~~ Md.
Red	Penick, Capt. E. S., Jr.	AF Inst. of Technology
Blue	Perkins, Capt. F. H.	AF Inst. of Technology
~~Red~~	~~Perkins, T. M.~~	~~Georgia Tech.~~
Tan	Perry, Lt. D. C.	AF Inst. of Technology
~~Green~~	~~Peterson, Lt. H. W.~~	~~NATC, Patuxent, Md.~~
Red	Peterson, Maj. L. L.	AF Inst. of Technology
Red	Pollock, Comdr. A. D.	NATC, Patuxent, Md.
Red	Porter, Maj. F. S., Jr.	AF Inst. of Technology
Blue	Prahl, Capt. V. E.	AF Inst. of Technology
~~Gold~~	~~Provost, Comdr. T. C.~~	~~NATC, Patuxent, Md.~~
Brown	Quail, Lt. D. E.	AF Inst. of Technology
~~Tan~~	~~Quinlan, W.~~	~~NATC, Patuxent, Md.~~
Blue	Rich, Lt. R. C.	NATC, Patuxent, Md.
Brown	Richards, Lt. M. R.	AF Inst. of Technology
Red	Richardson, Maj. J. C.	NATC, Patuxent, Md.
~~Red~~	~~Robinson, Lt. B.~~	~~NATC, Patuxent,~~ Md.
~~Blue~~	~~Roché, J. A.~~	~~Langley Liaison~~
Gold	Rooten, Capt. Albert	AF Inst. of Technology
Brown	Rootmayer, E.	USN Postgraduate School
Gold	Ryan, Col. W. F.	HQ., Air University
Blue	Sanford, T. W., Jr.	NATC, Patuxent, Md.
~~Gold~~	~~Sayer, R. B.~~	~~Georgia Tech.~~
Tan	Schaffer, Maj. G. J.	AF Inst. of Technology
Green	Schneider, Capt. D. B.	AF Inst. of Technology
~~Brown~~	~~Schoech, H.~~	~~NATC, Patuxent, Md.~~
Gold	Schwartz, Col. Philip	Staff College, Norfolk
Blue	Schwarzbach, J.	NATC, Patuxent, Md.
Green	Schweitzer, Capt. D. C.	AF Inst. of Technology
Blue	Scroggin, Lt. O. O., III	AF Inst. of Technology
Brown	Seay, Mrs. J.	NATC, Patuxent, Md.
Brown	Seay, J. O.	NATC, Patuxent, Md.
Green	Sellars, Lt. J. J.	NATC, Patuxent, Md.
Tan	Serio, V. J.	North American Products
Brown	Shepard, Lt. V. H.	AF Inst. of Technology
~~Gold~~	~~Sherwood, Lt. J. W., Jr.~~	~~AF Inst. of Technology~~
~~Red~~	~~Short, Comdr. W. C., Jr.~~	~~NATC, Patuxent, Md.~~
~~Red~~	~~Sickel, Lt. H. G., Jr.~~	~~NATC, Patuxent,~~ Md.
~~Gold~~	~~Sievers, Col. R. H.~~	~~Ind. College, Wash.~~ D.C.
Tan	Silliman, Maj. C. R.	AF Inst. of Technology
~~Brown~~	~~Simcoe, Maj. D. A., Jr.~~	~~AF Inst. of Technology~~
~~Tan~~	~~Slentz, Lt. G. L.~~	~~AF Inst. of Technology~~
~~Green~~	~~Smith, A.~~	~~NATC, Patuxent, Md.~~
Brown	Smith, Maj. C. C., Jr.	AF Inst. of Technology

Color Group	Name	Affiliation
Gold	Smith, Capt. H. M.	AF Inst. of Technology
Blue	Smith, Comdr. J. G.	NATC, Patuxent, Md.
Green	Smith, Capt. L. R.	AF Inst. of Technology
Blue	Snodgrass, Lt. J. G.	NATC, Patuxent, Md.
Green	Snook, Capt. A. W.	AF Inst. of Technology
Blue	Speltz, Lt. Comdr. P. H.	NATC, Patuxent, Md.
Green	Starns, Lt. (jg) C. E.	NATC, Patuxent, Md.
Gold	Steinberg, A. W.	University of Maryland
Red	Stephens, Maj. R. D.	AF Inst. of Technology
Blue	Stevens, Lt. Comdr. P. F.	NATC, Patuxent, Md.
Brown	Stewart, Maj. L. H.	NATC, Patuxent, Md.
Tan	Stickman, Lt. W.R., Jr.	AF Inst. of Technology
Blue	Stim, C.	NATC, Patuxent, Md.
Brown	Stockebrand, Lt. A. P.	NATC, Patuxent, Md.
Tan	Stuber, B.	NATC, Patuxent, Md.
Tan	Sviminoff, Capt. C.	USAFIT, Wright-Patterson
Green	Sweet, R. A.	NATC, Patuxent, Md.
Blue	Taylor, Lt. W.	NATC, Patuxent, Md.
Red	Teal, E. A.	Lehigh University
Red	Thomas, Lt. Comdr. J. E.	NATC, Patuxent, Md.
Red	Tifford, Prof. A.	Ohio State University
Blue	Tillen, Lt. F. J.	NATC, Patuxent, Md.
Red	Tillinghast, N.	NATC, Patuxent, Md.
Gold	Townsend, M. W.	Georgia Tech.
Gold	Tuck, D. A.	Georgia Tech.
Blue	Turner, Lt. R. H.	AF Inst. of Technology
Green	Umlauf, Lt. J. L.	AF Inst. of Technology
Blue	Vanbruggen, Capt. R.	AF Inst. of Technology
Red	VonEschen, G. L.	Ohio State University
Red	Wakefield, Capt. H. A.	Headquarters, Air University
Green	Walker, Lt. H. G., Jr.	AF Inst. of Technology
Red	Walker, Capt. R. V.	AF Inst. of Technology
Red	Weber, J.	NATC, Patuxent, Md.
Green	Webster, Lt. R. M., Jr.	AF Inst. of Technology
Red	Weikert, Maj. Gen. J. M.	National War College
Red	Wellman, Maj. R. J.	Air Comd. and Staff School
Brown	Williams, Lt. (jg) D. T.	NATC, Patuxent, Md.
Green	Williams, Capt. J. G., Jr.	USMA, West Point
Green	Williams, Comdr. J. W.	AF Inst. of Technology
Brown	Wilson, Capt. C. J.	AF Inst. of Technology
Brown	Winfree, Maj. I. O.	AF Inst. of Technology
Gold	Wynne, Lt. Col. E. P.	USMA, West Point
Gold	Zahringer, J.	NATC, Patuxent, Md.
Gold	Zimmerman, Capt. J. W.	AF Inst. of Technology

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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Additional Guests Approved by Director

May 25, 1951

Color Group	Name	Affiliation
Red	Alford, William	NACA - Langley
Blue	Carson, Capt. L. D.	School of Aviation Medicine, Pensacola, Fla.
Gold	Hase, Arthur L.	Pensacola, Fla.
Brown	Herring, T. C.	NADC, Johnsville, Pa.
Green	Hill, Paul R.	NACA - Langley
Gold	McCullough, Brig. Gen. A. L.	Mitchell Field, N. Y.
Blue	Muluc, R. W.	NACA - Langley
Gold	Robinson, Lt. Col. G. H.	Mitchell Field, N. Y.
Blue	Robinson, L. H.	Motorola Inc.
Brown	Schlieben, E. W.	NADC, Johnsville, Pa.
Red	Whitehead, Adm. R. F.	NAS, Norfolk

The following were first put into a Gray Group but on leaving the Full-Scale Tunnel were changed and distributed evenly through the remaining six groups:

Name	Affiliation
Alexander, William	NATC, Patuxent, Md.
Anderson, Capt. R. H.	Langley AFB
Bogart, Comdr. G. S.	Naval War College, Newport, R.I.
Byrnes, D. L.	NATC, Patuxent, Md.
Congdon, E. S.	NATC, Patuxent, Md.
Cornthwaite, C. E.	NATC, Patuxent, Md.
Davidson, T. W.	NATC, Patuxent, Md.
Erickson, Lt. Comdr. W. A.	NADC, Johnsville, Pa.
Ford, Capt. F. M.	Langley AFB
Gloeckler, F. M.	NADC, Johnsville, Pa.
Gold, A.	NADC, Johnsville, Pa.
Hayden, Brig. Gen. G.	Wright-Patterson AFB

Color Group	Name	Affiliation
	Insalata, I. A.	NADC, Johnsville, Pa.
	Kee, Richard	NATC, Patuxent, Md.
	Lawrence, Col. B. R.	Wright-Patterson AFB
	Levy, W. W.	NADC, Johnsville, Pa.
	Messina, Mauro	NATC, Patuxent, Md.
	Milling, R. W.	Langley - NACA
	Moroney, J. E.	NATC, Patuxent, Md.
	Navoy, A. J.	NATC, Patuxent, Md.
	Nutter, R. D.	NADC, Johnsville, Pa.
	Reid, Capt. W. E.	Langley AFB
	Reinsel, W. E.	NATC, Patuxent, Md.
	Schott, R. L.	NACA - Langley
	Spadaro, P. R.	NATC, Patuxent, Md.
	Stainback, Julian	NATC, Patuxent, Md.
	Thomas, J. L.	NADC, Johnsville, Pa.
	Trummel, L. R.	NATC, Patuxent, Md.
	Wright, Joan	NATC, Patuxent, Md.

Press letter

67808

April 13, 1951

Mr. xxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxx

Dear xxxxxxxxxxxxxxx:

You are cordially invited to inspect the facilities and work in progress at the Langley Aeronautical Laboratory and the Pilotless Aircraft Resarch Station of the National Advisory Committee for Aeronautics on May 17 and 18. The visit to the Pilotless Aircraft Research Station on the 17th will be the first ever for members of the Press. The visit to the Langley Laboratory will be the opening day of the 1951 Biennial Inspection there, May 18.

Transportation to the Pilotless Aircraft Research Station, at Wallops Island, Virginia, will be provided by NACA airplane the morning of May 17. Departure from the Washington National Airport will be at approximately 8:30 a.m., Eastern Daylight Time, from the lobby of Butler Aviation (formerly MATS Terminal). A firm departure time will be established not later than May 14.

In the afternoon of May 17, transportation will be provided from Wallops Island to Old Point Comfort, Virginia, where overnight reservations have been made at the Hotel Chamberlin. Because of the fact that May is a "convention month" for the Hotel, only double occupancy rooms are available. The cost, per person, will be approximately $5.

In the early evening of May 18, departure from the Langley Laboratory will be by steamer from Old Point Comfort, with arrival in Washington at 7:00 a.m., EDT, May 19. The cost of meals May 18, passage and stateroom, and breakfast May 19, will be approximately $17.

It is believed that progress being made in aeronautical research, which has a direct bearing upon the future quality of our nation's aircraft and guided missiles, will be of special interest to you this year.

Because both travel facilities and overnight hotel accommodations are severely limited, it is urgently requested that you signify as soon as possible whether we may have the pleasure of your company.

Sincerely yours,

J. F. Victory
Executive Secretary

NACA - Langley

1951 BIENNIAL INSPECTION

INTRODUCTION BY MR. F. L. THOMPSON

At this time we would like to take the opportunity to discuss briefly two subjects that we thought would be of general interest. The first of these concerns the problem of providing the tools for conducting research in the difficult speed range around Mach number 1.0; that is, the transonic range. We thought that a review of the current status of that problem would be of interest, and Mr. John Stack, Assistant Chief of Research of the Langley laboratory will discuss that subject.

The second subject that we would like to discuss briefly at this time concerns the problem of reducing the manual labor and time required to handle data reduction and the voluminous calculations required in a large research laboratory such as this. The capacity of the laboratory for making measurements is great. For example, a few days of operation of a single wind tunnel in an investigation of pressures on wings may yield hundreds of thousands of readings. This situation provides a fertile ground for reduction of manual labor by use of appropriate devices and machinery. Progress has been made in this problem and a display of equipment in current use has been arranged to be shown during the luncheon today. Mr. M. J. Stoller, Assistant Chief of the Instrument Research Division, will discuss this problem briefly at this time to provide you with a better understanding of the display to be shown at lunch time.

Talk presented by Mr. John Stack:-

As you may well know, wind tunnels have been inoperative through important parts of the transonic range. The phenomena is generally referred to as "choking". Viewed simply, the phenomena is related to the fact that the speed of sound is the speed at which small pressure impulses travel through any gas. Thus, for a wind tunnel without a model when the speed of sound is reached in the test section which, of course, is the throat or smallest section of the whole air circuit, any additional pressure field set up by the fan cannot travel upstream through the throat to cause more air to flow through the throat. If a model is put in the wind tunnel, it in effect makes the test section or throat area smaller by the space the model occupies and thus the amount of air that can flow through is lowered. Further, the velocity field around the model has local sonic or supersonic regions which add materially to the choking effect. Thus, fairly large regions of speed in the important region of the speed of sound are "blocked" so far as wind-tunnel operation, and so data for this region have been impossible to obtain in wind tunnels. The significance of the speed of sound is so great that we now have come to measure speed in terms of the speed of sound. I mean, of course, the Mach number, the actual speed divided by the speed of sound.

This "choking" limitation of the wind-tunnel technique has been a serious handicap and great efforts have been made to overcome the limitation or to devise other methods to do the necessary research.

You will recall that 2 years ago at the Langley Inspection, we reviewed the effort made to obtain aerodynamic data in the transonic range. At that time, we discussed the wind-tunnel choking limitations that prohibited or made impossible the obtaining of transonic aerodynamic data in wind tunnels. Some other methods had been devised all with more or less serious limitations. This slide was shown as a summary of the discussion to illustrate the position with respect to the methods of obtaining transonic data.

The bottom line shows the blocked out range of Mach number for conventional closed-throat wind tunnels using what was then, 2 years ago, conventional techniques. The line next above showed what was possible by improvement of technique and greatly reduced model size. The next three lines were the free-air methods developed and then in use to get results continuously through the transonic range. The upper line illustrated what we had been able to accomplish with what was then a new type of transonic tunnel - a very highly developed adaptation of the whirling arm concept. Such was the position then. The transonic tunnel of the whirling arm type and the "bump" or wing-flow techniques were the only Laboratory techniques capable of operation continuously through the transonic range and these methods had many serious disadvantages, limitations, or complications.

The effort then summarized was continued and, since then, by a special new development of a type of wind-tunnel throat, the "choke" limited speed range of wind tunnels can be eliminated. That is, true transonic wind tunnels have been developed. Security regulations prohibit complete disclosure of the means by which continuous transonic operation is achieved. This much can be said. The test section might be termed ventilated. There are many means by which the ventilation can be accomplished and by the same token, many of the means are unsatisfactory. We have developed a satisfactory system.

It must be pointed out that the idea of ventilated throats is not new except in its application transonically. Ventilated test sections to achieve nullification of wall corrections at subsonic speeds is a fairly old idea and the theory has been available and discussed in the literature. In fact, the arrangements we are now using in the transonic range were influenced to a very great extent by the older subsonic studies. The forms in which the ventilated throats or test sections have been applied here are designed as well to give zero wall correction for low speeds for many types of models.

As a practical construction matter, the new type throat is somewhat simpler to build - not requiring a high order of precision as to contour.

Aerodynamically, large models may be used. It is conservative to say models about three times the size that would choke at Mach number 0.9 in a conventional tunnel of the same size.

We now have two large transonic wind tunnels in operation - the Langley 8-foot and 16-foot wind tunnels. In addition, we have one smaller transonic wind tunnel approximately 2-foot throat operating as a blowdown tunnel, but capable of high Reynolds number because it can be operated to something above 5 atmospheres. Under construction is a fourth transonic tunnel of this new type having a test section cross-sectional area of approximately 50 square feet.

The next slide illustrates schematically the flow for the fore part of a body as investigated in the 8-foot transonic tunnel for a Mach number slightly over 1.0.

Describe setup

Note bow wave

The movie

1951 BIENNIAL INSPECTION
Talk presented by
Mr. John Stack
5/21/51

We cannot yet claim that we are satisfied with the present state of development. Two problems require further work. One is the wave reflection problem after the Mach number passes 1.0. We have achieved a considerable weakening of the reflected wave but not yet complete cancellation of the reflected wave. By modification of the testing technique, we are able to reduce to relative unimportance the effects on the aerodynamic characteristics of the weakened reflected wave. Eventually, we expect to accomplish satisfactory wave cancellation. The other is the power required. The power to operate is considerably more than required for a closed throat of the same size. We have made a material reduction from the power required in the initial installations and we can further reduce the power. Even so, at present power levels, the much larger size model that can be used much more than offsets the present additional power requirement.

In your tour today, you will be conducted through the 16-foot high-speed tunnel which has recently been placed in operation having been repowered and fitted with this new throat. You will not be able to see the exact means by which the test section has been made transonic, but you will be able to see that most major components of the wind tunnel, that is, the drive, the cooling system, the diffuser, the structure, generally remain familiar.

brn

Copy for Dr. E. R. Sharp
NACA Cleveland

116.1-64

DANIEL A. HILL
1633 COMPTON ROAD
CLEVELAND HEIGHTS 18, OHIO

72828

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Draft
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Mech Serv
Mech Oper
Contr Adm
Fac Eng
Plant Oper
Elec Oper

October 18, 1951

Dr. John F. Victory,
Executive Secretary, NACA
1724 F Street,
Washington, D. C.

Dear Dr. Victory:

May I congratulate the NACA for the marvelous show, which is the only way to describe the 1951 Inspection at the Lewis Flight Propulsion Laboratory.

It was a wonderful party. I enjoyed it very much. Please invite me again. Thank you.

Yours truly,

Daniel

CC
E. R. Sharp
R. Sessions

ACTION COPY

UNITED STATES AIR FORCE
HEADQUARTERS
ARNOLD ENGINEERING DEVELOPMENT CENTER
TULLAHOMA, TENNESSEE

IN REPLY ADDRESS BOTH COMMUNICATION AND ENVELOPE TO COMMANDING GENERAL, ARNOLD ENGINEERING DEVELOPMENT CENTER, ATTENTION FOLLOWING OFFICE SYMBOL:

RECD NACA
OCT 17 1951

8C

15 October 1951

Mr. John F. Victory
Executive Secretary
National Advisory Committee for Aeronautics
1724 F Street NW
Washington 2 5, D. C.

Dear John:

Twice now I have "pooped out" on scheduled attendance at your Laboratory Inspections -- last Spring at Langley and again last week at Cleveland.

From reports given me by people from this base who attended, I understand that the Cleveland show was outstanding and probably one of the best ever put on by NACA. I was certainly sorry to have missed it but was just unable to get away at that time.

The purpose of this letter is to ask you to please keep my name on the invitation list for later Laboratory Inspections as I plan to make the trip to Ames for the next inspection which I presume will be July 1952 or thereabouts.

With best wishes and kindest regards, I am,

Sincerely,

Ralph R. Graichen

RALPH R. GRAICHEN
Ass't Deputy Chief of Staff
Research & Development

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CLEVELAND 14, OHIO

October 15, 1951

Mr. John F. Victory, Executive Secretary
National Advisory Committee for Aeronautics
1724 F Street NW
Washington 25, D. C.

Subject: 1951 Biennial Inspection of the
NACA Lewis Flight Propulsion Laboratory

Dear Mr. Victory:

The opportunity to attend the above inspection at the Lewis Flight Propulsion Laboratory last week resulted in a conviction that, if and when it is convenient, I would like to have a larger number of our organization make a trip as nearly similar as possible. While aviation seems somewhat remote from the operation of foundries, I was able to see that your research work has many possible adaptations to the more prosaic manufacturing operations of such industries as ours. I am sure that some of our young engineers and operating men would glean both ideas and inspiration from the activities, methods and findings which were demonstrated to your visitors during this last inspection.

In one of the introductory addresses, the effort of your Advisory Committee toward acquainting the right kind of Americans with your activities included mention of public relations and it then occurred to me that you could bring some small part of your effort to the consciousness of thousands of additional engineers and manufacturers by fitting up a traveling exhibit, either by rail or bus and over carefully selected routes. Having used such an exhibit ourselves in a rather modest way, we could show it to some of your people at a mutually convenient time when they happen to be in Columbus, Ohio, where the motor coach is now parked for the winter. Let us know if we can be of service.

Thanks again for the privilege of attending the inspection last week.

Sincerely,

J. H. Redhead
J. H. Redhead
President

mm

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CARBIDE AND CARBON CHEMICALS COMPANY
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POST OFFICE BOX P
OAK RIDGE, TENN.

October 15, 1951

Mr. John F. Victory, Executive Secretary
National Advisory Committee for Aeronautics
1724 F Street NW
Washington 25, D. C.

Dear Mr. Victory:

It was indeed a pleasure to attend the 1951 Biennial Inspection of the NACA Lewis Flight Propulsion Laboratory. Although I have attended these inspections in the past, both at Cleveland and Langley Field, in my estimation the program given at Cleveland last week was by far the best exhibition of scientific progress the NACA has ever presented.

Let me extend our thanks to you for being invited to attend the inspection. With every good wish for continued success in scientific endeavor, I remain

Sincerely yours,

D. D. Cowen

D. D. Cowen, Superintendent
Information and Reports Division

DDC:imp

ARMED FORCES STAFF COLLEGE
OFFICE OF THE COMMANDANT
NORFOLK 11, VIRGINIA

15 October 1951

Mr. John F. Victory
Executive Secretary
National Advisory Committee
for Aeronautics
1724 F Street, N. W.
Washington 25, D. C.

Dear Mr. Victory:

The party from the Armed Forces Staff College, consisting of Rear Admiral McLean, Captain Junghans, and Lieutenant Colonel Carlson, who attended the 1951 Biennial Inspection of the Lewis Flight Propulsion Laboratory have reported it was an interesting and pleasant experience. These officers were very favorably impressed by the scope, magnitude, and progress of the research activities conducted by the Laboratory and by the smooth efficiency with which these facts were communicated to the guests.

The airplane in which this party made the trip experienced difficulty with an engine and essential navigation equipment en route to Cleveland which might have delayed departure. However, the personnel at the NACA Hangar under Mr. Gough cooperated wholeheartedly and quickly repaired these discrepancies.

Please accept our thanks for all the courtesies which were extended to the Armed Forces Staff College party.

Sincerely yours,

A D Bruce

A. D. BRUCE
Lt. Gen., USA
Commandant

RECD NACA
OCT 17 1951

NAVAL WAR COLLEGE
NEWPORT, RHODE ISLAND

A2-9

Ser 5293-51 (F/GSB:mm)

15 OCT 1951

Dear Sir:

I wish to express appreciation for the cordial reception extended to me and to eight other staff members of the Naval War College on the occasion of the 1951 Biennial Inspection of the Lewis Flight Propulsion Laboratory.

The opportunity for officers of this college to view firsthand, the progress made in the vital field of aircraft propulsion, was a distinct privilege. The N.A.C.A. staff at Cleveland deserves great credit for the fine quality and educational value of the demonstrations.

Thank you for the many courtesies extended to make our visit enjoyable.

Sincerely yours,

Wallace M. Beakley
WALLACE M. BEAKLEY
Rear Admiral, U.S.N.
Chief of Staff

Mr. John F. Victory
Executive Secretary
National Advisory Committee
for Aeronautics
1724 F Street, N.W.
Washington 25, D.C.

ALBERT M. HIGLEY
2036 EAST 22ND STREET
CLEVELAND

gw

October 12, 1951

Mr. John F. Victory
Executive Secretary
NACA
1724 F. Street N.W.
Washington 25, D.C.

Dear Mr. Victory:

I appreciate very much having been invited to the 1951 Biennial Inspection of the Lewis Flight Propulsion Laboratory in this city.

It has been my good fortune to attend two other such inspections, and I think this one far exceeded the other two in the ingenious manner in which the work which you are doing was explained to the visitors.

It is very heartening to see the fine job which is being done in this city by your fine organization.

Thanks again.

Yours truly,

Albert M. Higley

THE CLEVELAND CHAMBER OF COMMERCE

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October 12, 1951

Dr. John F. Victory
Executive Secretary
National Advisory Committee for Aeronautics
1724 F Street NW
Washington 25, D. C.

Dear John:

Once again I want to thank you for the privilege of attending a N A C A Inspection.

Each one seems better than the last, and certainly the performance at Lewis Flight Propulsion Laboratory on Wednesday surpassed everything that preceded it.

I congratulate you on the excellence of the presentation and the marvelous precision of the entire event.

It was splendid.

Cordially,

Clifford Gildersleeve

Clifford Gildersleeve
Industrial Commissioner

CG:M

BORG-WARNER CENTRAL RESEARCH LABORATORY
706 SOUTH TWENTY-FIFTH AVENUE
BELLWOOD, ILLINOIS

October 12, 1951

Dr. John F. Victory, Executive Secretary
National Advisory Committee for Aeronautics
1724 F Street, Northwest
Washington 25, D.C.

Dear John:

It would have been possible for me to have grabbed onto you while I was at the Lewis Laboratory Inspection in Cleveland, but I realized that if every one there who was your friend did the same thing you wouldn't have moved ten feet. As a result, I decided to defer seeing you until my next trip to Washington, when I hope we can have luncheon together.

When I attended the Inspections at Langely Field and at the Ames Laboratories I didn't feel that the presentation could be improved. However, after seeing the Inspection at Lewis I realized that there must have been room for improvement for this seemed to me to be the most outstanding Inspection I have ever seen. Again I could see no way in which it could be improved. I appreciate that I was asked to attend this Inspection, and I felt the day was well spent.

I had expected you to be at the Conference on Research, at Ann Arbor, and was sorry to hear that there was illness in your family and that you could not attend. I hope that all is well again.

Sincerely

Maurice

Maurice Nelles
Director

MN:rfb

J. WALTER THOMPSON COMPANY

Chicago 11, Illinois

410 N. MICHIGAN AVENUE

October 12, 1951

Mr. John F. Victory
Executive Secretary
National Advisory Committee for Aeronautics
1724 F Street NW
Washington 25, D.C.

Dear Mr. Victory:

These sincere thanks for the invitation to attend the 1951 Biennial Inspection of the Lewis Flight Propulsion Laboratory can be shared, I hope, with everybody connected with the NACA organization at Cleveland.

I have seldom had a more pleasant experience and I owe thanks particularly to Mr. Lewis A. Rodert and those who assisted him in shepherding the "White" group during the demonstrations.

The experience was not only pleasant but instructive and inspiring, and, in view of the world situation, extremely re-assuring.

Continued strength and success to you all.

Sincerely,

H. B. Rorke
Radio-TV Manager

HBR/FS

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October 12, 1951

Mr. John F. Victory
Executive Secretary
National Advisory Committee
for Aeronautics
1724 F. Street, NW
Washington 25, D. C.

Dear Mr. Victory:

Your 1951 Biennial Inspection of the NACA Lewis Flight Propulsion Laboratory was certainly an outstanding event. Both Mr. Bryant, our President, and I thank you for your thoughtfulness in inviting us to be one of your guests.

We not only marveled at all of the things which are being accomplished at the Laboratory, but neither of us can ever recall having attended an inspection where the entire program had been so carefully thought out and every detail arranged for. This all reflected the high degree of operating efficiency with which the work is carried on at the Laboratory.

Both Mr. Bryant and I congratulate you and Dr. Sharp on your outstanding achievements.

With kindest regards.

Sincerely yours

J. K. Gannett

J. K. Gannett
Vice President and Director
of Engineering and Research

JKG:ds

CC: Dr. E. R. Sharp

IN REPLY
REFER TO ....
Address
Commanding Officer
Naval Air Station

U. S. NAVAL AIR STATION
Norfolk 11, Virginia

for PEACE OF MIND BUY SAVINGS BONDS

SC

JBV

11 October 1951

Mr. John F. Victory
Executive Secretary
National Advisory Committee for Aeronautics
Washington, D. C.

Dear Mr. Victory:

I desire to express the appreciation of the group of civilians and officer personnel from this Station, who visited the Lewis Flight Propulsion Laboratory yesterday, for a most interesting and instructive trip. The entire inspection tour was planned and executed in an outstanding manner.

Very sincerely yours,

H. W. Keopka

H. W. KEOPKA

THE OHIO BELL TELEPHONE COMPANY
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CLEVELAND 15, OHIO

RANDOLPH EIDE
PRESIDENT

October 11, 1951

Dr. John F. Victory, Executive Secretary
National Advisory Committee for Aeronautics
Washington, D. C.

Dear Dr. Victory:

The day spent at Lewis Flight Propulsion Laboratory in Cleveland was most interesting and worthwhile. I was glad to have had a few minutes' discussion with you, and I want to reiterate that both as a citizen and as a taxpayer I think your organization is doing a splendid job.

Specifically the inspection in Cleveland showed a fine selection of subjects, all of which were presented ably. One's reactions to the organization in Cleveland, after spending a day in the Laboratory, indicate that the Laboratory is directed in a most businesslike and constructive manner.

With kind regards,

Yours very sincerely,

Randolph Eide

THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

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RECD. NACA
OCT 12 1951
25U

October 10, 1951

SC

Mr. John F. Victory, Executive Secretary
National Advisory Committee for Aeronautics
1724 F Street N.W.
Washington 25, D. C.

Dear Mr. Victory:

Congratulations to you and your organization for an outstanding performance at the 1951 Biennial Inspection of National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory. Thanks to you for the invitation.

It was an outstanding day for me. I thoroughly enjoyed the comfortable, informative, and interesting inspection trip.

Thanks sincerely,

R. E. Mausk

R. E. Mausk
Industrial Sales Department

REM:pam

Louis E. Leverone
18 South Michigan Avenue
Chicago 3, Illinois

October 10, 1951

Mr. John F. Victory, Exec. Secy.
National Advisory Committee for Aeronautics
1724 F Street, Northwest
Washington 25, D. C.

Dear John:

Sorry that we had to skip out to catch a plane so didn't spend the entire day at the Lewis Flight Propulsion Laboratory. However, every minute of it was interesting and I greatly enjoyed the trip.

I marveled at everything I saw. You are doing a wonderful job. Of course, there wasn't the chance there to have the little intimate talk that I always enjoy with you.

I expect to be in Washington around the 30 and 31 of this month, also perhaps the 1 and 2 of November--not all of those dates but one of them. I am going to contact you, and I do hope your plans will be such that we can get together and spend a little time having a real visit. I am definitely looking forward to it.

I am grateful to you for the courtesies you extended to me and to Mr. Regan yesterday. To repay you we skipped off without turning in our luncheon tickets. You may want them for your records. Anyway, I am sending them along.

Every good wish.

Sincerely yours

L. E. Leverone

LEL/bc
Enclosures-2

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OCT 12 1951

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October 10, 1951

Mr. J. F. Victory, Executive Secretary
National Advisory Committee for Aeronautics
Washington, D. C.

Dear Mr. Victory:

I should like to express the appreciation of Messrs. E. Bodenmann, M. T. Pattie and myself for the opportunity of visiting your 1951 Biennial Inspection of the Lewis Flight Laboratory.

I can assure you it was most enlightening as well as interesting. Please express our congratulations to Dr. Sharp and his organization for the successful detailed preparation of this inspection.

Very truly yours,

W. O. Springer

W. O. Springer

ln

C
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Offices and Warehouse, 5300 Lakeside Avenue

Cleveland 14, Ohio

Mail Address P. O. Box 6208
Cleveland 1, Ohio

October 10, 1951

Mr. J. F. Victory, Executive Secretary
National Advisory Committee for Aeronautics
Washington, D. C.

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Very truly yours,

/s/
W. O. Springer

ln

THE OHIO BELL TELEPHONE COMPANY

750 Huron Road

Cleveland 15, Ohio

October 11, 1951

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National Advisory Committee for Aeronautics
Washington, D. C.

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With kind regards,

Yours very sincerely,

/s/ Randolph Eide

THE AUSTIN COMPANY

ENGINEERS AND BUILDERS

16112 Euclid Avenue Cleveland 12, Ohio

October 12, 1951

Mr. John F. Victory
Executive Secretary
National Advisory Committee
for Aeronautics
1724 F. Street, NW
Washington 25, D. C.

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Sincerely yours

/s/ J. K. Gannett

J. K. Gannett
Vice President and Director
of Engineering and Research

KJG:ds

cc: Dr. E. R. Sharp

THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

75 Public Square

Cleveland 1, Ohio

October 10, 1951

Mr. John F. Victory, Executive Secretary
National Advisory Committee for Aeronautics
1724 F Street, N. W.
Washington 25, D. C.

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Thanks sincerely,

/s/

R. E. Mausk
Industrial Sales Department

REM:pam

U. S. NAVAL AIR STATION

Norfolk 11, Virginia

11 October 1951

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Executive Secretary
National Advisory Committee for Aeronautics
Washington, D. C.

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/s/

H. W. KEOPKA

Louis E. Leverone

18 South Michigan Avenue

Chicago 3, Illinois

October 10, 1951

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National Advisory Committee for Aeronautics
1724 F Street, Northwest
Washington 25, D. C.

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Every good wish.

Sincerely yours

/s/ L. E. Leverone

LEL/bc
Enclosures-2

BORG-WARNER CENTRAL RESEARCH LABORATORY

706 South Twenty-Fifth Avenue

Bellwood, Illinois

October 12, 1951

Dr. John F. Victory, Executive Secretary
National Advisory Committee for Aeronautics
1724 F Street, Northwest
Washington 25, D. C.

Dear John:

It would have been possible for me to have grabbed onto you while I was at the Lewis Laboratory Inspection in Cleveland, but I realized that if every one there who was your friend did the same thing you wouldn't have moved ten feet. As a result, I decided to defer seeing you until my next trip to Washington, when I hope we can have luncheon together.

When I attended the Inspections at Langley Field and at Ames Laboratories I didn't feel that the presentation could be improved. However, after seeing the Inspection at Lewis I realized that there must have been room for improvement for this seemed to me to be the most outstanding Inspection I have ever seen. Again I could see no way in which it could be improved. I appreciate that I was asked to attend this Inspection, and I felt the day was well spent.

I had expected you to be at the Conference on Research, at Ann Arbor, and was sorry to hear that there was illness in your family and that you could not attend. I hope that all is well again.

Sincerely

/s/ Maurice

Maurice Nelles
Director

MN:rfb

THE CLEVELAND CHAMBER OF COMMERCE

400 Union Commerce Building Cleveland 14, Ohio

October 12, 1951

Dr. John F. Victory
Executive Secretary
National Advisory Committee for Aeronautics
1724 F Street NW
Washington 25, D. C.

Dear John:

Once again I want to thank you for the privilege of attending a NACA Inspection.

Each one seems better than the last, and certainly the performance at Lewis Flight Propulsion Laboratory on Wednesday surpassed everything that preceded it.

I congratulate you on the excellence of the presentation and the marvelous precision of the entire event.

It was splendid.

Cordially,

/s/

Clifford Gildersleeve
Industrial Commissioner

CG:M

ALBERT M. HIGLEY

2036 East 22nd Street

Cleveland

October 12, 1951

Mr. John F. Victory
Executive Secretary
NACA
1724 F. Street N.W.
Washington 25, D. C.

Dear Mr. Victory:

I appreciate very much having been invited to the 1951 Biennial Inspection of the Lewis Flight Propulsion Laboratory in this city.

It has been my good fortune to attend two other such inspections, and I think this one far exceeded the other two in the ingenious manner in which the work which you are doing was explained to the visitors.

It is very heartening to see the fine job which is being done in this city by your fine organization.

Thanks again.

Yours truly,

/s/ Albert M. Higley

J. Walter Thompson Company

Chicago 11, Illinois

410 N. Michigan Avenue

October 12, 1951

Mr. John F. Victory
Executive Secretary
National Advisory Committee for Aeronautics
1724 F Street NW
Washington 25, D. C.

Dear Mr. Victory:

These sincere thanks for the invitation to attend the 1951 Biennial Inspection of the Lewis Flight Propulsion Laboratory can be shared, I hope, with everybody connected with the NACA organization in Cleveland.

I have seldom had a more pleasant experience and I owe thanks particularly to Mr. Lewis A. Rodert and those who assisted him in shepherding the "White" group during the demonstrations.

The experience was not only pleasant but instructive and inspiring, and, in view of the world situation, extremely re-assuring.

Continued strength and success to you all.

Sincerely,

/s/ Hal Rorke

H. B. Rorke
Radio-TV Manager

HBR/FS

THE CHRISTIAN SCIENCE MONITOR
One Norway Street
Boston 15, Massachusetts

Editorial Department

October 15, 1951

Mr. Eugene Miller
Director of Public Relations
National Advisory Committee for Aeronautics
1724 F Street, N. W.
Washington 25, D. C.

Dear Gene:

May I express my personal pleasure at seeing you again and also congratulations to NACA for the fine show they put on at Cleveland.

Also, could you relay to Mr. Hunter my very hearty thanks for going back into the administration building to see if he could find my notes and pix which I absent-mindedly left behind me. I see they arrived air mail, special, here, for which many thanks, as I am preparing more copy on the trip.

I started looking inside, with customary modesty, for my story and then discovered it was on the front page. Hence, it got cut, being longer than page one length. However, I am very happy for the display.

Hope to be seeing you all again soon.

Sincerely,

/s/ Al Hughes

Al Hughes
Aviation Editor

AH:cm

THE LAKE CITY MALLEABLE CO.

5000 Lakeside Avenue

Cleveland 14, Ohio

October 15, 1951.

Mr. John F. Victory, Executive Secretary
National Advisory Committee for Aeronautics
1724 F Street NW
Washington 25, D. C.

Subject: 1951 Biennial Inspection of the
NACA Lewis Flight Propulsion Laboratory

Dear Mr. Victory:

The opportunity to attend the above inspection at the Lewis Flight Propulsion Laboratory last week resulted in a conviction that, if and when it is convenient, I would like to have a larger number of our organization make a trip as nearly similar as possible. While aviation seems somewhat remote from the operation of foundries, I was able to see that your research work has many possible adaptations to the more prosaic manufacturing operations of such industries as ours. I am sure that some of our young engineers and operating men would glean both ideas and inspiration from the activities, methods and findings which were demonstrated to your visitors during this last inspection.

In one of the introductory addresses, the effort of your Advisory Committee toward acquainting the right kind of Americans with your activities included mention of public relations and it then occurred to me that you could bring some small part of your effort to the consciousness of thousands of additional engineers and manufacturers by fitting up a traveling exhibit, either by rail or bus and over carefully selected routes. Having used such an exhibit ourselves in a rather modest way, we could show it to some of your people at a mutually convenient time when they happen to be in Columbus, Ohio, where the motor coach is now parked for the winter. Let us know if we can be of service.

Thanks again for the privilege of attending the inspection last week.

Sincerely,

J. H. Redhead
President

Copy to Dr. E. R. Sharp

OAK RIDGE NATIONAL LABORATORY

Operated by

CARBIDE AND CARBON CHEMICALS COMPANY

A Division of Union Carbide and Carbon Corporation

Post Office Box P
Oak Ridge, Tenn.

October 15, 1951

Mr. John F. Victory, Executive Secretary
National Advisory Committee for Aeronautics
1724 F Street, NW
Washington 25, D. C.

Dear Mr. Victory:

It was indeed a pleasure to attend the 1951 Biennial Inspection of the NACA Lewis Flight Propulsion Laboratory. Although I have attended these inspections in the past, both at Cleveland and Langley Field, in my estimation the program given at Cleveland last week was by far the best exhibition of scientific progress the NACA has ever presented.

Let me extend our thanks to you for being invited to attend the inspection. With every good wish for continued success in scientific endeavor, I remain

Sincerely yours,

/s/

D. D. Cowen, Superintendent
Information and Reports Division

DDC:imp

ARMED FORCES STAFF COLLEGE
Office of the Commandant
Norfolk 11, Virginia

15 October 1951

Mr. John F. Victory
Executive Secretary
National Advisory Committee
for Aeronautics
1724 F Street, N. W.
Washington 25, D. C.

Dear Mr. Victory:

The party from the Armed Forces Staff College, consisting of Rear Admiral McLean, Captain Junghans, and Lieutenant Colonel Carlson, who attended the 1951 Biennial Inspection of the Lewis Flight Propulsion Laboratory have reported it was an interesting and pleasant experience. These officers were very favorably impressed by the scope, magnitude, and progress of the research activities conducted by the Laboratory and by the smooth efficiency with which these facts were communicated to the guests.

The airplane in which this party made the trip experienced difficulty with an engine and essential navigation equipment en route to Cleveland which might have delayed departure. However, the personnel at the NACA Hangar under Mr. Gough cooperated wholeheartedly and quickly repaired these discrepancies.

Please accept our thanks for all the courtesies which were extended to the Armed Forces Staff College party.

Sincerely yours,

/s/

A. D. BRUCE
Lt.Gen., USA
Commandant

NAVAL WAR COLLEGE

Newport, Rhode Island

15 October 1951

Dear Sir:

I wish to express appreciation for the cordial reception extended to me and to eight other staff members of the Naval War College on the occasion of the 1951 Biennial Inspection of the Lewis Flight Propulsion Laboratory.

The opportunity for officers of this college to view firsthand, the progress made in the vital field of aircraft propulsion, was a distinct privilege. The N.A.C.A. staff at Cleveland deserves great credit for the fine quality and educational value of the demonstrations.

Thank you for the many courtesies extended to make our visit enjoyable.

Sincerely yours,

/s/

WALLACE M. BEAKLEY
Rear Admiral, U.S.N.
Chief of Staff

Mr. John F. Victory
Executive Secretary
National Advisory Committee
for Aeronautics
1724 F Street, N.W.
Washington 25, D.C.

UNITED STATES AIR FORCE
Headquarters

ARNOLD ENGINEERING DEVELOPMENT CENTER

Tullahoma, Tennessee

15 October 1951

Mr. John F. Victory
Executive Secretary
National Advisory Committee for Aeronautics
1724 F Street NW
Washington 25, D. C.

Dear John:

Twice now I have "pooped out" on scheduled attendance at your Laboratory Inspections -- last Spring at Langley and again last week at Cleveland.

From reports given me by people from this base who attended, I understand that the Cleveland show was outstanding and probably one of the best ever put on by NACA. I was certainly sorry to have missed it but was just unable to get away at that time.

The purpose of this letter is to ask you to please keep my name on the invitation list for later Laboratory Inspections as I plan to make the trip to Ames for the next Inspection which I presume will be July 1952 or thereabouts.

With best wishes and kindest regards, I am,

Sincerely,

/s/

RALPH R. GRAICHEN
Ass't Deputy Chief of Staff
Research & Development

DANIEL A. HILL

1633 Compton Road

Cleveland Heights 18, Ohio

October 18, 1951

Dr. John F. Victory
Executive Secretary, NACA
1724 F Street,
Washington, D. C.

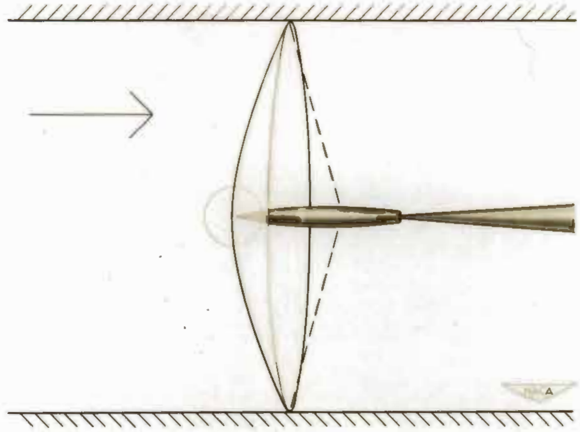
Dear Dr. Victory:

May I congratulate the NACA for the marvelous show, which is the only way to describe the 1951 Inspection at the Lewis Flight Propulsion Laboratory.

It was a wonderful party. I enjoyed it very much. Please invite me again. Thank you.

Yours truly,

/s/ D. A. Hill



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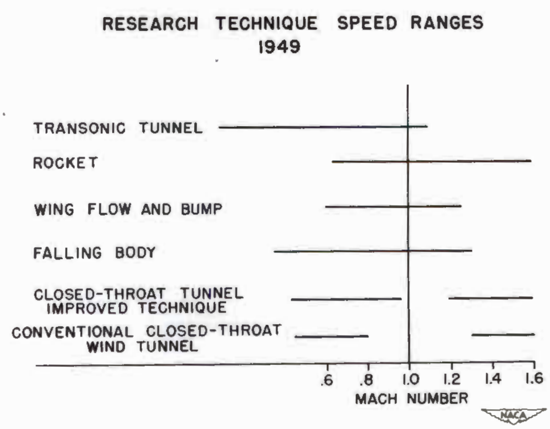


LAL 71091

To show how data reduction procedures fit in our work, let us look at the first slide. (Slide 1) The work here, as at any large laboratory, naturally divides into analytical and experimental phases. After a research project is started and the experimental and analytical work progresses, the results are studied and compared so as to provide the information which is used to plan additional work. Both the analytical and experimental phases require computational procedures. The computations for the analytical phase are in general very extensive and of an involved nature, and therefore require fast, automatic, high-capacity computers.

In use at the Laboratories, we have several IBM electronic card-programmed calculators, a Bell digital computer, which incidentally runs three shifts, as well as Reac, Philbrick and other analog machines. The Laboratories also make use of high capacity computing machinery at other government, commercial and university locations.

In contrast to analytical computations, the processing of experimental data involves calculations of a relatively simple nature applied to an extremely large number of points.

Handling test data, however, involves much more than just numerical computations. Our major interest is to measure the physical quantities and from the test data to derive the final results of the experiment. This requires a number of steps, such as those shown here, which are detailed on the next slide. (Slide 2) These steps have generally been carried out manually, but the tremendous volume of tedious work makes it necessary to devote a good deal of effort to the elimination of manual procedures.

We must not lose sight of the fact that the measurement must be made satisfactorily. Instruments which satisfactorily meet the requirements of accuracy, reliability and over-all economy are used to convert the data into a signal which is then recorded. The records are edited and read, calculations are made and finally tabulations and plots are prepared.

The series of steps which is used varies from test to test; for instance, the steps required to process wind-tunnel data will be different from those used to process flight or rocket-powered model data. What we're trying to do is to mechanize as much of this as possible. However, there are certain aspects of the work in which a machine cannot make an intelligent decision. For example, manual editing makes it possible to monitor and control the quality of thé records and to reduce unproductive calculations.

We therefore use a number of techniques to automatically or semi-automatically assist in the data reduction. For instance, we record the data in more advanced form, that is, with a certain amount of combining and computing already done. We also use a number of devices to semi-automatically carry out the various steps of the data reduction process and finally we funnel the material through automatic calculating machines. As an example of the by-passing of steps of the data reduction process, let us look at the next slide (Slide 3). Here it is desired to obtain the aerodynamic forces and moments on a wind-tunnel model. The forces are sensed by electric strain gages on the internal balance and the strain gage signals are combined in weighting networks. From these networks we operate the indicators for the tunnel operator and the punched card recorder. This arrangement is typical of those in which a number of the data reduction steps are combined. This equipment will be shown at the display after lunch.

Another illustration is shown on the next slide, (Slide 4) which represents the case in flight or in wind-tunnel testing where a plot of the variation of pressure on the wing is required for study. The pressures are sensed by optical pressure pickups, which throw spots of light on a film in such positions that the pressure diagram is recorded directly. Here again we have a device that has eliminated manual operations and has by-passed individual data reduction steps. You will see motion pictures of pressure diagrams taken with this equipment later on today.

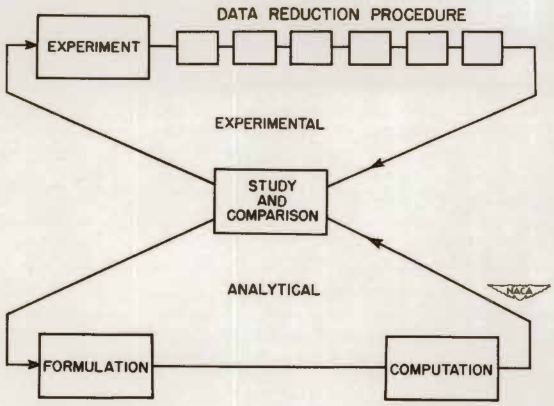
Data reduction aids may be part of a system which processes all of the related test information. The next slide shows how the data from our rocket-powered models is processed. The telemetered information from the rockets is recorded by oscillographs and is then converted to punched cards. The data provided by the Doppler radar are recorded on a magnetic tape, and a device which you will see after lunch converts this raw displacement data into velocity data from which other cards are punched. Similarly, the position radar data which are in photographic form and the radiosonde charts are converted to punched cards.

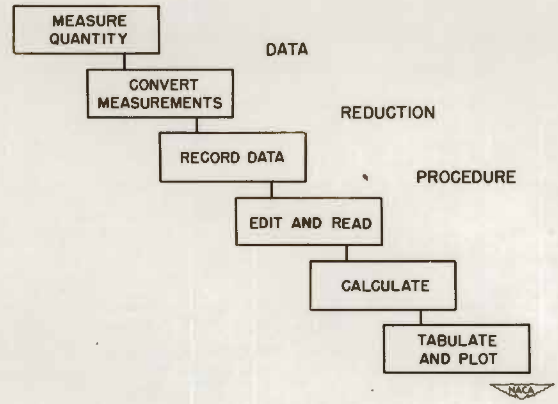
The preparation of the punched cards is carried out by using manual and semi-automatic card punches. It is at these points that we can edit and screen the raw data. With all the necessary information in punched card form, the data are then automatically processed and tabulated by an IBM electronic calculator. The punched cards are also used to automatically plot graphs if they are desired. This then is a case where manual steps remain in the process because of their effectiveness, yet all the data are funneled through an automatic calculator.

The reduction processes used are continually being studied and reviewed to strike the proper balance between quality, reliability and economy of time, personnel and funds. In the course of development a number of interesting devices have been built, and are now in use. During the lunch period you will have an opportunity to see some of these data reduction aids as well as a variety of instrument components.

Morton J. Stoller

(Typed 5-25-51, ebb)


DATA REDUCTION PROCEDURE
EXPERIMENT
EXPERIMENTAL
STUDY AND COMPARISON
ANALYTICAL
FORMULATION
COMPUTATION


MEASURE QUANTITY
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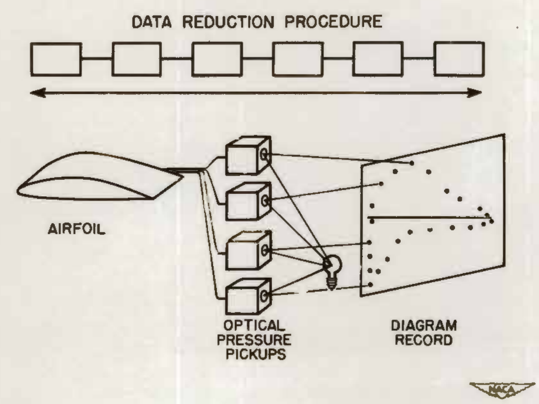
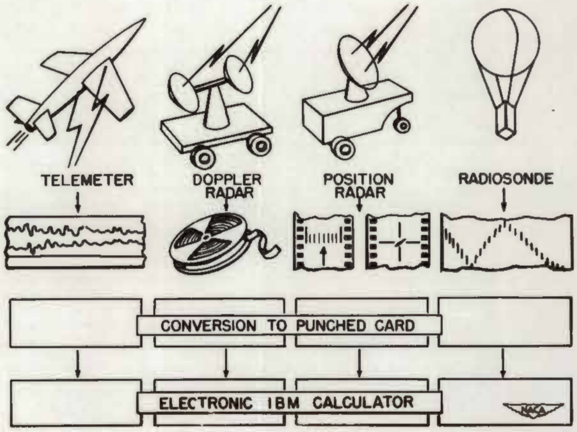
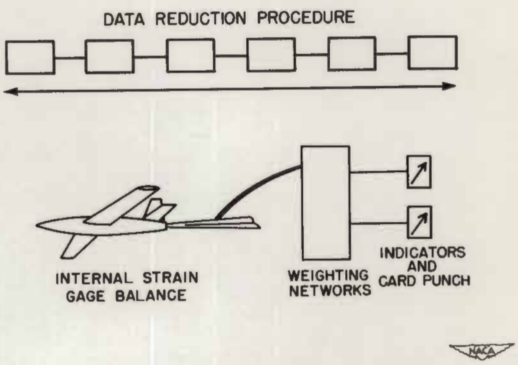
CONVERT MEASUREMENTS
REDUCTION
RECORD DATA
PROCEDURE
EDIT AND READ
CALCULATE
TABULATE AND PLOT


DATA REDUCTION PROCEDURE
AIRFOIL
OPTICAL PRESSURE PICKUPS
DIAGRAM RECORD

LAL 71140





NACA
LAL 71141

Low-Speed Characteristics of High-Speed Plan Forms

By Ernst F. Mollenberg and Stanley Lipson
Author: Robert H. Neely

Presented at Full-Scale Tunnel

LAL 1951 Biennial Inspection

The Langley Full-Scale Tunnel is a large-scale, low-speed test facility in which both helicopter and wing research is conducted. The tandem helicopter, which you saw as you came in, is one of a group of configurations to be studied in a general helicopter investigation. At one of the other facilities that you will visit later today, a detailed presentation will be given of some of the more pertinent results of the NACA's helicopter work, so we will say no more about helicopters at this time. The thick high-aspect-ratio wing in the corner is being used in a study of boundary-layer control for long-range aircraft. Tests of this wing have not yet begun.

What we want to discuss here is some of the NACA's work on the landing-speed characteristics of sweptback wings. These characteristics have been the subject of considerable research in all of the NACA's large-scale wind tunnels. Representative plan forms of wings which have been tested are shown on this panel. We have tested a considerably larger number of wings than shown here and have made several types of tests on each wing. On this wing, for example, we have studied flow characteristics, lift and drag characteristics, longitudinal stability with and without a tail, lateral stability, and lateral control. We have been able to generalize our test results so that reasonable predictions of some of the low-speed characteristics can be made for wings of this type. I would like to review these generalizations regarding flow phenomena, maximum lift, and longitudinal stability.

1951 BI
F.S.T.
Mollenberg
Lipson

With regard to the flows associated with the stall phenomena, it is well known that the stall of these wings is characterized by initial flow breakdown at the tips - or tip stalling; however, the precise nature of this tip stall may be different for different wings. The flow phenomena may be classified into two predominant types. These two types of flow are illustrated by diagrams in this chart. Down here, the pitching moment is plotted against the lift. The circled points represent conditions corresponding to the flow diagrams. Let us consider the flow over this wing (left side), which has a round-nose section of moderate thickness. The spanwise flow near the wing surface causes the boundary layer to build up along the rear part of the wing near the tip. With increasing angle of attack, this region of low-energy air expands until eventually the tip sections stall out. For this wing, the pitching moment is zero up to high lifts, which means that the lift is equally disposed about the center of gravity (point to line). When the tip stalls, lift is lost at the rear part of the wing. As a result, the nose pitches up and the airplane goes even further into the stall. This means that the wing is unstable. If the aspect ratio is large, that is, if the wing is long and slender, the build-up of the boundary layer will cause this nose-up moment to develop at lower lifts; that is, the moment curve will start swinging up sooner.

In the case of thin wings or wings with small leading-edge radii, a different type of flow is encountered. This flow is illustrated here for a sharp-nosed wing (right) having the same plan form as this wing (left). At fairly low angles of attack, the flow separates around the leading edge and then reattaches to the wing surface. Within this separated region, a vortex is formed which lies along the leading edge and trails off over the tip sections. As the angle of attack and lift increase, the vortex moves inboard as shown in this diagram. Outboard of the vortex, the wing is stalled. Over the area occupied by the vortex there is an increase of lift. Therefore, when the vortex passes over the tip sections, the lift behind the center of gravity is increased so that a nose-down moment is obtained. When the flow is as shown here, the decreased lift due to stalled flow and the increased lift due to the vortex cause the resultant lift force to move ahead of this line, which results in the nose-up moment shown here. Both wings exhibit this undesirable nose-up moment change. However, it should be noted that the wing with vortex flow also shows this large nose-down moment change which may be undesirable. It is important to know what type of flow is occurring on a wing. The type of flow affects other characteristics besides the pitching moment and determines the line of approach to be followed in improving the wing characteristics.

In order to help you visualize these two types of flow, we will now show a short movie illustrating the flows by means of tufts. The first part of the movie shows the flow over the wing on the left.

Start movie.

α = 12.7-----This angle of attack is well below the stall. The camera is first focused on the left wing tip, and it will gradually move over to the right. The direction of the airflow is down. At this angle, the flow is smooth but there is a slight lateral flow of the boundary layer near the trailing edge.

α = 18.0-----This angle is a half degree below the stall. Here, the cross flow is very severe and extends over a considerable part of the chord, particularly at the tip.

α = 18.5-----At this angle, the wing is stalled as indicated by the violent behavior of the tufts. As we go to the right panel, note that the tip is first unstalled and then stalled.

We will now show some flow studies on a wing which has the vortex type of flow at an angle of attack where the vortex has moved considerably inboard of the tip. For this case, a single tuft attached to a probe is used because surface tufts would not indicate the phenomena adequately.

Here, the path of the vortex across the wing is traced. The tuft whirls rapidly when it is at the center of the vortex. Now, a traverse is made straight across the wing to show the different regions of flow. Here, we start further back. The tuft is in the region of the vortex. Note that there is a secondary vortex. Now, we make a traverse still further back. Note that the vortex center is well defined. Finally, we retrace the path of the vortex. Development of vortices downstream of a wing will be shown at the 7- by 10-foot tunnel later in the day.

It is possible to predict on what wings these flows will appear. The basic parameters that determine the flow are the wing nose radius and sweep angle. On this slide we have plotted an empirical boundary curve as a function of the sweep angle and nose radius. Increasing nose radius is up and increasing sweep angle is to the right. In this region the stall tends to build up from the rear; in this other region the vortex flow is obtained. Near the boundary, both types of flow may appear on a given wing. It can be seen that the vortex flow occurs for a greater range of nose radii as the sweep angle increases.

The airfoil nose radius and sweep angle also have an important effect on the maximum lift. In this slide the maximum lift is plotted against the sweep angle for sharp- and round-nose airfoil sections. The sharp-nose airfoil has a low maximum lift at zero sweep, but it increases as the sweep increases. The upper curve represents, roughly, the maximum measured lifts for round-nose airfoils. A greater lift is obtained at zero sweep, but the lift decreases as the sweep increases.

The maximum lift values shown on this slide are not necessarily usable values because of the longitudinal instability near the stall that was shown on the first slide. For a large number of swept wings, this instability at high angles of attack poses a fundamental problem. The approach consists of controlling the flow over the wing. On this slide are shown the various methods of controlling the flow that we have investigated. The devices are shown mounted on a semispan wing (Point to bottom configurations). Enlarged sections through the wing nose are shown in some cases. Shown here are:

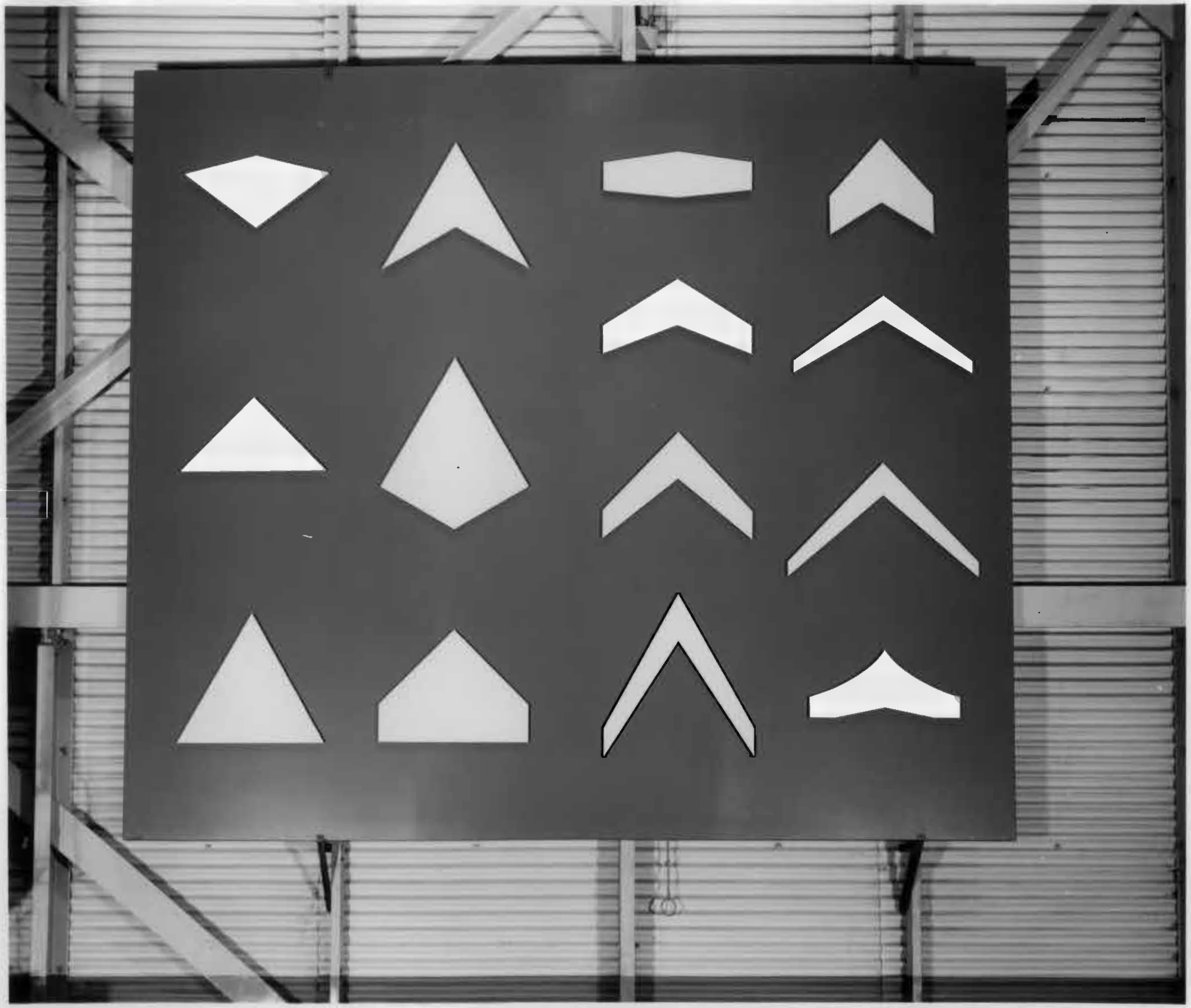
1. a Krueger type leading-edge flap,
2. a slat,
3. a single suction slot located near the leading edge,
4. area suction through a porous material,
5. a droop-nose flap,
6. a fence,

and 7. a leading-edge chord extension.

A considerable amount of research has been conducted, from which a number of important principles have been determined to aid in the selection and design of the devices. It has been found that the type of flow over the basic wing influences the choice and design of the device, as shown, for example, on these two models. These two models were tested in the 19-foot pressure tunnel. For this wing (left), which has the vortex type of flow, we were able to obtain satisfactory stability by using this simple chord extension. On this wing, which has the other type of flow, a leading-edge slat and fence were employed. The fence was used to minimize the bad effects of the spanwise boundary-layer flow.

In conclusion, our position regarding the low-speed characteristics of sweptback wings is that we possess a working knowledge of the flows, know the aerodynamic properties of a large family of wings, and have a large amount of basic aerodynamic information needed for the improvement of certain characteristics.

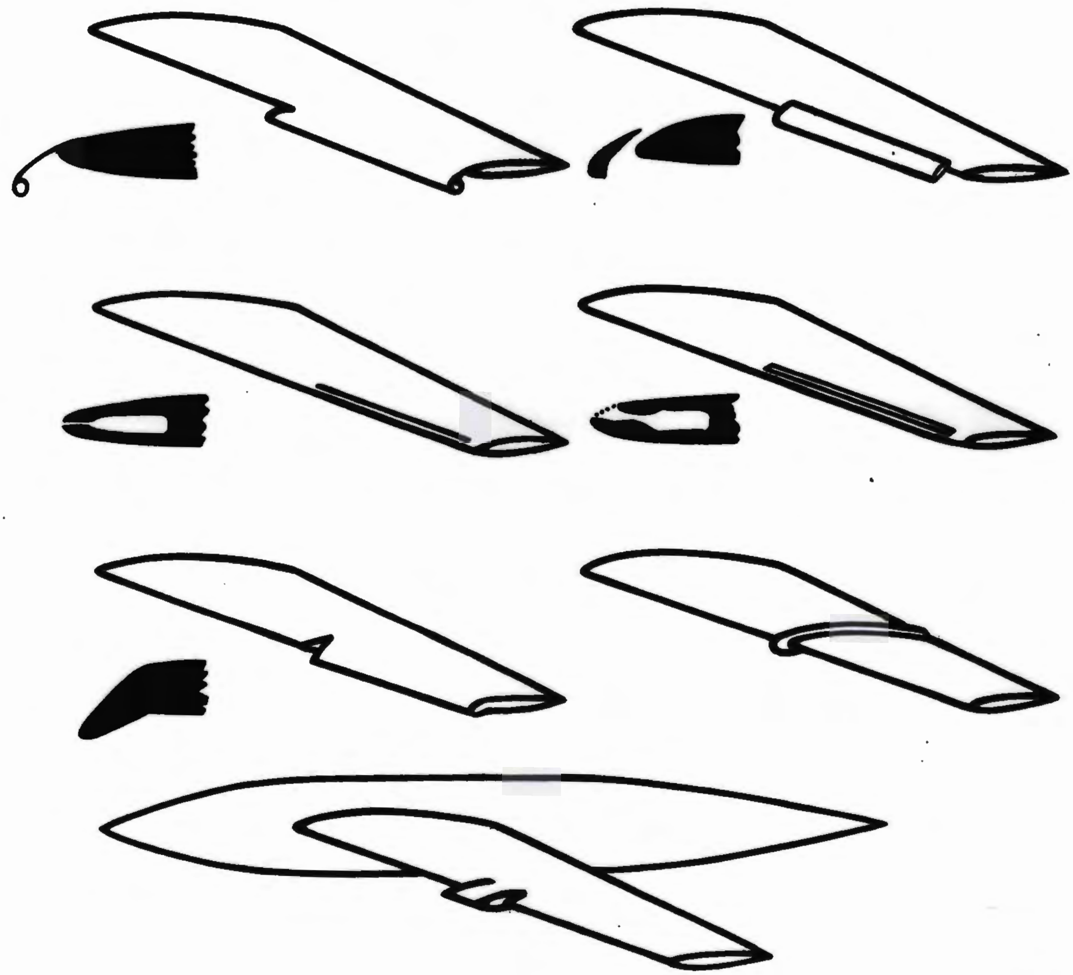
LAL 70621



NACA

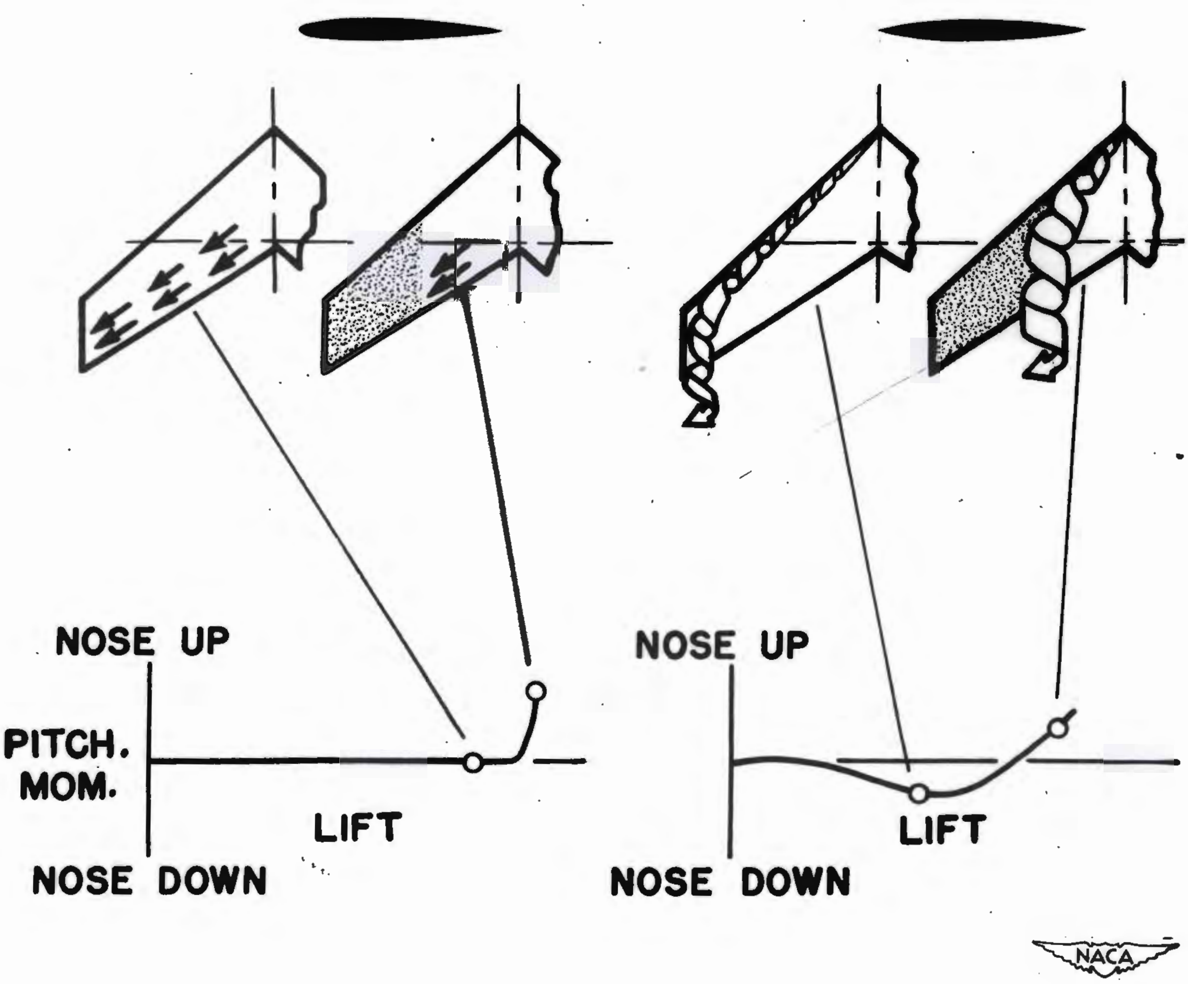
LAL 70622

FLOW CONTROL DEVICES



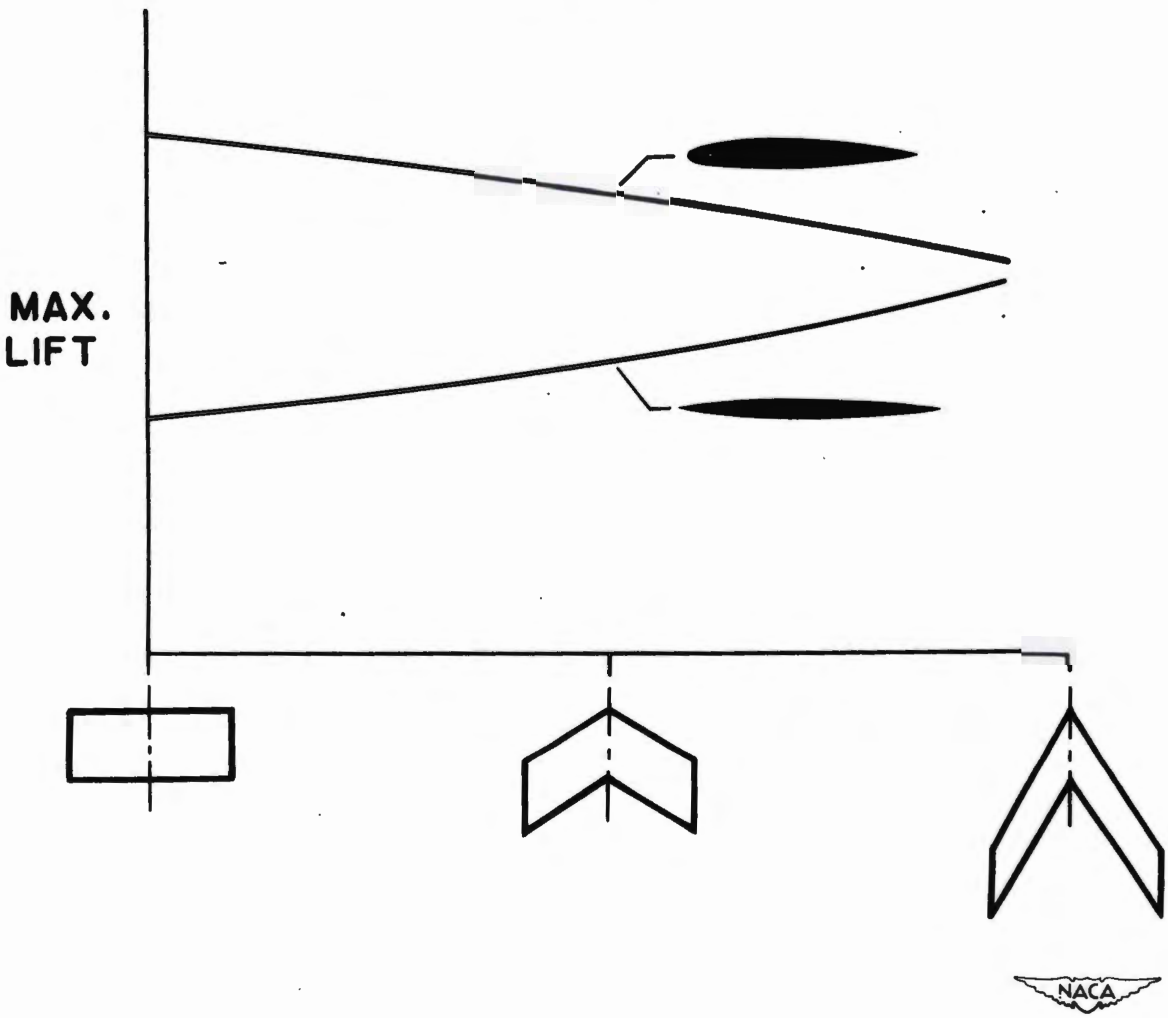
LAL 71092

TWO TYPES OF FLOW

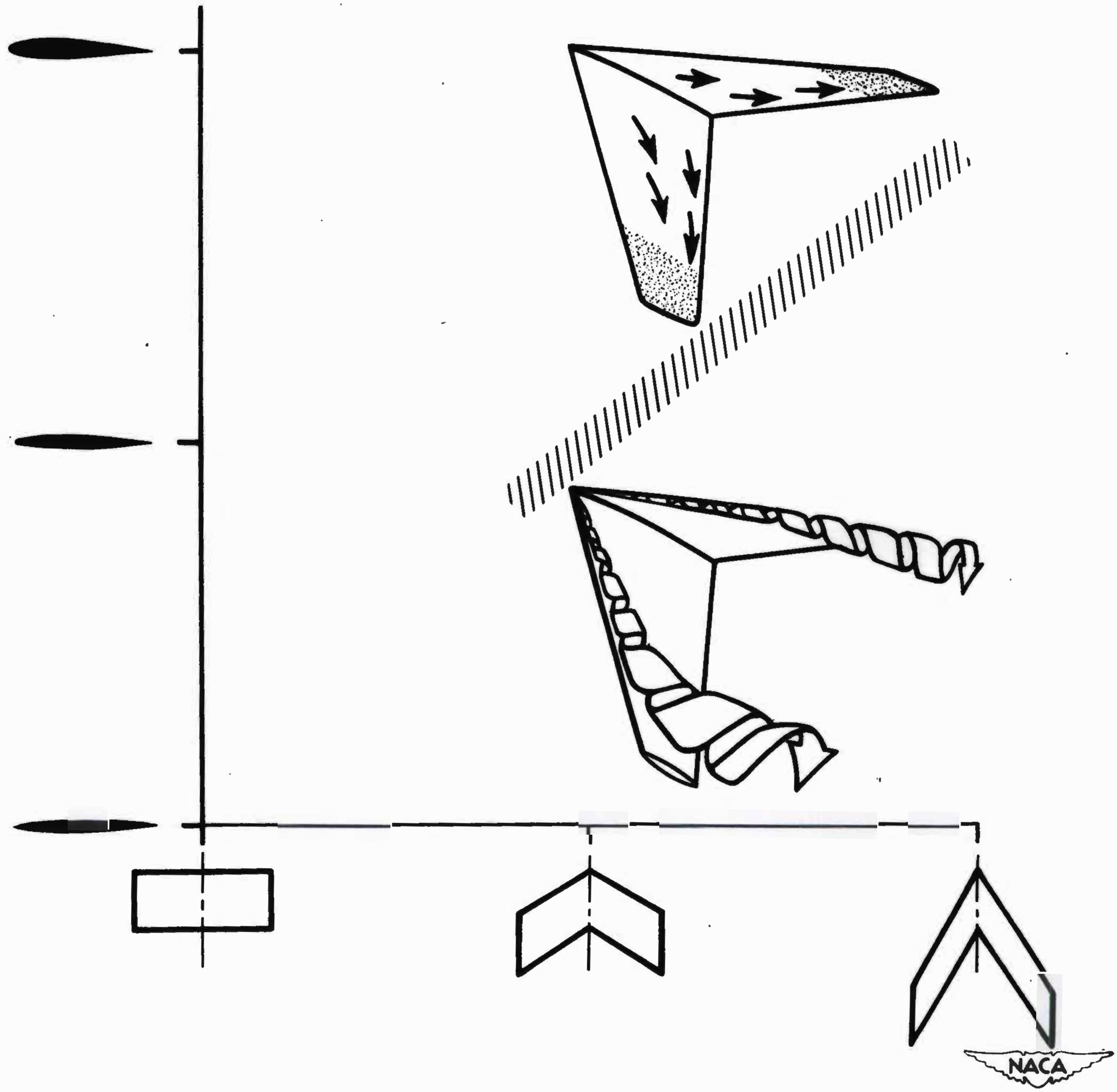


NACA
LAL 71093

NOSE RADIUS AND SWEEP AFFECT MAXIMUM LIFT



NOSE RADIUS AND SWEEP DETERMINE FLOW



NACA
LAL 71095

1951 MAY INSPECTION

Vibration and Flutter Branch

PROPELLER FLUTTER

by John E. Baker and A. G. Rainey

I. INTRODUCTION

At this location we are concerned with many types of dynamic problems involving oscillatory phenomena. Our program today will consist of three talks which are concerned with various aspects of the flutter problem. The talks will deal with propeller flutter, oscillating air forces, and dynamic models.

I would like to discuss first, propeller flutter.

II. FLUTTER OF THIN PROPELLERS

Propeller flutter has been recognized as a problem since World War I. Early investigations of propeller flutter indicated that making blade sections thicker was one of the most effective ways to relieve the problem. Thick sections could then be employed without significant aerodynamic losses since these propellers were not required to operate at high speeds. For propeller-driven transonic aircraft, however, propellers must have thin blade sections in order to obtain good aerodynamic performance. As a consequence, propeller flutter has now become a critical factor in the design of these thin propellers. I have here two of the simplified test models used in studying the flutter of blades having thin sections.

It may be of interest to give a laboratory demonstration of propeller flutter, which some of you may have seen before. A flashing light illuminates the blade tip at a given point in each revolution. In addition to the sound accompanying flutter, you may observe the flutter visually by noting the image of the white blade tip in the mirror. Note that this type of flutter occurs primarily as a torsional oscillation. The flutter you are about to see on this model will not be destructive.

Demonstration (see Appendix)

It may be mentioned that the flutter problem is also of importance for compressor and turbine blades, for which similar phenomena to propeller flutter have been encountered.

A few technical aspects of the propeller flutter problem can be illustrated with the aid of this chart. The ordinate is the flutter speed in terms of tip Mach number, and the abscissa is a flutter parameter which contains the physical properties of the blade, chord and the torsional frequency, and also the speed of sound of the test medium. The areas enclosed by the curves indicate flutter regions at high angles-of-attack and at low angles.

For a given propeller the chord and torsional frequency are fixed and, if the speed of sound is held constant, the operating conditions of the propeller are represented by a vertical line. Propeller blades having values of the flutter parameter in this lower range, having rectangular planform blades and thin sections would look like the left hand propeller. The blade mounted on the stand would fall about here (about half way to first line). Making the chord greater would increase the value of the flutter parameter, and shortening the blades raises the torsional frequency which also raises the flutter parameter. Blades having the same percentage thickness as the left hand propeller, but with values of the flutter parameter in this range (larger value line) would look like the right hand propeller.

Propellers must operate over a wide range of conditions. In normal flight the blades operate at low angles-of-attack where the flutter region is very small. However, during the take-off the blades operate at fairly high angles-of-attack where the flutter region is considerably expanded and flutter speeds are lower.

Our experimental studies of propeller flutter, at high speeds showed a beneficial effect of Mach number, in that, the flutter boundaries turn back rather than continuing as straight lines. Although this upper portion of the flutter boundary is not fixed as yet, there is considerable experimental evidence that it exists in the manner shown here. This aspect of the propeller flutter problem is being studied further. The turning back of the flutter boundary makes it possible to design blades having thin sections that will be completely free of flutter, and such a blade is indicated by the right hand propeller. It can be seen that the line representing this blade does not come in contact with the flutter region at any operating condition.

A propeller such as this one on the left could also be used without encountering flutter by means of proper programming of operations. For instance, this propeller could be brought up to speed at low angles of attack without fluttering, since its operating line does not intersect with the flutter region. Then the angle-of-attack could be increased to the high values necessary for the take-off without causing the propeller to flutter, since the operating condition is still outside the flutter region. Of course, the opposite procedure must be followed in stopping the propeller if flutter is to be avoided.

Thus two ways of circumventing flutter on thin high speed propellers have been mentioned. One, build blades such that flutter will not occur at any operating condition (right hand propeller), and, two, program the operation of blades that could flutter in such a way as to avoid the flutter regions. Although I have indicated methods of avoiding flutter, there may be aerodynamic and structural problems as well as other vibration problems, that must be considered before such propellers can be used successfully.

Mr. Martin (or substitute) will now speak on oscillating air forces.

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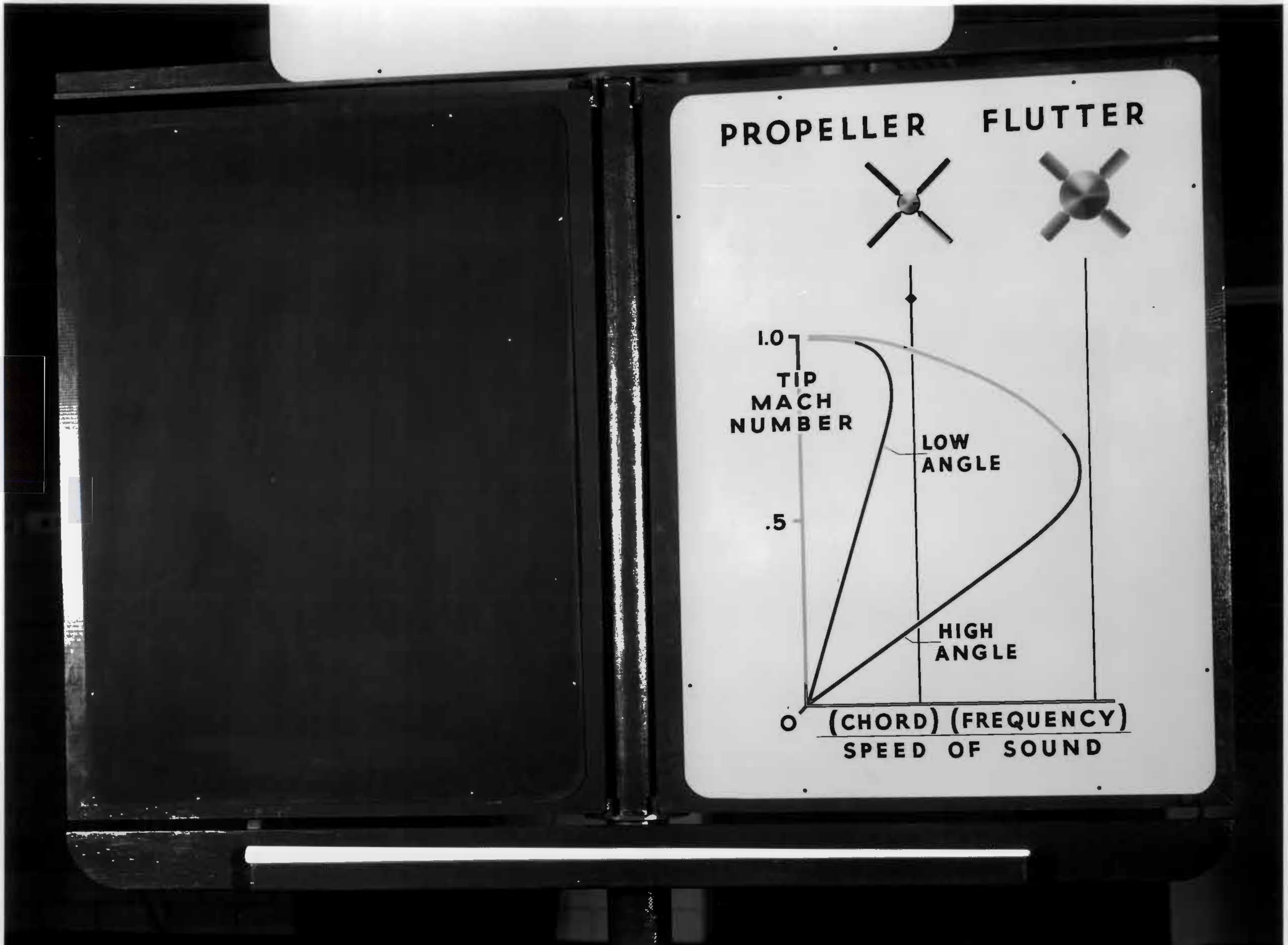

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LAL 70558

1951 MAY INSPECTION

Vibration and Flutter Branch

OSCILLATING AIR FORCES

by D. J. Martin, S.A. Clevenson, E. Widmayer, and D. J. Woolston

You have just seen some propeller flutter. There are many types of flutter that are encountered on aircraft, propellers, turbines, helicopters, etc., and there are many speed ranges and conditions in which the phenomena are different. In order to calculate the critical conditions for any of these flutter phenomena it is necessary that we know many parameters, both aerodynamic and structural. I would like to talk mainly about the aerodynamic quantities that we need.

Some of the aerodynamic quantities can be illustrated in this chart. The information for this chart has been calculated for a wing that would be oscillating many times a second at a certain forward velocity. The wing is oscillating in pitch about the midchord and its angular position is plotted against time and is shown by the heavy solid line. Now for comparison, if we used steady state aerodynamic data, the lift, for example, would, of course, be in phase with the motion and if plotted here would follow the same curve as the angle. However, the actual lift on the airfoil is shown by the dotted line and you can see that the lift reaches a maximum before the motion reaches its maximum. In other words there is a phase difference between them and in this case the lift leads the motion. You can also see that it differs in its maximum value from that found from steady state data. A similar situation also exists for the moment which is shown by the dashed line. The moment in this case lags the motion.

The magnitudes and phases must be known as they determine whether energy is being transferred into or out of the structure. Thus we need to know four quantities to describe the aerodynamics for a simple motion of this type, namely magnitude and phase of both the lift and moment. Furthermore, it is necessary to know these four quantities for every motion or degree of freedom entering into flutter.

The oscillating forces, moments and phases have been derived theoretically for rather idealized conditions and have proven most useful in all types of flutter calculations. There are however, many flight conditions and configurations that stretch rather severely the assumptions of the theory and there are other conditions for which no theory exists. It is for many of these cases where we need experimental measurements of the oscillating air forces.

I would like to describe two of the techniques that we are using to make direct measurements of the oscillating air forces. One is where we force a wing, like this dummy wing, to oscillate in a prescribed manner and to then measure the resulting air forces by means of the small NACA inductance type pressure gauges mounted in the wing to measure the instantaneous pressure distribution which can be used to determine the magnitudes and phases of the lift and moment.

Another technique is one in which a wing which is similar to this one is mounted on quick response strain gauge beams. The wing is then forced to oscillate in an airstream and the resulting lift, moment and phases are measured on the strain gauge beams and from the power required to oscillate the model. Additional information on the spanwise load distribution is determined by means of a number of the small NACA pressure gages which are mounted in the spanwise direction.

This is a removable test section in which the wing is mounted. The test section is mounted in the Flutter Research tunnel which directs air in this direction. One sidewall has been removed so that you can see the test wing. This wing is of aspect ratio 2. Other aspect ratios and other plan forms such as delta and swept wings may also be studied in this apparatus. The wing will now be oscillated by turning on the power to the magnetic shakers which are used to force the wing. This wing is oscillating about the midchord. The oscillation is from plus to minus 2° and the frequency is 30 cycles per second.

Methods such as these of making direct measurements of the oscillating air forces may add materially to our knowledge and understanding of many parameters of interest in flutter. However, another method of studying flutter on which we have had to rely almost exclusively is where we measure the flutter speed of various model configurations under various conditions. Many experimental facilities are used, subsonic, transonic and supersonic wind tunnels, bomb drop or freely falling bodies and by the use of rocket vehicles. At the PARD there is an exhibit which illustrates the use of rockets in flutter testing.

The method of measuring the flutter speed gives an integrated answer in which the aerodynamic and structural quantities are intermingled and it is not possible to work backwards and find out what the contributions of all the component parts were. These experiments are used to obtain answers to specific problems, check theories, establish trends and to ascertain what parameters are significant to certain configurations.

The models used range in complexity from very simple cantilever wing models to very complex dynamically similar models. Some typical models can be seen over here. These models vary in construction and in purpose. Here are two delta wing models, one mounted cantilever, the other has a rolling degree of freedom. Rib and spar models, fighter type, bomber type, wings with spoilers, varying sweep angles, simplified laboratory models, taper and various other planform and configurations. An example of this approach with regard to a complete dynamically scaled jet helicopter will be presented by the next speaker, Mr. Brooks.

1951 MAY INSPECTION

Vibration and Flutter Branch

DYNAMIC MODELS

by Geo. W. Brooks and M. Sylvester

As indicated by the previous speaker, much flutter testing has been done of component parts of aircraft by use of simplified models of the components. If the flutter of the components can be treated as isolated problems, as is often the case, dynamic models of the wings or tails may be tested in wind tunnels or on rocket and bomb vehicles in free-flight. In other cases the flutter and vibration problems may involve the elastic behavior of the entire aircraft and it may be necessary to test complete dynamic models of the aircraft under free-flight conditions.

Recent design trends, particularly for very large aircraft, have indicated the need for flutter and vibration studies using completely scaled dynamic models. Such models are of necessity complex instruments to be had only at considerable cost and effort, but if properly designed they are capable of providing much useful information. They may be used to obtain data from actual vibration and flutter tests which cannot be obtained on the actual ship without risking destruction. They may be used to indicate the beneficial or detrimental effects of changes in design; a particularly desirable feature for non-conventional types. In essence, such models are effective mathematical and physical analog computing machines in that they may be used to help set up and solve certain complex vibration and flutter problems which are difficult to formulate let alone solve.

This dynamic model of a large jet helicopter is such a model. Because of the growing interest expressed in large helicopters and the unique design features of this particular helicopter, this model was constructed and tested to determine to what extent available theories may be applied to predict the behavior of such aircraft under free-flight conditions. In addition it was considered desirable that the model be dynamically scaled in order that the results of the model and full scale tests might be compared.

In consideration of the vibration and flutter problems involved, the flexibility and damping of the tires, landing struts, and pylon as well as the rotor characteristics were all important parts of the problems, hence, it was necessary to scale the full scale properties of these essential components. The projections which you will see as I rotate the blades toward you are counterweights which are used to adjust the blade flutter characteristics. Since the problems also depended on the flight condition, it was necessary to fly the model with various loadings and to make various types of take-offs and landings.

The model tests in connection with these objectives have been successfully completed; and the model behavior correlated well with that of the full scale ship in so far as the ship has been tested. In an effort to establish the flutter trends and margins for various changes in the design parameters, flutter was obtained on the model many times. Theoretical flutter calculations have been made for different values of blade mass, damping and stiffness and the trends obtained from theory and experiment by variation of the flutter parameters are in good agreement. One significant conclusion drawn from the tests is that the predominant modes involved in the flutter of the model were the flapping mode and first torsion mode.

We should now like to give you a flight demonstration. Since the flutter of the blades is a rather violent and dangerous condition, we will not demonstrate flutter on the model but the flutter will be shown by a short movie following the flight demonstration. The model is powered by compressed air which passes up through these plastic tubes, out through the blades and is expanded through the tip jets. It is equipped with conventional control devices but for demonstration purposes the controls will be fixed and the model will be controlled by the cables attached to the lower bay of the fuselage. The cables attached just below the pylon are safety cables.

The flutter which you will see in the movie was photographed with a camera mounted on the pylon and turning with the rotor as illustrated by this camera model. There will be some downwash during the demonstration so you might be careful of your cigar ashes.

FLIGHT DEMONSTRATION

Remarks Before the Movie

As I mentioned before, the movies which you will see were taken with a camera directed toward the blade tip. The motion is slowed down about 5 times and you will see the blades just before the flutter speed is reached and during flutter. The increased drag induced by the flutter is an effective safety feature in that it slows the rotor down and momentarily stops the flutter. The speed then increases and the flutter reappears. For this reason the flutter occurs intermittently.

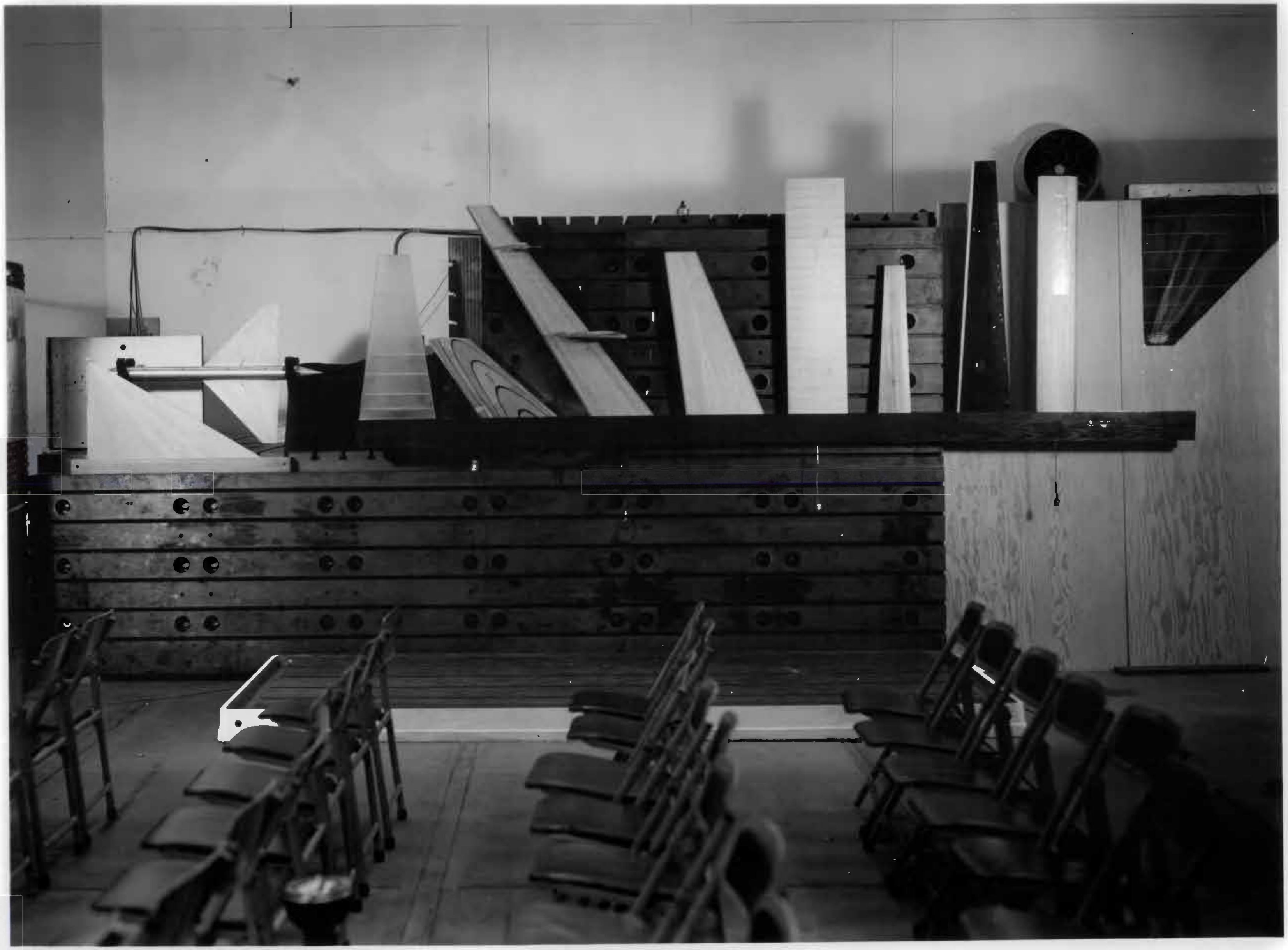
Remarks During Movie

The rotor speed is now approaching the flutter speed and about 70 percent of the blade is visible. The blade is now fluttering.

FINAL REMARKS

In conclusion it might be mentioned that both the simple dynamic model and the completely scaled model are playing important roles in research. In addition, completely scaled models such as the helicopter model which we have demonstrated are particularly useful in the evaluation of unique designs and modifications.

This concludes the discussion at this location. If you desire you may inspect the various models on display.



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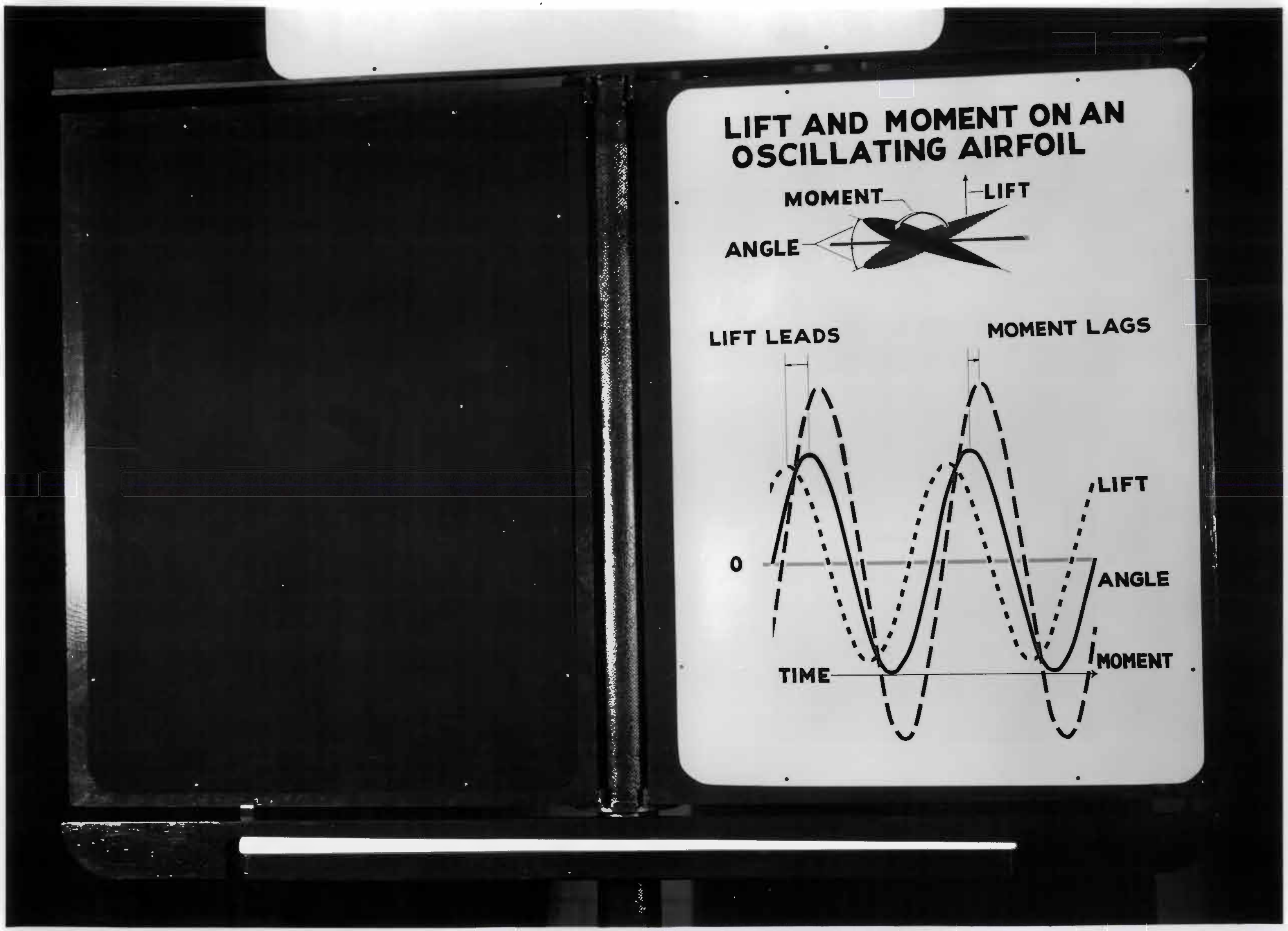

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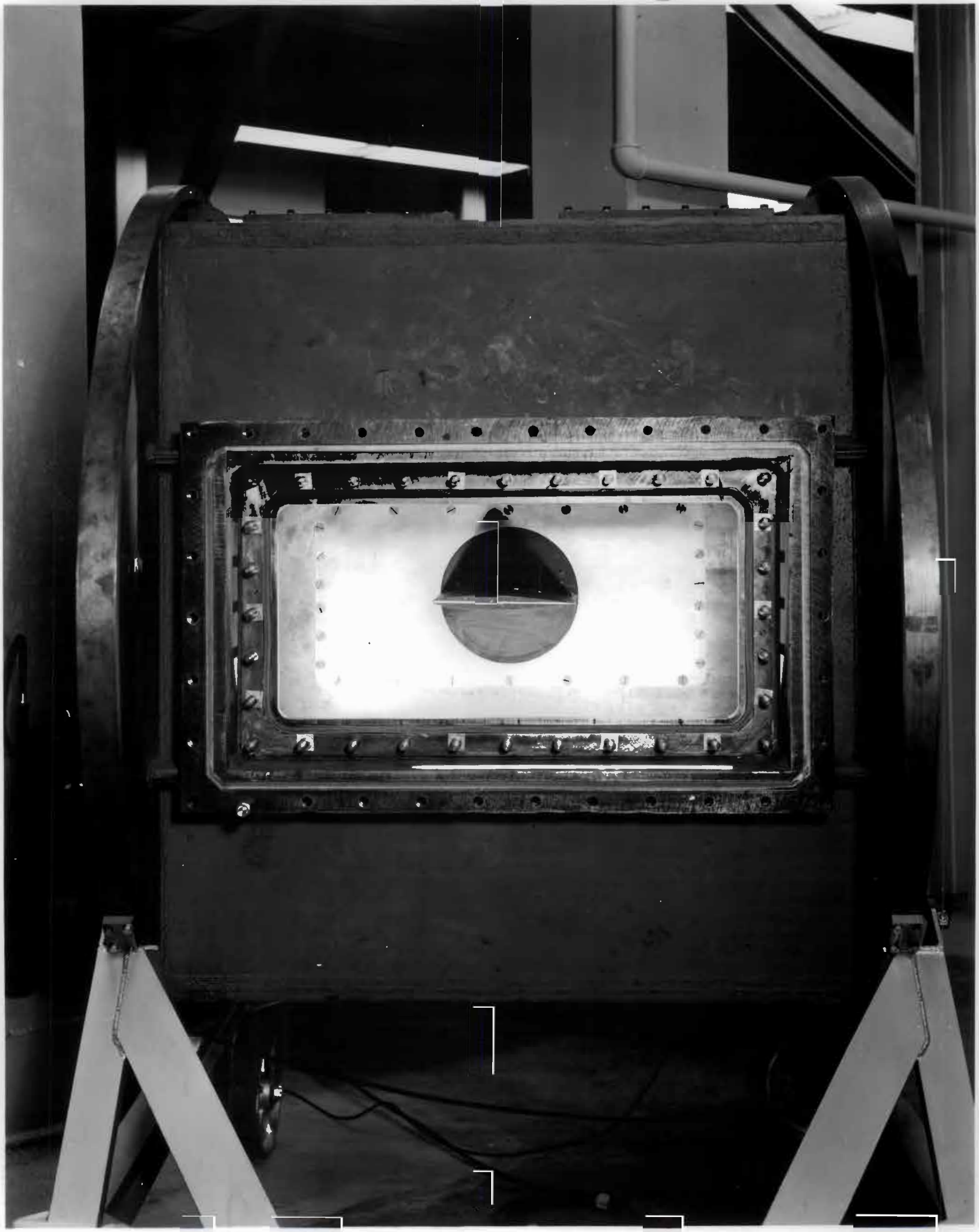

NACA
LAL 70559

11-INCH HYPERSONIC TUNNEL BIENNIAL INSPECTION TALK 1951

A great deal of effort is being expended in providing research data for missile designs in the Mach number range up to about 3. There are, however, certain applications where much higher maximum Mach numbers are contemplated - Mach numbers in the range of 5 to 10 and even higher. In order to explore the aerodynamic problems at these extremely high speeds, new equipment and techniques have been recently developed by the NACA. One of these facilities is this 11-inch hypersonic tunnel which was put into operation in 1947. The principal elements of this tunnel are shown schematically on this chart (chart 1). Air is stored in a high-pressure tank at 730 psi which is 50 times atmospheric pressure. From the high-pressure tank the air passes through a heater, settling chamber, nozzle, test section, cooler, and vacuum tank. Only this portion of the tunnel can be seen here in this room and the test section is located here. Mach numbers in the range of 5 to 10 are obtainable. If the tunnel were a lower speed tunnel, say for a Mach number of 2, the pressure in the high-pressure tank would only need to be twice the pressure in the vacuum tank. However, at a Mach number of 7, the pressure in the high-pressure tank must be at least 100 times the vacuum tank pressure in order to establish the flow in the nozzle.

The nozzle, in which the air is accelerated to the high Mach number, is shown schematically at the top of the next chart (chart 2). For a Mach number of 7, the air must pass through this very small slit which is only 1/10 inch high. The large increase in area which follows is required to develop a Mach number of 7 in the test section which is 11 inches high. In passing through this nozzle the large changes in area are accompanied by large changes in pressure. Assuming a pressure of 35 times atmospheric pressure in the settling chamber at this point, the pressure in the test section would drop to only 1/100 of atmospheric pressure. This very low pressure creates problems in flow measurement and visualization. The large pressure change is accompanied by a very large temperature change through the nozzle. If the air is initially at room temperature, the temperature will drop along this dashed curve to about 410° F below zero. This is well into the shaded region in which the air will liquefy. This liquefaction is a problem peculiar to wind-tunnel operation. A heater which could provide air temperatures up to 800° F was therefore included so that the formation of liquid air particles could be either studied or entirely avoided. With the temperature in the settling chamber of 700° F the temperature will drop along the solid curve and will remain above the liquid air zone. Very shortly after the tunnel was put into operation it was determined that liquid air particles actually were present when the air was not heated. It was also found that liquefaction could be avoided by use of the heater. All aerodynamic tests, of course, are made with the heater in operation.

We are now preparing to make a run without heat in which you will be able to observe the presence of the liquid air particles in the tunnel. The sound you have just heard is the opening of the valve to the vacuum tank. One of the methods that we have developed to show the presence of liquid air particles utilizes a strong beam of light passed through the test section (beam on and lights off). Without the flow, reflections are seen where the light beam passes through the test section windows. The light beam cannot be seen in the test section. This is exactly the same appearance as obtained in the heated condition. Without heat, the liquid air particles in the stream scatter light making it visible, giving the familiar appearance of a strong light beam passing through an ordinary fog. It must be emphasized that the air is dry and that the fog that will be seen is a fog of liquid air particles and not a fog of water particles.

The tunnel is still being prepared for the demonstration run. The starting sequence employed consists of first opening the valve to the vacuum tank exposing the nozzle and test section to the low pressure. Next, the valve just downstream of the heater will be opened exposing the heater to the low pressure. It should be pointed out that the heater will be cold during this run in order to maintain the air temperature entering the nozzle at about room temperature. The run will finally be started by opening the valve just upstream of the heater. The pressure in the settling chamber will be maintained at approximately 30 times atmospheric pressure.

The run will now begin. Be sure to direct your attention to the test section.

After demonstration

Valid aerodynamic tests cannot be made with the liquid air particles in the stream which you have just observed. Since they are not present in flight, all aerodynamic tests are made in the heated condition in which liquefaction is entirely avoided. The next speaker, Mr.   , will summarize some of the results obtained in this facility.

Speakers:

(1) Charles H. McLellan
(2) Ralph D. Cooper
(3) Jim A. Penland

Second Half of Talk

One problem which we have investigated in this tunnel is development of the boundary layer at hypersonic speeds. The boundary layer is the layer of air adjacent to a moving surface which is dragged along with the surface due to the action of viscosity. In the next chart (chart 3), the great increase in boundary-layer thickness at hypersonic speeds is shown. Consider a wing flying through the stratosphere where the air temperature is -67° F, at a Mach number of 1.5 and also at a Mach number of 7. The shaded areas above and below the wing indicate the effective boundary layer. We find that at the lower Mach number the temperature rise through the boundary layer is just beginning to become important as the air temperature rises from -67° F at the outer extremity of the boundary layer to 110° F next to the surface of the model. At a Mach number of 7, the boundary-layer temperature increases from -67° F to 3,800° F near the model surface. This temperature is the temperature of the boundary-layer air near the surface and not the wing surface temperature. As discussed elsewhere during this inspection the wing surface temperature may be much lower. Associated with this high temperature there is approximately an eight-fold increase in effective boundary-layer thickness at the high Mach number. This thick boundary layer, in effect, changes the shape of the surface on which it forms so that the pressures on the surface are altered. At the bottom of this chart (chart 3), a thin wing is shown at a small angle of attack. The dashed line represents the pressure distribution that would be obtained on the bottom surface of the wing if no boundary layer were present while the solid line is that which is actually obtained in the presence of the boundary layer, the difference between the two being, of course, the effect of the boundary layer in altering the profile shape. This effect is of considerable importance at a Mach number of 7 on a thin wing and will assume even greater importance as the Mach number is increased still further.

In order to compare the nature of the flow at hypersonic speeds with the more familiar flows at lower speeds, the next chart (chart 4) has been prepared. At the left of the chart are sketches of the flow about wings in three speed ranges. At low subsonic speeds, at Mach numbers of the order of 3/10, no large disturbances are present in the flow. At a Mach number of 1.5 shocks are present at the leading and trailing edge. At a Mach number of 7 the leading-edge shocks are swept back close to the model. In the center of the chart pressure distributions are presented over the airfoils. The pressures are represented by the arrows. It can be seen from these distributions that at low speeds most of the lift is derived from the upper surface of the wing while at moderate supersonic speeds more of the lift is obtained from the lower surface. At hypersonic speeds, most of the lift is derived from the lower surface. If the Mach number were further increased this trend would continue until virtually all the lift was carried on the lower surface. To the right of this chart (chart 4) perspective views of a wing are shown for the three speed ranges. The blue shaded areas indicate the portion of the wings which are influenced by flows about the wing tips. At subsonic speeds, the flow about the wing tips influences the characteristics of all the elements of the wing having its greatest influence near the tips. Thus, the lifting efficiency of all the elements of the wing are adversely affected. In order to minimize this effect, large wing spans are used at subsonic speeds. At moderate supersonic speeds, disturbances from the tips cannot influence the flow ahead of these boundaries. The zone ahead of these boundaries at the center of the wing is undisturbed by the tip flow and has the same high lifting efficiency of a wing of infinite span. At hypersonic speeds, the boundaries of the tip disturbances are swept backward for the same reason that the leading-edge shocks are swept back. Thus, the area influenced by the tip is further decreased, leaving most of the wing area with a high lifting efficiency. Wings of small span in comparison to the chord can therefore be used without significantly reducing the lifting efficiency of the wing.

In the next chart (chart 5), the maximum lift-drag ratio, which is an index of the aerodynamic efficiency, is plotted against Mach number. The top curve is for a wing of infinite span with skin friction. This curve shows that at a Mach number of 1.5 the maximum lift-drag ratio is about 9 which decreases to about 6 at a Mach number of 7. The dashed curve is for a wing having a span equal to its chord. At low supersonic Mach numbers the lift-drag ratio is decreased considerably by the tip effects. As the Mach number is increased, the lift-drag ratio approaches that for the infinite span wing indicating that considerably lower span wings can be effectively used without seriously altering the aerodynamic efficiency. Also included on this chart is the lift-drag ratio variation of a typical body. Unlike the wings, the lift-drag ratio increases with Mach number indicating that at hypersonic speeds more of the lift can be efficiently carried on the body.

Up to this point we have considered Mach numbers of the order of 7. Here the air temperatures about the body are high - they are not high enough, however, to cause any significant change in the molecular structure of the air. At higher flight Mach numbers, that is, in the range above 10, the temperatures can become enormous becoming 10,000° F or greater, and can cause marked changes in the structure of the air passing about a body. Such high temperatures are not obtainable in wind tunnels but they can be realized by using ballistic techniques. In order to get some idea of the characteristics of these high temperature flows, small-scale exploratory ballistic tests are being made at this laboratory. By firing from a modified gun a small model similar to this through a stationary gas, a velocity of about 7,000 ft. per sec. can be obtained. In air at room temperature this corresponds to a Mach number of 6.5; however, if some other gas which has a low speed of sound is used, a Mach number of about 11 can be reached. By cooling the gas in order to still further reduce the speed of sound a Mach number of 17 has been obtained using a small sphere similar to the one mounted on this cartridge case.

This (chart 6) is a photograph of the flow about a conical-nosed body traveling through Xenon gas at a Mach number of 11. The gas temperature here behind the shock wave is calculated to be 19,000° F. This is high enough to cause significant changes in the molecular structure of the gas which can be seen visually because of the emission of considerable light as shown by the light area at the nose of the model.

Preliminary analysis of data obtained in exploratory tests of this kind indicates that the drag is not greatly affected as a result of these changes in the structure of the gas; however, there is an indication that the rate of heat transfer to the body is considerably increased. That is, the body temperature in flows of this type will increase more rapidly than expected from experience with ordinary air flow.

Some of the models used in the ballistic tests are shown here and a few of the models used in the 11-inch hypersonic tunnel such as this highly swept wing are shown here.

Speakers:

(1) Mitchel H. Bertram
(2) John A. Moore
(3) Alexander Sabol

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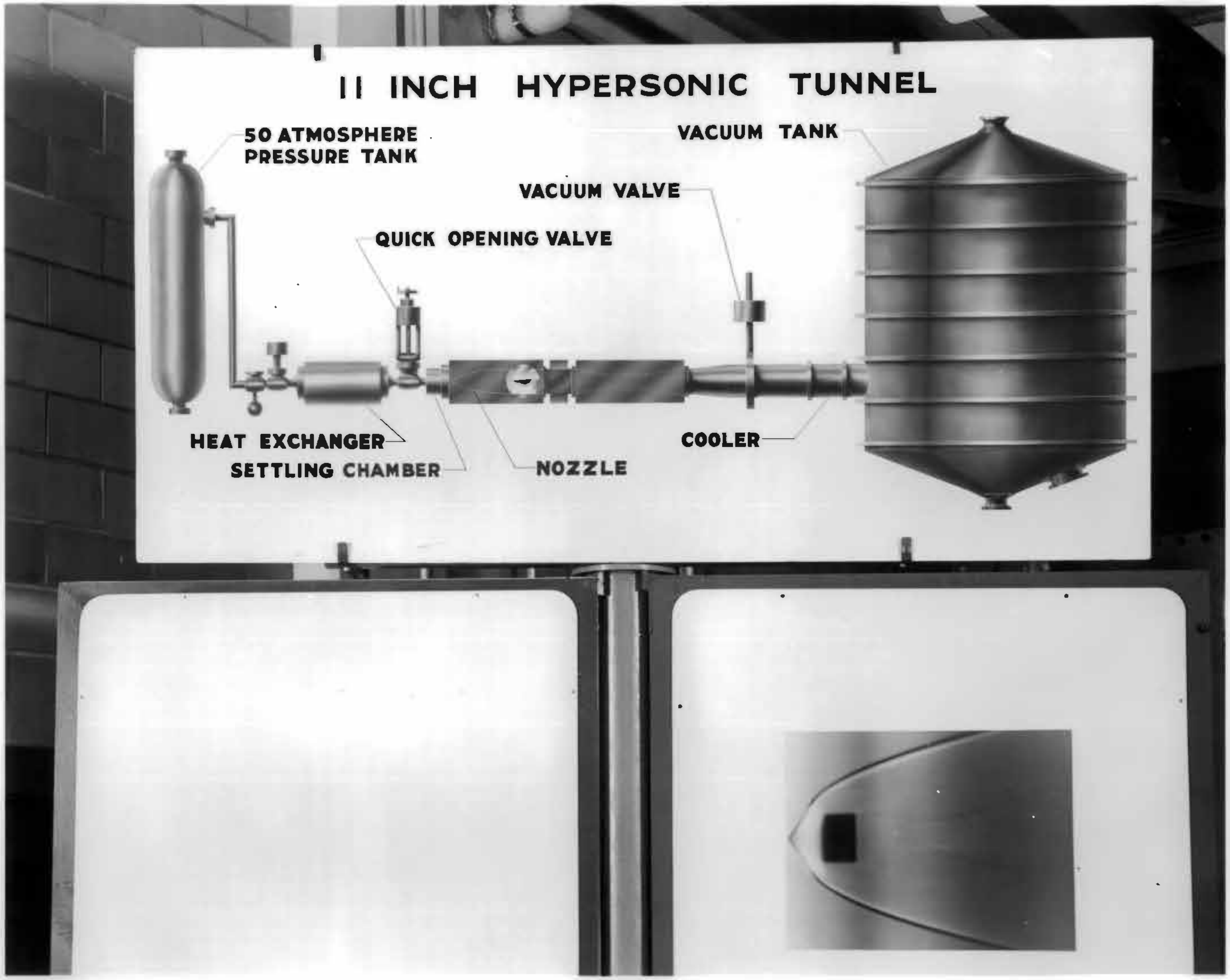

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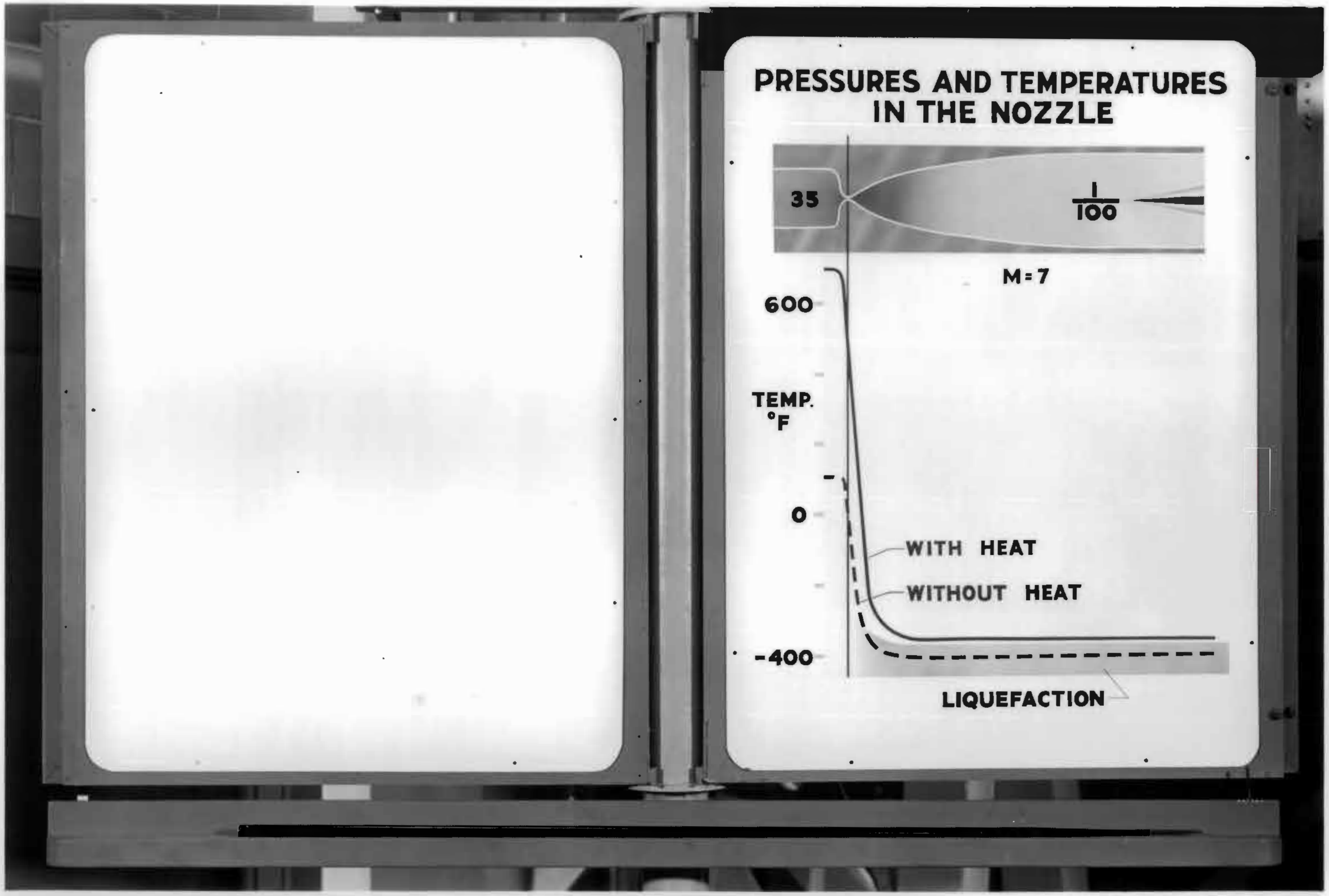

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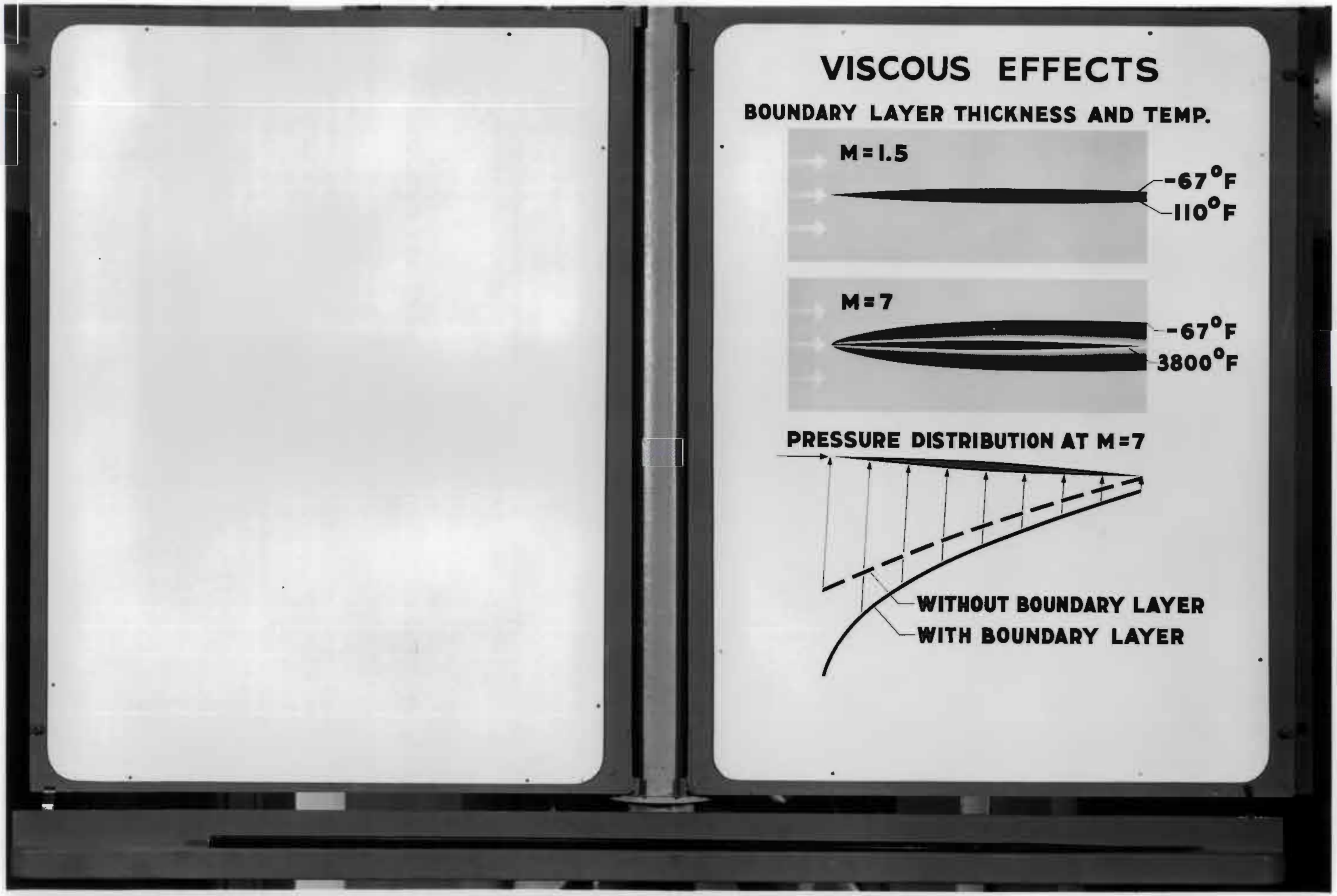

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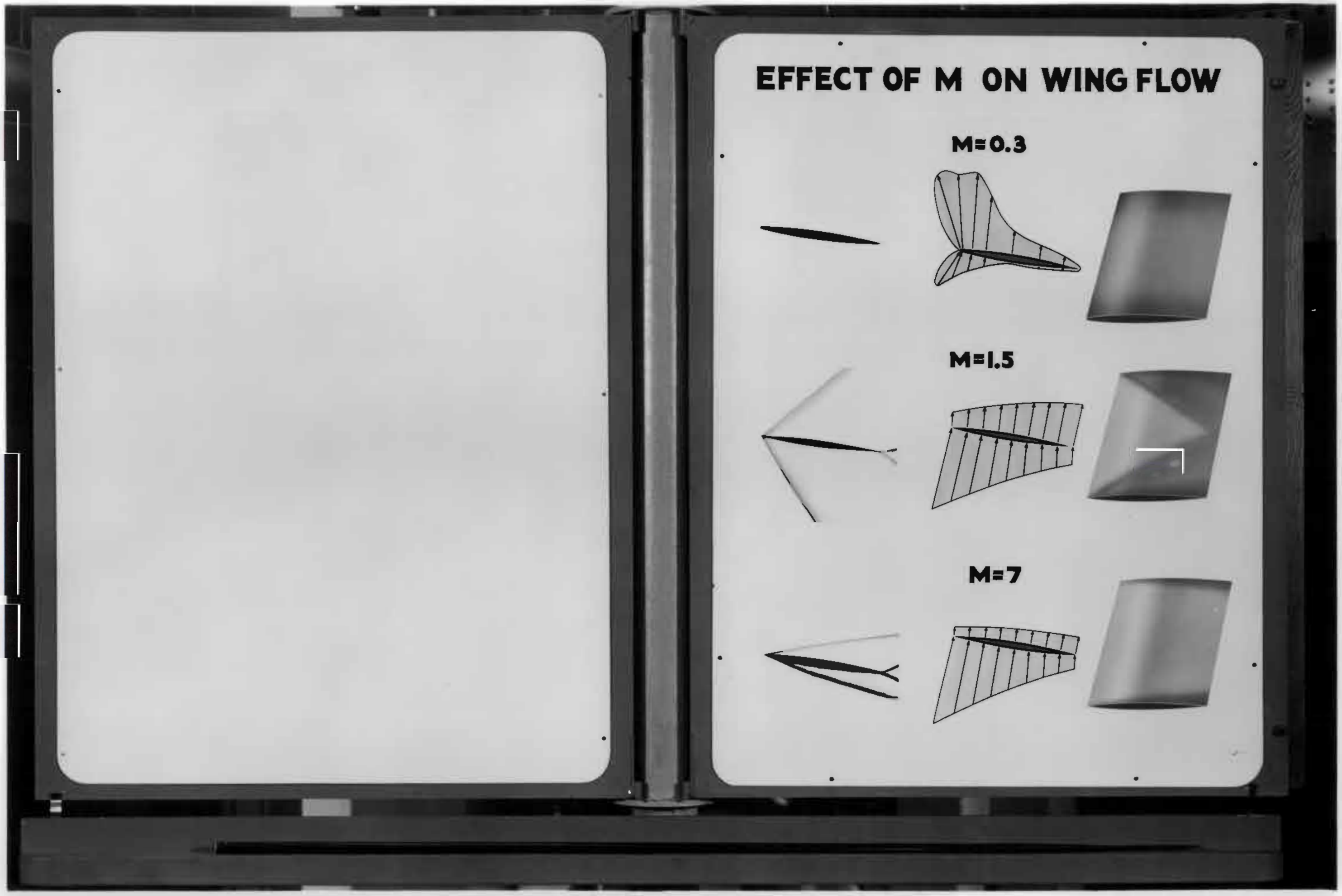

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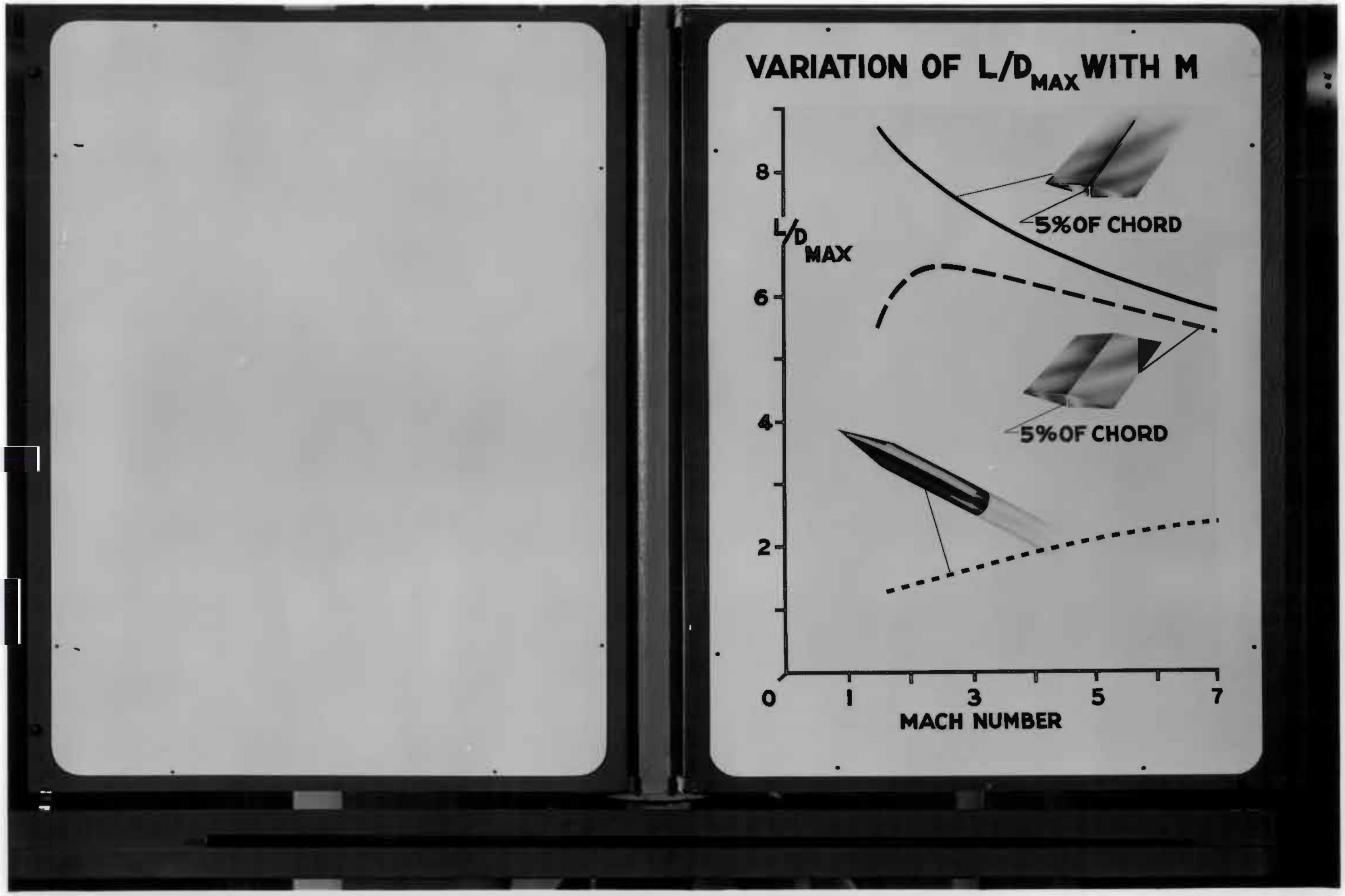

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LAL 70515

PARD BIENNIAL INSPECTION 1951

Introduction and Pulse Model

Presented by W. M. Bland, Jr., A. J. Vitale, E. M. Fields, and C. T. D'Aiutolo

You are now in the model assembly shop of the Pilotless Aircraft Research Division. Extensive use of rocket-propelled free-flight models launched from the ground has enabled this division of the Langley Laboratory to gather quickly large amounts of varied information about aerodynamic behavior in the transonic and supersonic speed ranges. For some time these rocket-model techniques have been a principal source of large-scale transonic and supersonic information. During your visit here today some of the techniques for obtaining aerodynamic data from rocket models will be discussed and you will be given an opportunity to view some of the test models and equipment.

Rocket-model techniques for obtaining aerodynamic data at transonic and supersonic speeds involve rockets, radar, telemetering, and motion-picture camera tracking combined with a suitable test vehicle and measuring instruments. The rocket motors, which are of the solid propellant type, are used as a means of propulsion to accelerate the test vehicle to the desired speed. Radar is used to determine the location of the model in space and its velocity at any time during the flight. A special type of radio system known as telemetering is used to obtain a recording of the various aerodynamic reactions of the models as measured by instruments installed in the models. Motion-picture cameras are used to obtain a visual record of the initial phase of the flight. The models are instrumented here at the Langley Laboratory, but the actual flight tests are conducted at Wallops Island, a sparsely settled area located on the Atlantic Ocean near the Maryland-Virginia state line. This is an aerial photograph of the test station, where the models are launched from this area out to sea. Here is a photograph of one of the models immediately after takeoff.

There are many combinations of models, instruments, rockets, radar, and telemetering. These combinations are used to investigate many aerodynamic problems, some of which are listed here, (chart) lift and drag, control effectiveness, damping in roll, inlet performance, flutter, buffeting, boundary-layer phenomena, and the complete longitudinal and lateral flying qualities of airplane and missile configurations. In all of these investigations the data are obtained continuously from high subsonic speeds, through the transonic region, and as far into the supersonic region as desired.

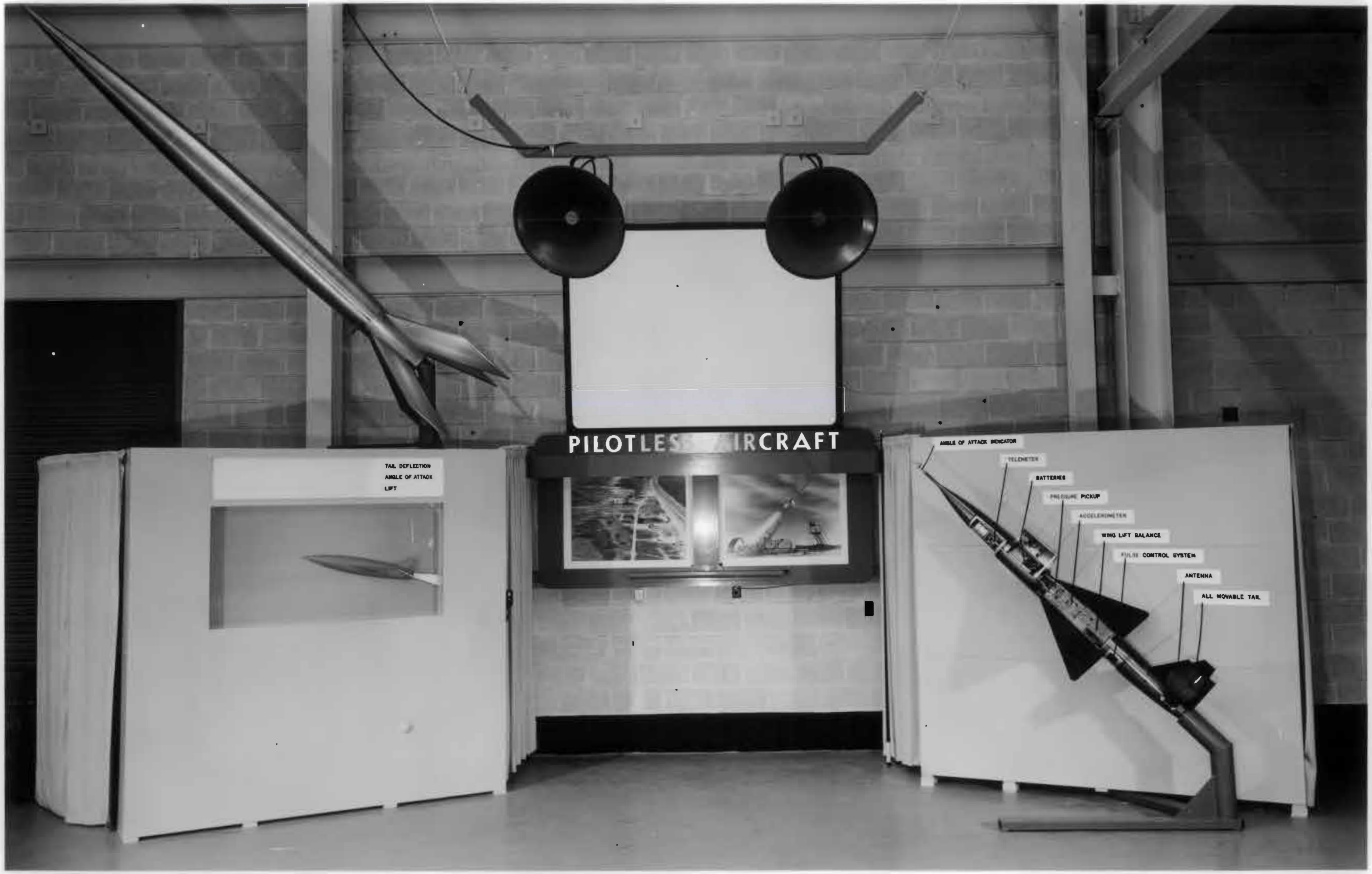
Here is a general research vehicle used to investigate the longitudinal flying qualities of various airplane configurations. The hatches have been removed so that you can see some of the equipment. This is the telemetering unit capable of detecting and transmitting ten separate items of information continuously to ground receiving and recording stations. The complete weight of this unit including the batteries is about 13 pounds and it is so rugged that it can withstand loads which are greater than 100 "g's". Here can be seen an angle of attack indicator, which measures the direction of the air relative to the model. These are the pressure pickups used to obtain Mach number, and here are the so-called accelerometers which are used to measure the total aerodynamic forces acting on the model. The wing is mounted on a beam-type balance which measures wing lift. The antenna for transmitting the telemeter signals to ground receiving and recording stations is located along the leading edge of the vertical tail. The horizontal tail is moved in an approximately square wave periodic motion during flight by a hydraulic power system located here. The model is propelled to supersonic speeds by a booster rocket, that is, by a rocket motor which, after expending its fuel, separates from the model, allowing the model to fly freely through the air.

After the model is free from the booster it responds to the movement of the horizontal tail in a manner such that aerodynamic data are obtained throughout the angle of attack range. The motion of an airplane after a sudden control deflection will be demonstrated by this flight simulator. The time history of the control deflection, angle of attack, and lift will be shown here.

Control moves - model oscillates with decreasing amplitude - trims at new angle of attack - etc. (About 2 up and 2 down control movements.)

From the flight of one pulsed control model such as this, the following aerodynamic data are obtained continuously from high subsonic speeds through the transonic range and far into the supersonic region. (Chart) Lift, both total and wing lift; drag, minimum and induced; static longitudinal stability; dynamic longitudinal stability; trim; control effectiveness; and hinge moments.

Mr.   will now discuss another rocket-model technique.



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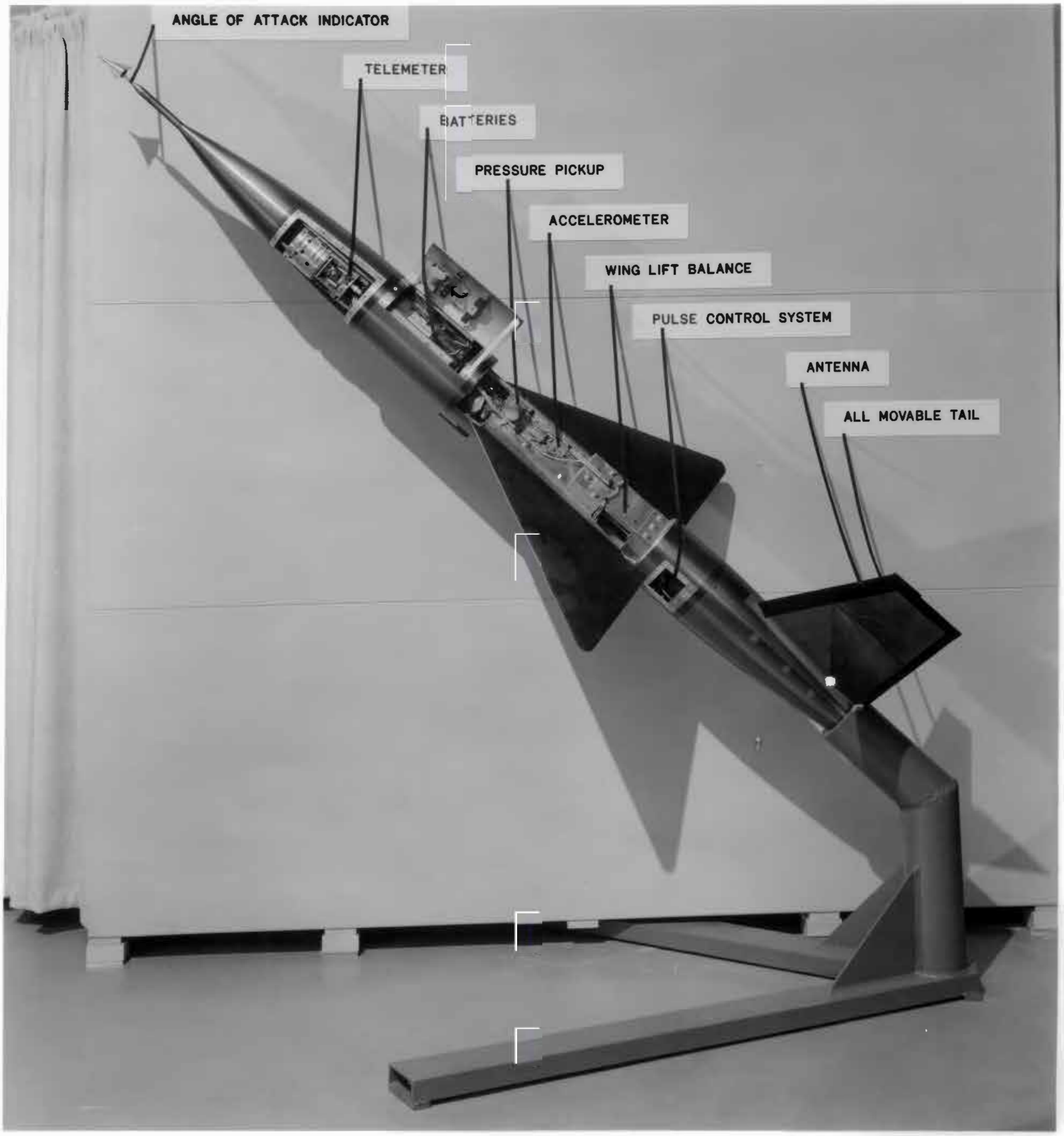

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Boundary-Layer Survey and Movie

Presented by J. D. Church, A. H. Hinners, A. E. Dietz,
and T. L. Kennedy

This model is used to investigate boundary-layer and skin-friction phenomenon at supersonic speeds. The distribution of total pressure through the boundary layer is measured with this six-tube total-pressure rake located on the aft portion of this parabolic body. The local static pressure is measured with a flush orifice in the skin. Here is a chart illustrating the characteristics of a boundary layer at a free-stream Mach number of approximately 3.

The total pressure distribution varies from the free-stream total pressure value to the local static pressure at the skin surface.

Here is the velocity distribution which is obtained from these pressures and from measured and calculated temperatures. At the skin surface, the velocity has a zero value, yet at only 1/16 of an inch from this surface, the velocity is approximately 2/3 of the free-stream value and varies smoothly through the boundary layer to the free-stream value. Hence, the importance of a smooth, polished skin is evident.

The loss of momentum in the boundary layer, which is a measure of the skin-friction drag, is then obtained by integration of the velocity-density relation through the boundary layer.

Before discussing other rocket-model techniques we will show you by means of a motion picture some views of the Wallops Island test station and equipment and some actual model flights.

Movie

This is an aerial view of the Wallops Island test station. Here is the launching area from which the models are fired out to sea. This is the final assembly shop where the test vehicles are prepared for launching. Here is the building which houses the electronic receiving and recording instrumentation. This is the control tower from which all the model launchings are coordinated.

Here is a close-up view of the preflight testing facility where ramjet engines and inlet investigation models are placed in an air jet for calibration and final adjustment prior to actual testing on rocket-propelled vehicles. The spheres shown here are the air storage tanks for this facility.

This is a ramjet engine mounted in position for a ground test in a Mach number 2 air jet. The fuel control system and starting mechanism are being checked before the engine is flown on a free-flight test vehicle. The glowing of the combustion chamber indicates the large amount of energy being released. These "Mach diamonds" in the exhaust show that it is supersonic.

This is an inlet investigation model and its booster rocket on the launcher. Here can be seen the takeoff of this model.

This is another view of the model takeoff and flight. Note the booster rocket being rejected from the model, leaving the vehicle to fly freely at supersonic speeds.

This radar is tracking the model to determine its velocity. Another radar unit shown here is recording the position of the model in space throughout the entire flight. (Statements about radiosonde must be made while the

584 is still on the picture). Immediately after the test, a radiosonde balloon is released to determine the pressure, temperature, and density of the air through which the model has flown.

The model on the launcher is a research vehicle used to investigate the large-scale drag characteristics of airplane configurations. This model has a rocket motor within the fuselage. There is takeoff. This is another view of the takeoff and flight of the model. Note that, in this case, after expenditure of fuel the model flies freely without the need of separation from a booster. The maximum Mach number of this flight was about 1.5.

The next scene is the launching of a nacelle drag research model. This illustrates the two-stage rocket technique. The model takes off under the power of a booster rocket, and after the expenditure of its fuel is rejected from the model. A sustainer rocket in the model then propels the model to its maximum speed.

This is the launching of a test vehicle for investigating boundary layer and aerodynamic heating over a wide range of Mach number and Reynolds number. This model also has a two-stage rocket motor. The sustainer firing is delayed so that the model will reach a maximum altitude of some 100,000 feet and a maximum Mach number of approximately 4.0.

It should be pointed out at this time that all of the model launching pictures are shown in slow motion. The actual flight motion is approximately 4 times faster than that seen here.

The model shown here is one of the pulsed control vehicles previously discussed. This, again, illustrates the single-stage type of launching. At separation, it can be seen that the model responds to the motion of the pulsed tail.

The final research vehicle shown is used to investigate aerodynamic and automatic stabilization problems associated with missile configurations. Again, a single-stage of propulsion is employed; however, in this case, two rocket motors in parallel are used.

If you will please step over to the area to my right Mr.   will discuss other rocket model investigations.

NACA
LAL 70502

1951 BI
PARD
Loposer

Flutter Discussion and Inlet Display

Presented by J. D. Loposer, C. F. Merlet, W. A. Bartlett, Jr., and W. E. Stoney

This is a model used to investigate flutter in the transonic speed range. Test wings of predetermined strength and flexibility are bolted to the wing root casting. The remaining space is filled with a resin plastic to give a rigid root attachment. Strain gages are placed near the wing root to give an indication of wing twisting and bending motions in flight. The model is also instrumented with an angle-of-attack indicator and accelerometers to measure the body motions and to determine if any coupling exists between wing and body modes. A two-stage rocket motor carries the model through the test Mach number range at a forward acceleration of about 8 g's.

Here is an actual telemeter record of the flight of one of these models. These two oscillating channels marked wing bending and wing torsion indicate the motions of the wings as sensed by the strain gages. When flutter begins, the amplitude of the wing motions builds up very rapidly so that the wing is destroyed after 10 or 20 cycles or at about this point. However, in this test the wings fluttered at a Mach number slightly greater than 1 and did not fail even at the maximum Mach number of the test (slightly greater than 1.5). The greatest amplitude of flutter occurred at about 1.2 Mach number.

Tests such as these enable us to modify and extend existing flutter theory for use in the design of modern high-speed aircraft.

Inlet Display

A method has been developed to obtain air inlet performance throughout the Mach number range and over a wide range of air flows. Here is a typical model with a scoop type inlet. The air enters the model here, and is led through a diffuser to an air flow regulator located here. The regulator is continuously operated in flight by this electric motor.

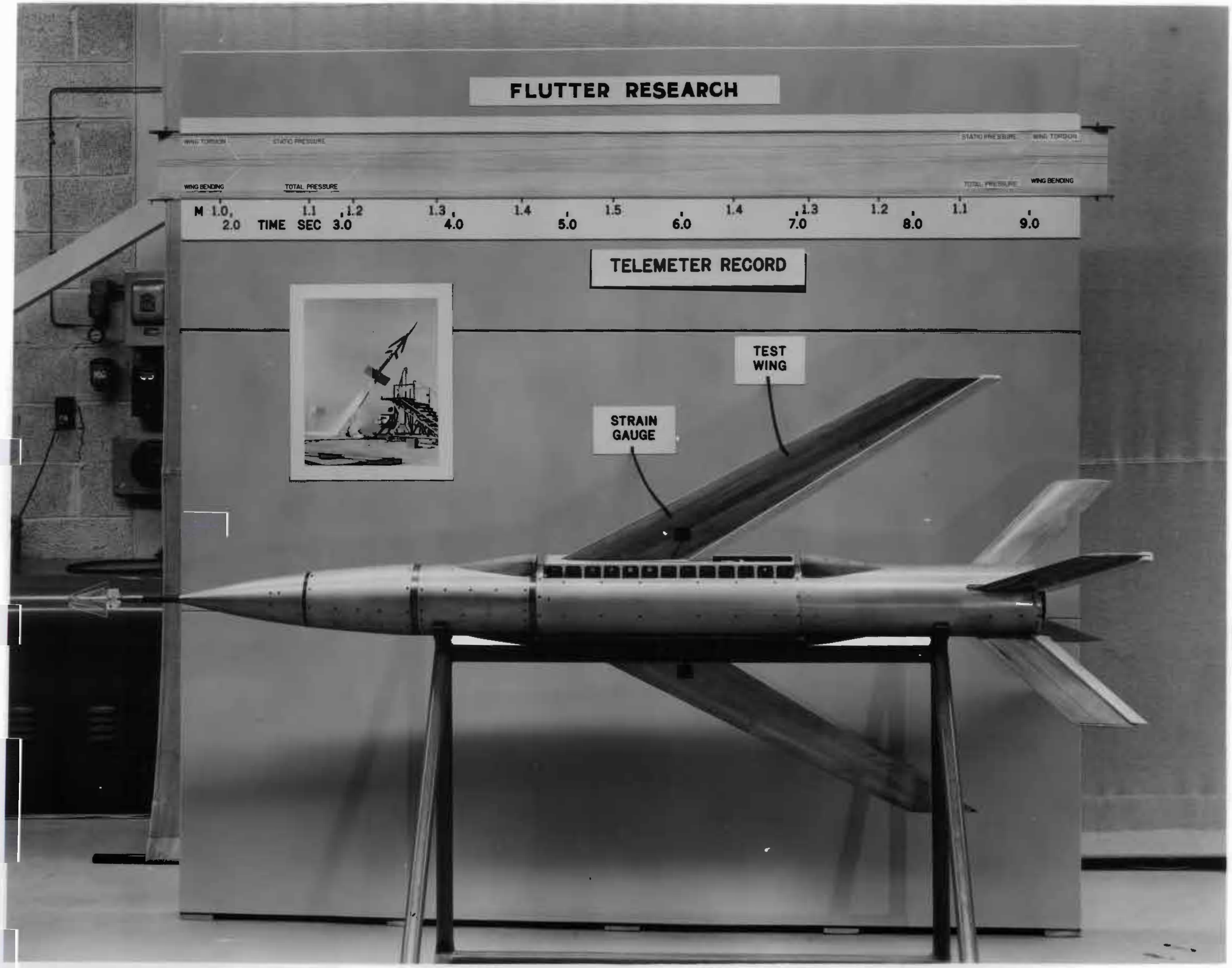
This is a cutaway view showing the internal portion of the air flow regulator with the shutters rotating. The rotation of the shutters causes the air flowing through this mockup to increase and decrease periodically, as shown by the rise and fall of the tufts.

This is a time history of the data obtained during the supersonic portion of the flight of one of these models. The lower curve shows how the air flow varies. The middle curve shows the total pressure recovery, which is a measure of duct efficiency. The upper curve presents the model external drag. Note the periodic change in both pressure recovery and drag with varying air flow. The maximum values of pressure recovery and drag occur when the air flow is at a minimum.

Thus, data on inlet performance are obtained for the many different conditions that may be required by modern jet engines.

NACA

LAL 70506



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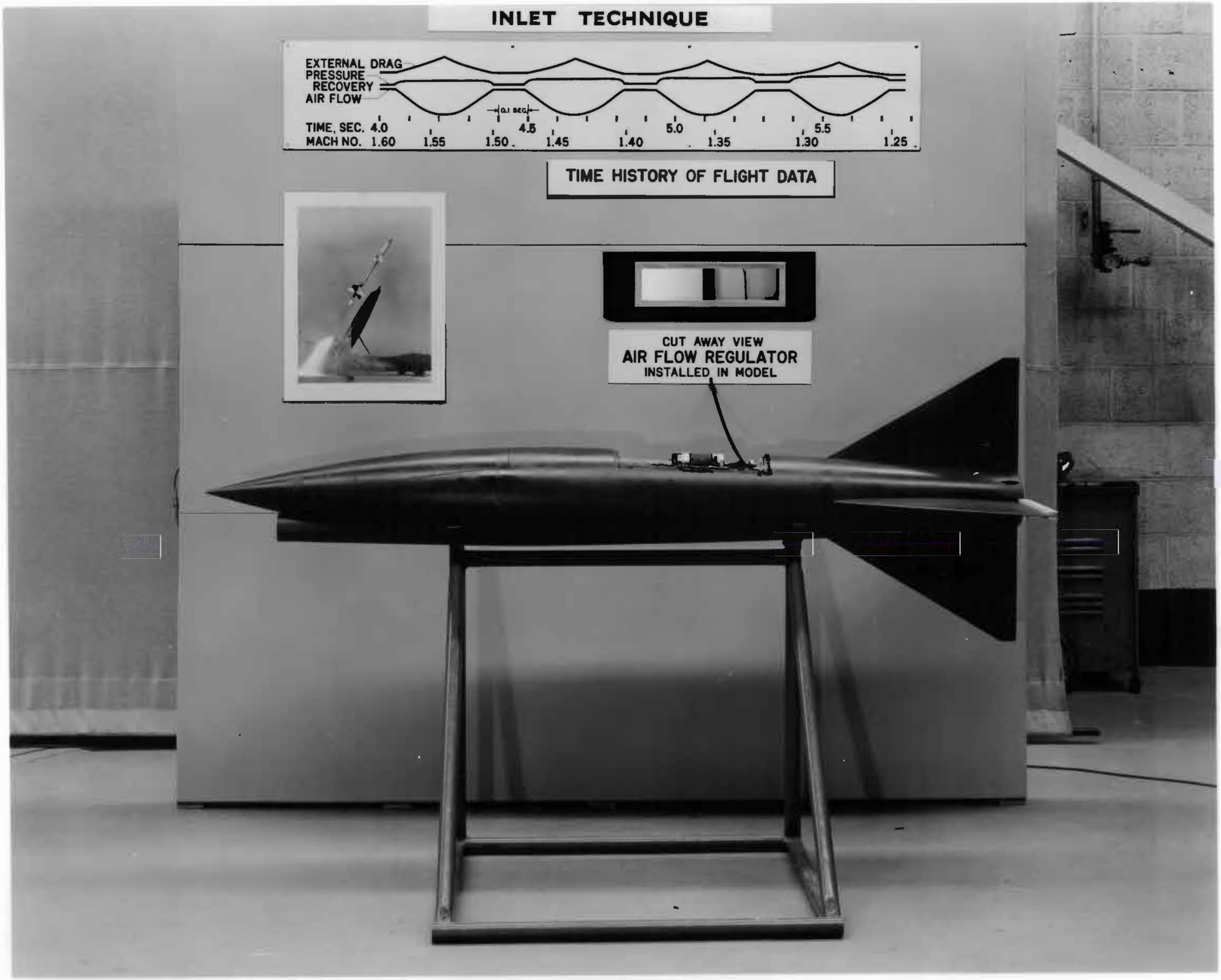
LAL 70504



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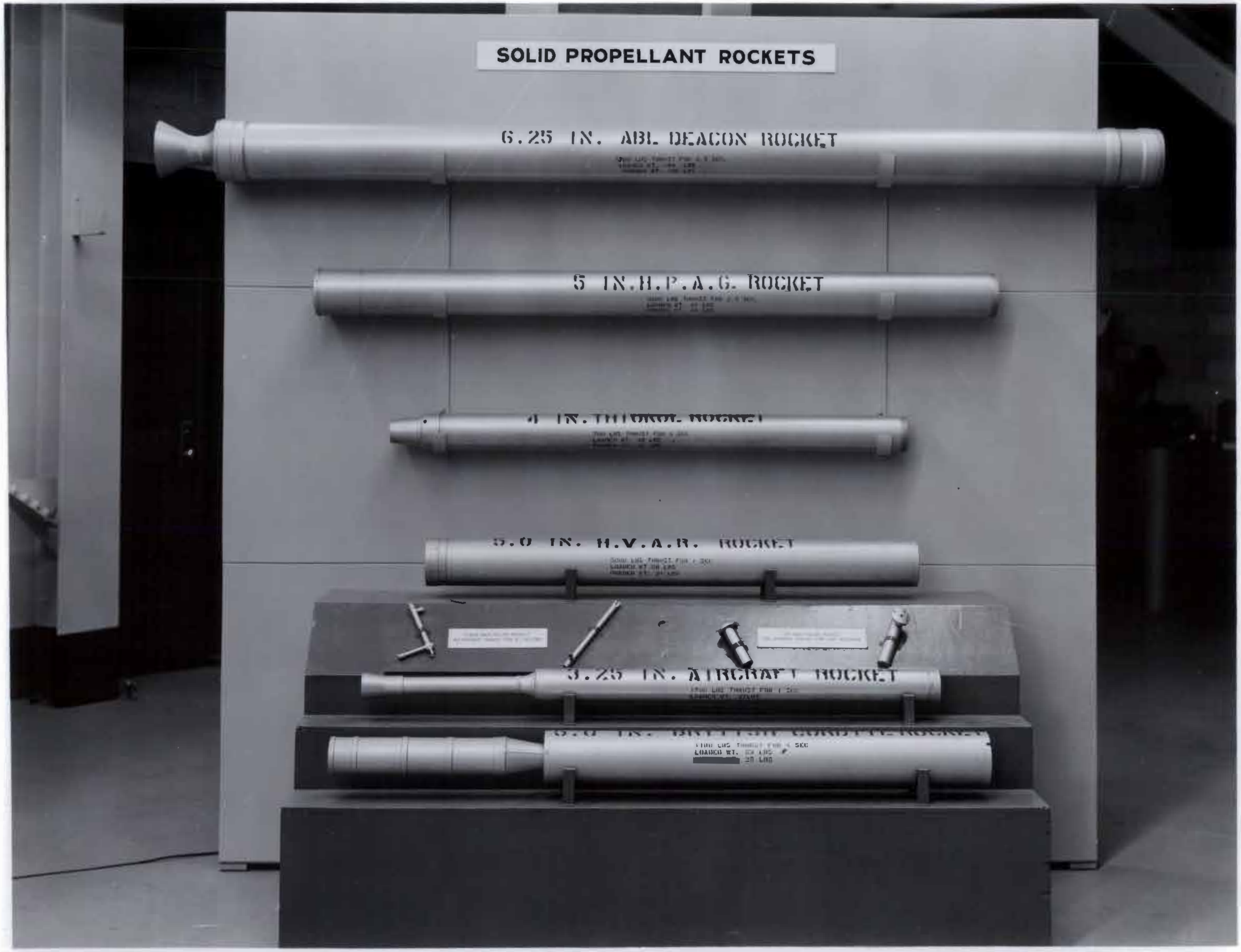

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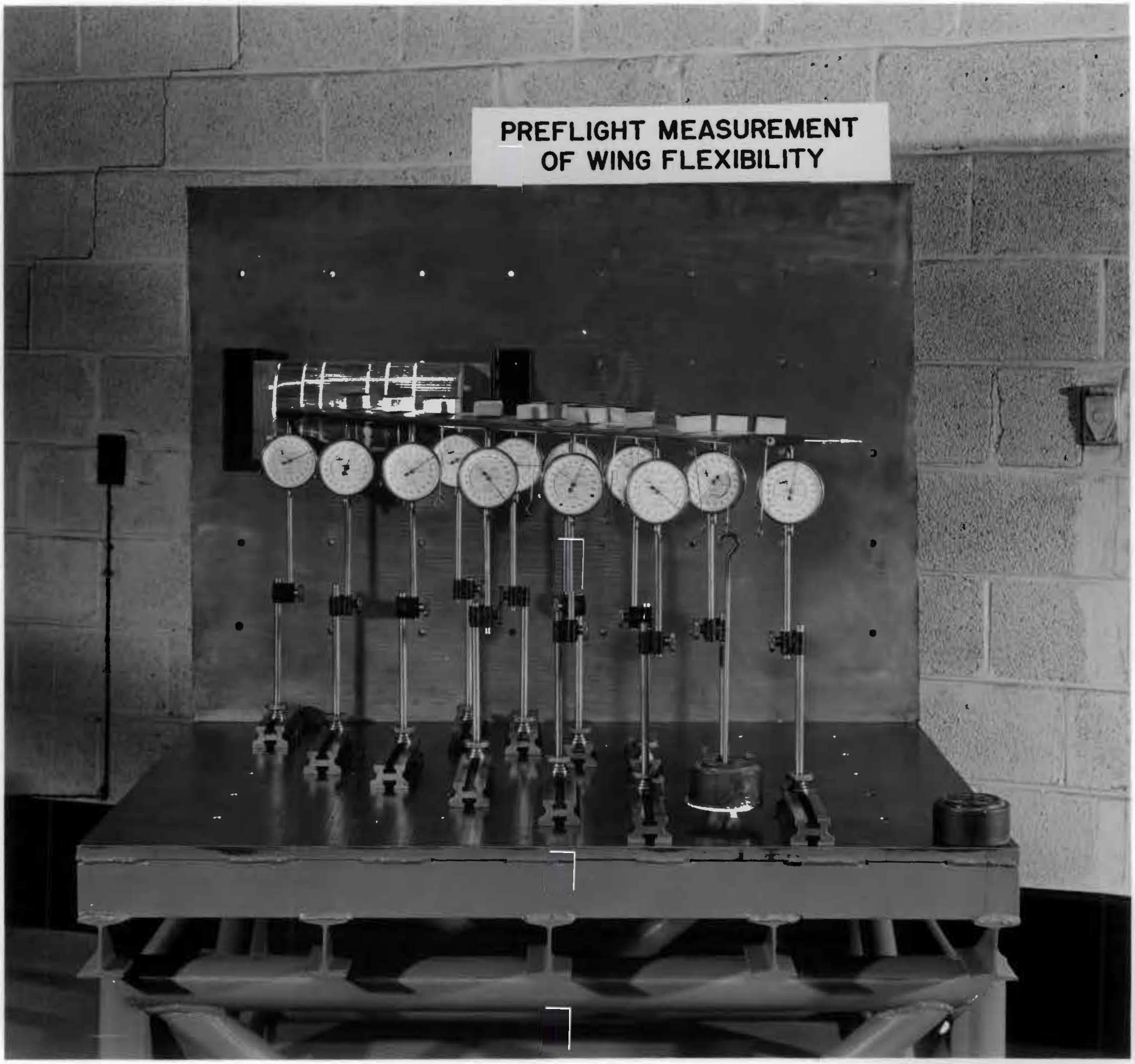
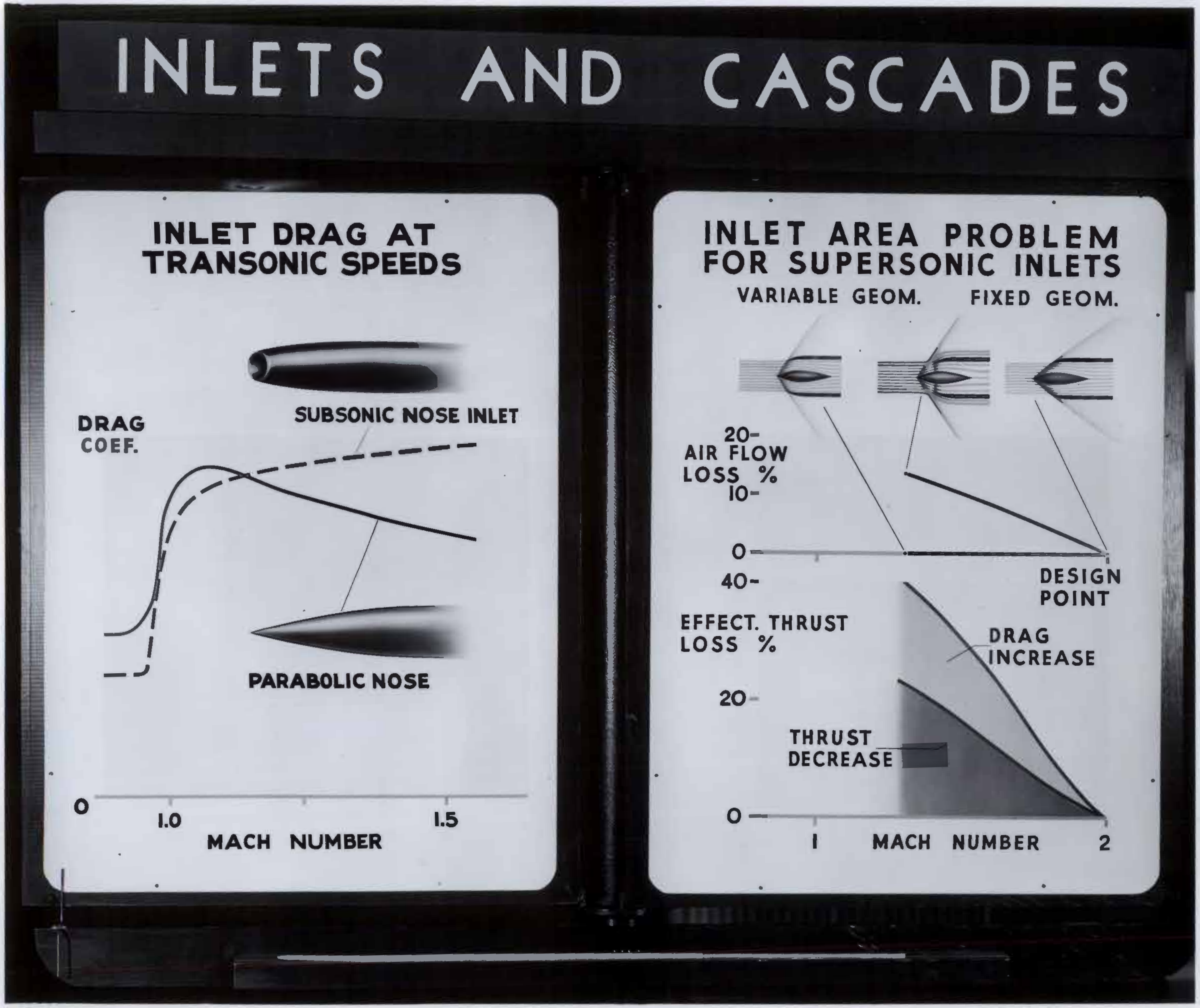


NACA

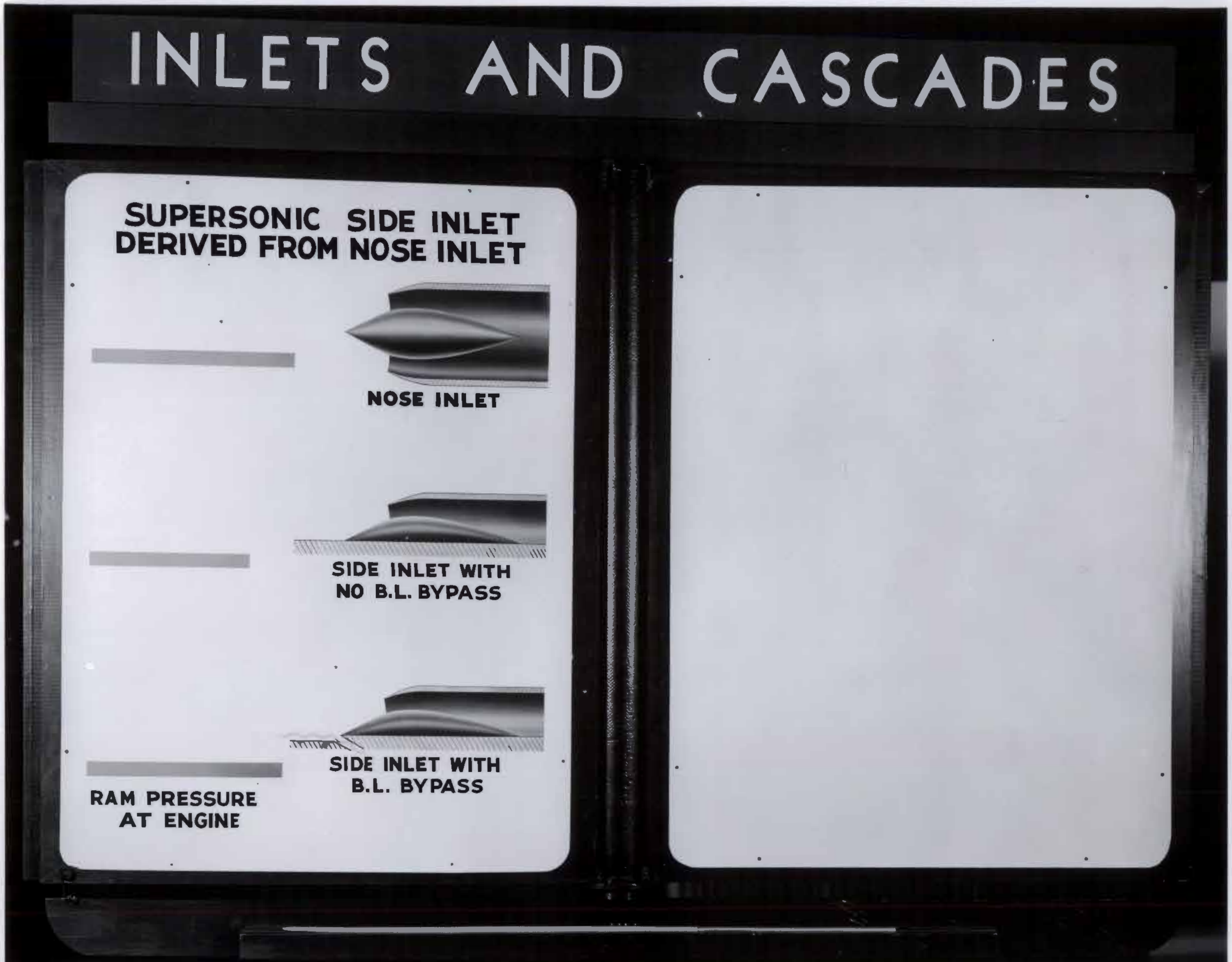
LAL 70509

INLETS AND CASCADES
INLET DRAG AT TRANSONIC SPEEDS
SUBSONIC NOSE INLET
DRAG COEF.
PARABOLIC NOSE
0
1.0
1.5
MACH NUMBER
INLET AREA PROBLEM FOR SUPERSONIC INLETS
20
AIR FLOW LOSS
10
0
DESIGN POINT
EFFECT THRUST LOSS
20
THRUST DECREASE
0
1
MACH NUMBER
2
MACH NO.

LAL 70475


INLETS AND CASCADES
INLET DRAG AT TRANSONIC SPEEDS
DRAG COEF.
SUBSONIC NOSE INLET
PARABOLIC NOSE
0
1.0
1.5
MACH NUMBER
INLET AREA PROBLEM FOR SUPERSONIC INLETS
VARIABLE GEOM.
FIXED GEOM.
20-
AIR FLOW LOSS %
10-
0
40-
DESIGN POINT
EFFECT. THRUST LOSS %
DRAG INCREASE
20
THRUST DECREASE
0
1
MACH NUMBER
2

LAL 70477


INLETS AND CASCADES
SUPERSONIC SIDE INLET DERIVED FROM NOSE INLET
NOSE INLET
SIDE INLET WITH NO B.L. BYPASS
SIDE INLET WITH B.L. BYPASS
RAM PRESSURE AT ENGINE

LAL 70478

Improved Compressors Through Cascade Research

The range and load-carrying capacity of high speed, transonic and supersonic aircraft are related directly to the fuel economy and thrust of gas turbine engines. For this reason a considerable effort is being devoted to the development of efficient, high-flow, high-pressure ratio, axial-flow compressors. During previous inspections of this laboratory, we have reported the status of research on supersonic compressors. These compressors have great potentialities, and their development is being continued at this laboratory and at the NACA Lewis Laboratory. At present, however, the efficiency of supersonic compressors is not high enough to warrant general application to aircraft gas turbines. Therefore, an equal effort has been devoted to the study of the more efficient subsonic compressor. This program has produced information which has been used in the design of efficient aircraft and industrial axial-flow compressors. Today we would like to discuss recent improvements in axial-flow-compressor blading which have resulted from this program.

From the standpoint of developing high performance power plants, the gas turbine enjoys an advantage over the piston engine in that the compression, combustion, and expansion phases of the thermal cycle are steady-flow processes that occur in component parts which can be separated for individual study. The compressor and turbine components can be further separated into single-stage units and single blade rows for more thorough instrumentation and study over a wider range than is feasible with complete engines. The rotor from such a stage is shown here, and here is a mockup which represents a portion of a typical compressor blade row, either rotor or stator. As a further simplification compressor blade sections can be studied two-dimensionally if the annular blade rows are unwrapped into linear cascades. The blade rows can then be mounted stationary in a cascade tunnel and air blown past them. Two-dimensional cascade testing permits rapid detailed study of blade performance under controlled conditions. Surface pressures and velocities, flow directions, and losses in the wake can be measured with comparative ease. Information can also be obtained over a wide range of Mach numbers.

The maximum Mach number at which the blades can operate efficiently strongly affects the weight flow that can be accepted and the pressure ratio produced by a compressor. As for aircraft wings, optimum high-speed performance occurs if there are no localized high velocity regions on the blade surface. Because of the pressure rise, however, shapes which are best for wing airfoils have undesirable velocity distributions when used as compressor blades. This is illustrated in the first chart which shows the local Mach number distribution on the blade surface plotted along the chord line. A typical wing section commonly used as a compressor blade, the 65-(12) 10, has the local Mach number distribution shown by the black curve. Because of localized high velocities over the forward part of the convex surface, supersonic velocities and shock losses occur at relatively low entering Mach numbers. A compressor blade suited for higher operating Mach number would have constant velocity over the forward part of the convex surface with no localized high velocity regions similar to the red curve. An improved compressor blade section, the 65-(12A) 10, intended to approach this ideal is compared with the conventional section in the upper figure on this chart. The conventional blade shape is shown in gray while the improved blade is outlined in red. Note the rapid deceleration or diffusion of the flow required in the region of the trailing edge of the improved blade corresponding to the sharp curvature in the blade shape.

Cascade Comparison

In order to determine how closely the improved section actually approaches the ideal, and whether the rapid diffusion can be accomplished efficiently, compressor blades of this type have been mounted in the new Langley 7-inch high-speed cascade tunnel shown in the background. The test blades are mounted in the center of the large circular plates. These plates can be rotated to simulate the entering flow over the compressor operating range. As the tunnel is operated, the flow through the blade passages will be shown visually using the schlieren technique. The schlieren image will be projected on this screen. The flow will be from right to left on the screen. A Mach meter will also be projected on the screen to show the entering Mach number. The tunnel will be run at a maximum Mach number of approximately 0.83. As the tunnel is brought to speed notice the small region of separated flow off the trailing edge which appears as a gray cloudy region on the schlieren image. As the entering Mach number reaches 0.77 the first indications of supersonic velocity will appear as waves on the convex surface at about mid-chord.

The speed will be held at 0.77 for a few seconds. Then as the speed is increased to 0.83 the waves become weak shock waves. Note, however, that the amount of separation increases very little after the shocks appear indicating that the performance is still efficient. We will now operate the tunnel. The first sound you will hear is the supercharger which is used for tunnel wall boundary layer removal ahead of the cascade. The main tunnel drive flow is now being started.

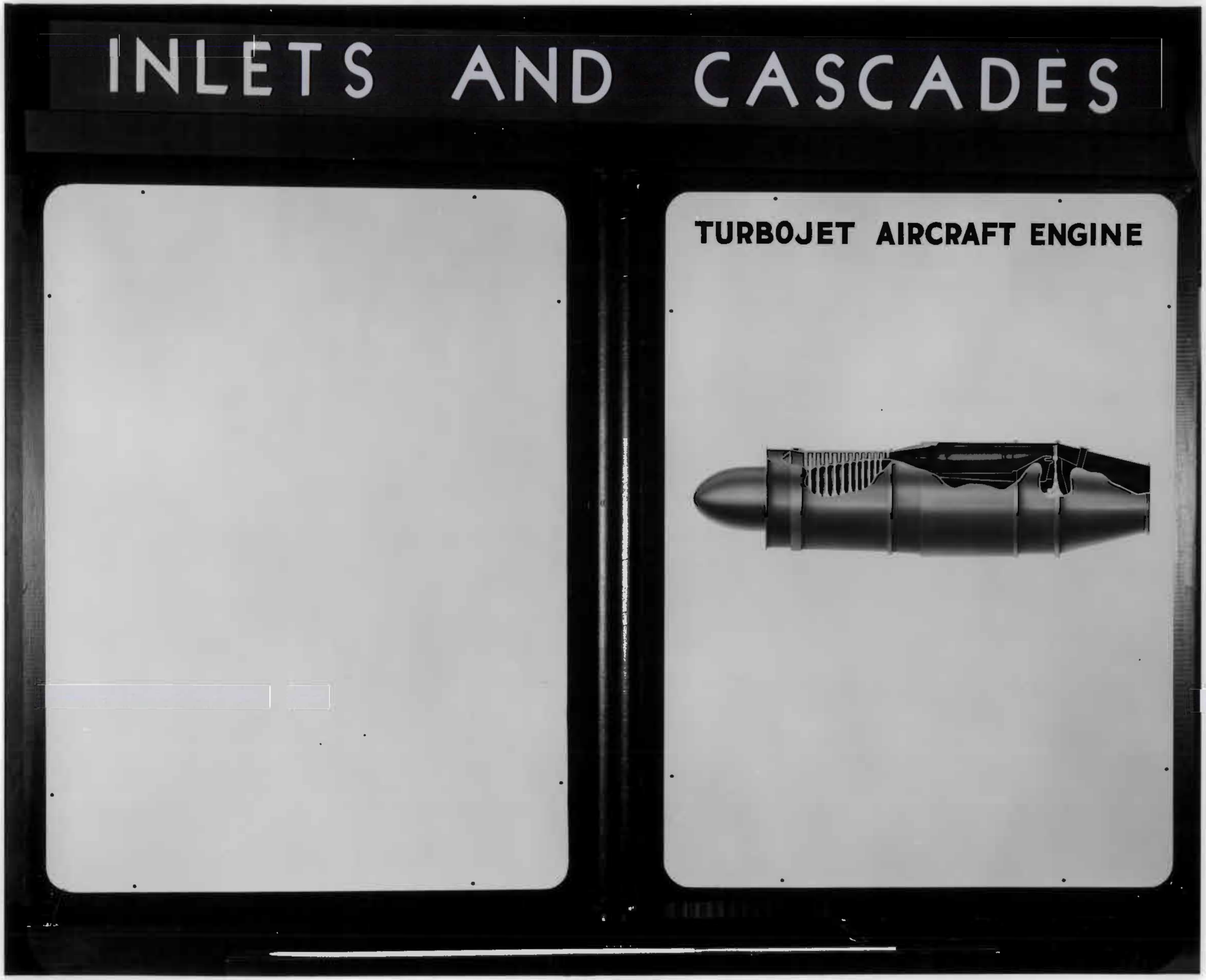
You've seen visual evidence of efficient performance for the improved blades. This chart gives a quantitative comparison of performance between the conventional blade and the improved blade. Shown are the drags of the two blades through the Mach number range with the improved blade shown by the solid line and the conventional blade shown by the dashed line. It can be noted that at Mach numbers from 0.6 to 0.8 the drag of the improved section is significantly less than that of conventional blades.

Rotor Comparison

To verify the results obtained from theory and from cascade tests, an axial-flow compressor rotor has been designed and tested at Langley using the improved blade sections. This is the rotor mounted on the table. The performance of this rotor through the Mach number range is compared to that of a similar rotor having conventional blades on the next chart. The Mach number given here is measured relative to the blades at the mean blade diameter. The performance of the improved rotor is again shown by solid lines and the conventional rotor by dashed lines. It can be seen that the improved rotor retains its efficiency to higher operating Mach numbers. From the stage pressure rise curves, calculated from rotor tests in each case, it can be seen that the improved rotor gives appreciably higher pressure rise primarily because of the increase in permissible operating Mach number.

From these results, it is apparent that increases in operating Mach number indicated by theory and investigated in cascade are realized and even exceeded in actual rotor tests. The next step in the program will be tests of complete stages and systematic cascade tests to provide design data for the entire operating range of axial-flow compressors.

This concludes the presentation at this facility.



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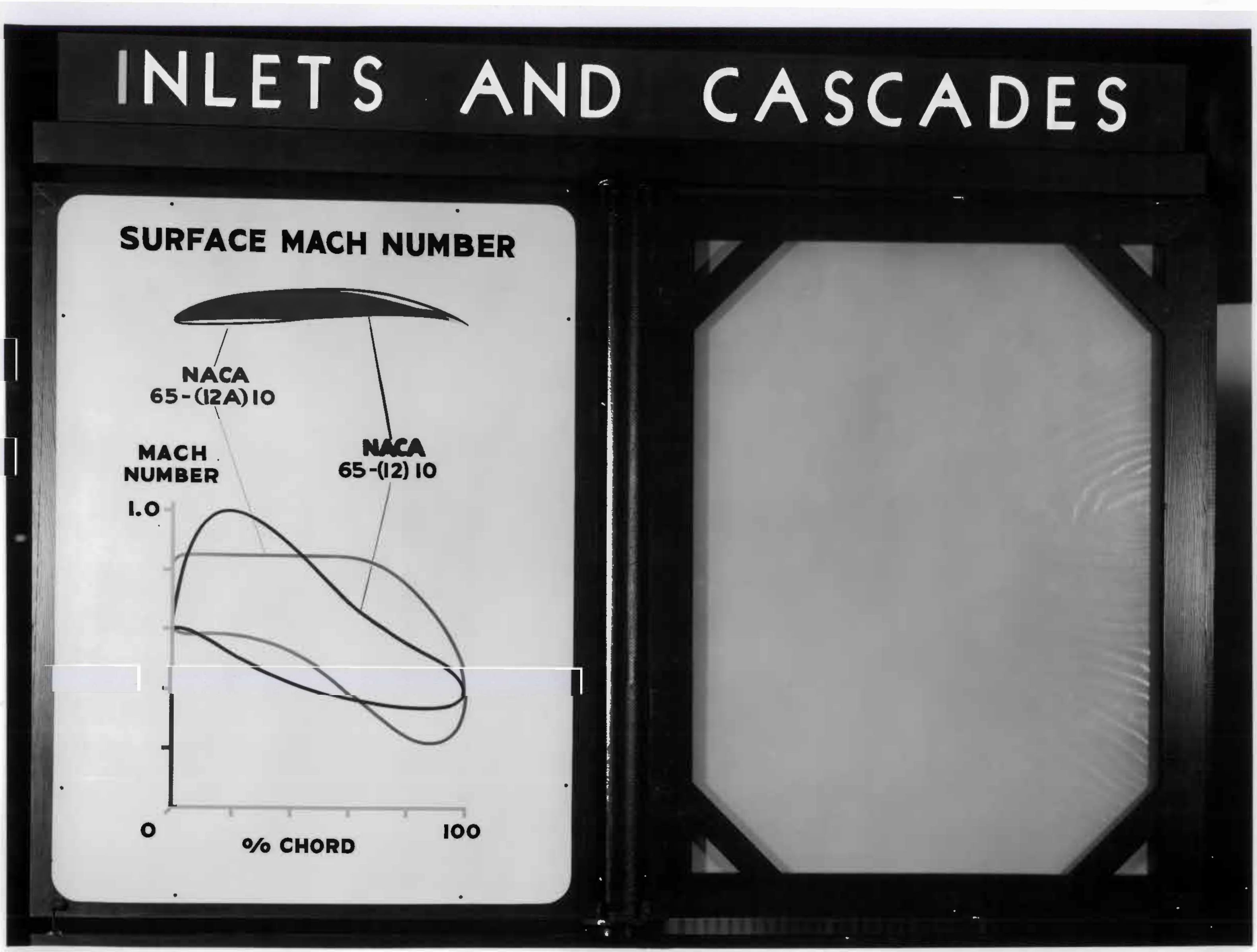
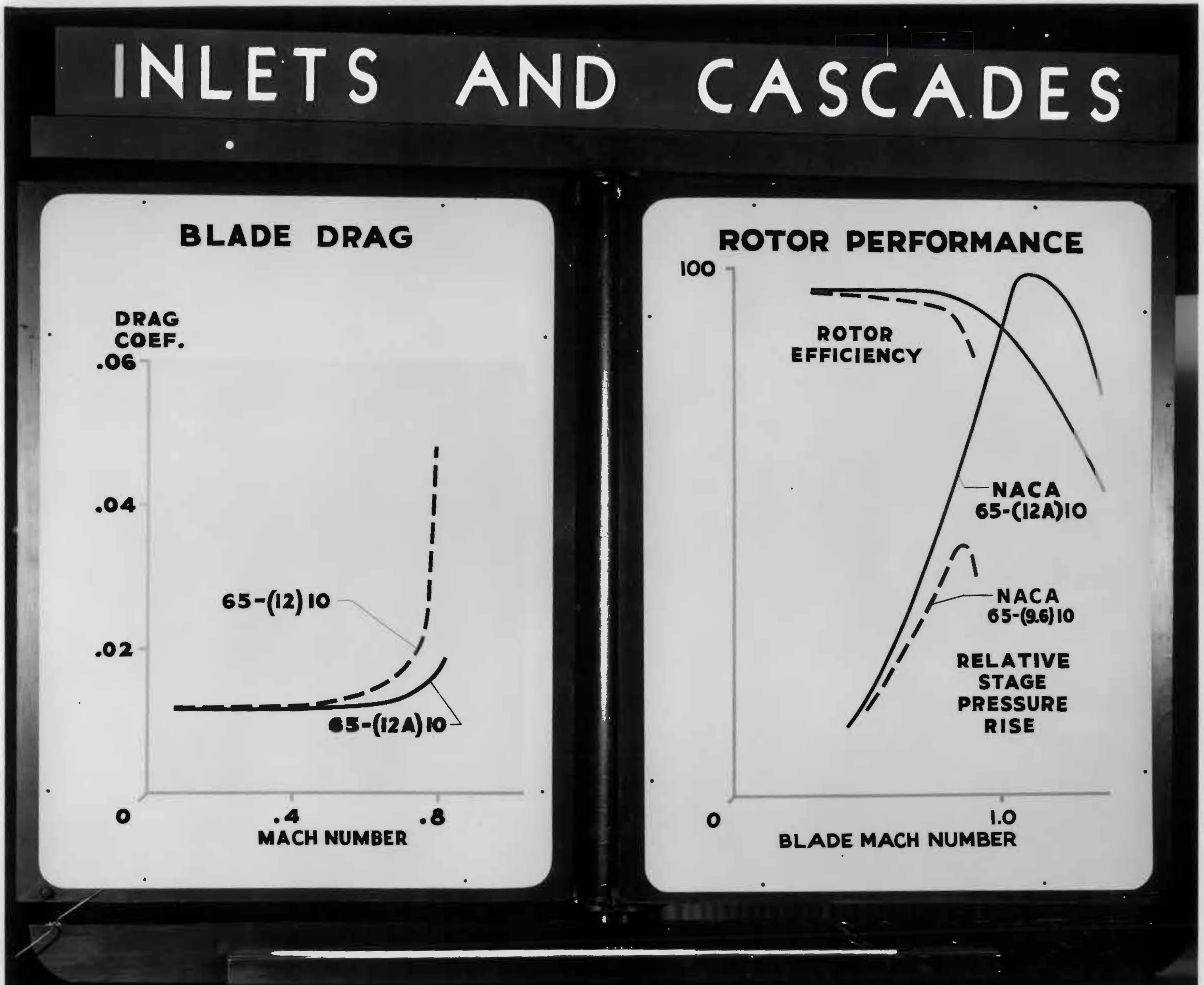

INLETS AND CASCADES
SURFACE MACH NUMBER
NACA
65-(12A)10
NACA
65-(12)10
MACH
NUMBER
1.0
0
% CHORD
100

LAL 70480



NACA

LAL 70476

Speaker - John [illegible] Mayer Alternate - Paul W. H[illegible]er Maneuver Loads Branch

1951 BIENNIAL INSPECTION

May 1951

LOADS CALIBRATION LABORATORY

TALK NO. 1

The building that you are now in is the Loads Calibration Laboratory which is a part of the NACA facilities devoted to aircraft loads research. The subject of Aircraft Loads Research will be discussed here along with other work being conducted in this facility. The machine that was operating when you entered is being used for making fatigue tests on full-scale aircraft structures and will be discussed later.

The net or structural loads acting on an airplane are determined by the interrelated action of aerodynamic, inertia, and elastic forces, and may be imposed on the airplane in steady flight, maneuvering flight, gusts, or in landings. It is important to know the magnitudes and the distribution of these loads over the aircraft structure so that adequate structural designs may be obtained.

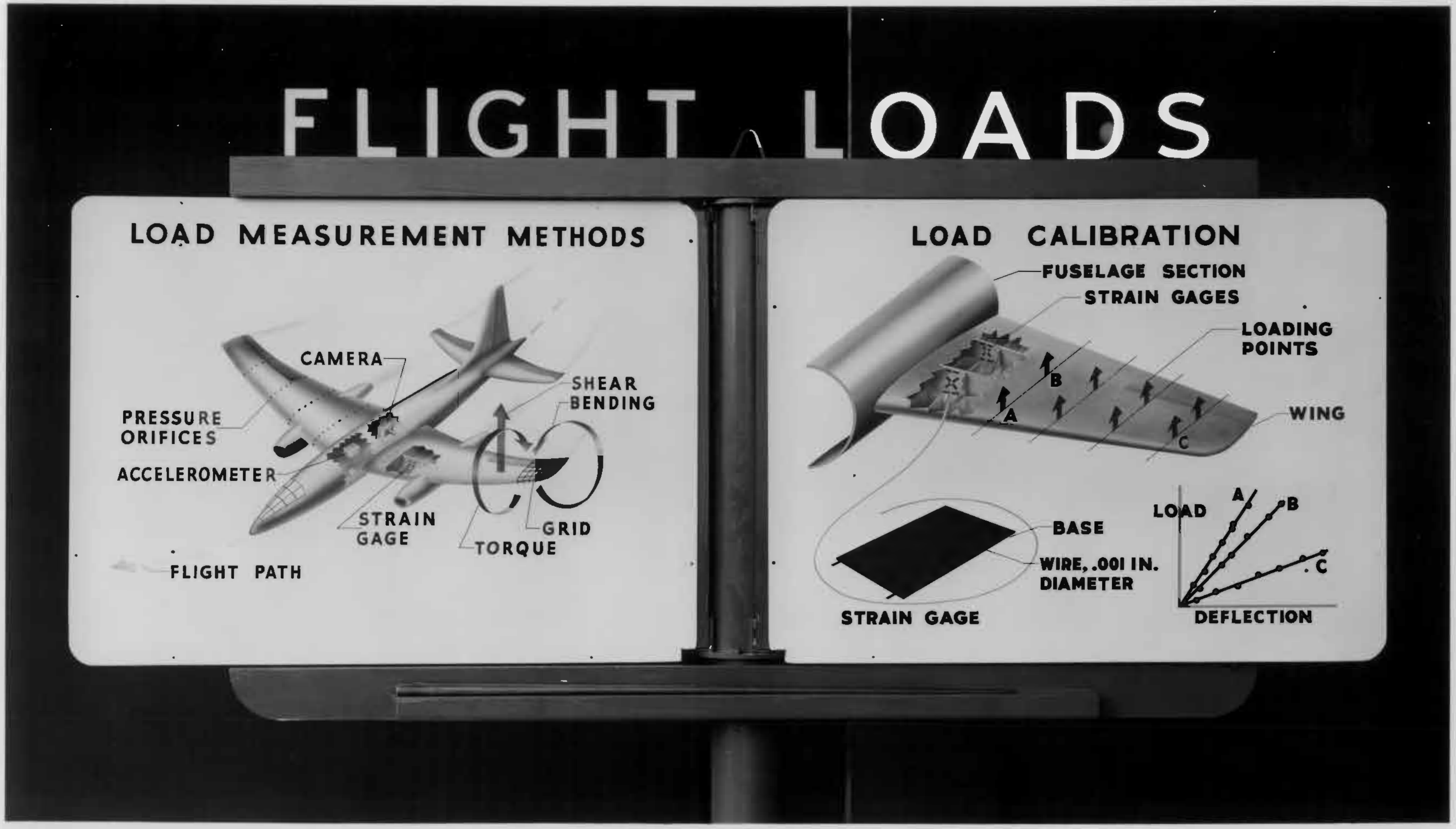
Loads may be determined in flight by means of acceleration measurements, pressure measurements, and deflection measurements as indicated on the first chart. Acceleration measurements are useful in obtaining the overall airplane loads and the inertia loads. In this case an accelerometer is shown at the airplane center of gravity in order to measure the overall loads. Pressure measurements obtained at orifices such as these on the wing determine not only the load on the surface but also the distribution of load as well. Deflection measurements are useful in obtaining loads induced by elastic deformation. One form of deflection measuring device is shown on this chart. It consists of a camera which photographs a grid on the wing tip. From the distortion of this grid the bending and twisting of the wing can be determined.

Another important form of deflection measuring device is the electrical wire-resistance strain gage which consists of a length of very fine wire cemented to a piece of paper or other material whose size may even be smaller than a postage stamp. (On this frame are several such strain gages.) In practice the strain gage is cemented to the structure on which the measurement of strain is desired. When the structure deforms due to some load the fine wires in the strain gage are stretched and this stretching causes a change in the electrical resistance of the wire.

The actual stress measurement at the strain gage location is not of primary importance in flight loads measurement. More important, however, is the relationship between the load applied to the structure and the response of the gage attached to the structural member. A method for determining this relationship has been developed through research at this laboratory within the last ten years. The measurements which are usually desired are the shear or vertical load, the bending moment or bending load along the wing, and the torque or twisting load. It would be desirable to locate a strain gage at such a place on the wing so as to measure only shear, or only bending moment, or only torque; however, this is seldom possible so we try to locate the strain gages in the wing structure at locations where the principal influence on the strain gage is either to shear or moment or torque. Therefore, for the usual airplane structure, shear gages are placed on the spar or beam shear webs; bending moment gages are placed usually on the upper and lower beam flanges; and torque gages are usually placed on the spar webs or on the wing skin. At these locations, for instance, the shear gages respond mostly to shear, although the gages probably will still respond to bending moment and torque to some extent. For instance, one shear gage, located here, will respond differently to loads A, B, and C as indicated in this figure. It is our problem in calibrating the structure to separate out the combined effects of bending moment and torque on a shear gage installation, and, similarly, to separate the effects of shear and torque on bending moment gages, etc.

The strain gages are calibrated by placing approximately 200 individual concentrated loads on the wing at about 20 different spanwise and chordwise locations as shown on this chart. The strain gage deflections are then interpreted in terms of wing load by means of a rather elaborate mathematical procedure from which equations are determined which relate the strain gage deflections to the desired loads. Once the equations are determined it is then possible to combine two or more strain gages electrically so that only one measurement is necessary to obtain shear, and one for bending moment. Thus, in effect, we have found one strain gage which measures shear and one which measures bending moment.

The next speaker will now discuss applications of strain gage measurements to flight loads research.



NACA
LAL 70586

Speaker - John B. [illegible]rvin, LCLAlternate - J. O. Thom[illegible]n Maneuver Loads Branch

1951 BIENNIAL INSPECTION

May 1951

LOADS CALIBRATION LABORATORY

TALK NO. II

One service airplane on which loads measurements have been made by means of strain gages is the B-45 jet propelled bomber which you see on your right. Strain gage measurements of the loads on the wing, horizontal tail, and vertical tail have been made on the airplane throughout the speed range. Later you may inspect an installation of strain gages used in this airplane for the measurement of wing loads by looking up into the wheel well where the gages have been illuminated for ease in viewing. The purpose of the flight program carried out on the B-45 was not to determine the conditions for maximum load, but rather to establish the agreement which might be expected between flight parameters and those available to the engineer at the design stage. During the course of the flight tests a series of abrupt push-down pull-up maneuvers were made in order to compare measured and calculated tail loads in abrupt maneuvers. Analysis of these data indicated among other things that the flexibility of the rear fuselage and tail combination affected the calculation of the tail loads. It was found that the tail portion of the fuselage oscillated through several cycles every time there was an abrupt elevator deflection. This chart shows time histories of some measured quantities during an abrupt pull-up. The elevator angle is shown at the top. Next the normal acceleration in gravity units is given. Below that, the pitching angular acceleration is shown and at the bottom the incremental tail oscillatory accelerations are indicated. Ordinarily for a rigid airplane the top three quantities are sufficient to determine the tail loads with the methods usually used. The tail oscillatory acceleration would be zero for a rigid airplane. You can see here that the B-45 deviates from a rigid airplane. These incremental accelerations represent an oscillating vertical bending motion of the rear part of the fuselage.

In the next chart are shown the horizontal tail loads during this maneuver. The black symbols represent the measured values of the tail load as obtained from strain gage measurements. The dashed line represents the tail load calculated from the parameters shown on the preceding chart but neglecting the flexibility parameter. The solid line represents the calculated tail loads including the effect of flexibility. It may be seen that the agreement is fair for the case where flexibility is neglected but the average errors in the calculated tail loads are about 500 pounds while the maximum errors are as large as 2400 pounds: In the case where flexibility was included in the calculations, however, the agreement is excellent.

The B-45 is actually a rather rigid airplane and flexibility may not be too important here; however, for larger and more flexible airplanes it is indicated that flexibility should be considered in methods used to calculate horizontal tail loads since large oscillatory loads due to the flexibility might be superposed upon the critical maneuvering tail loads.

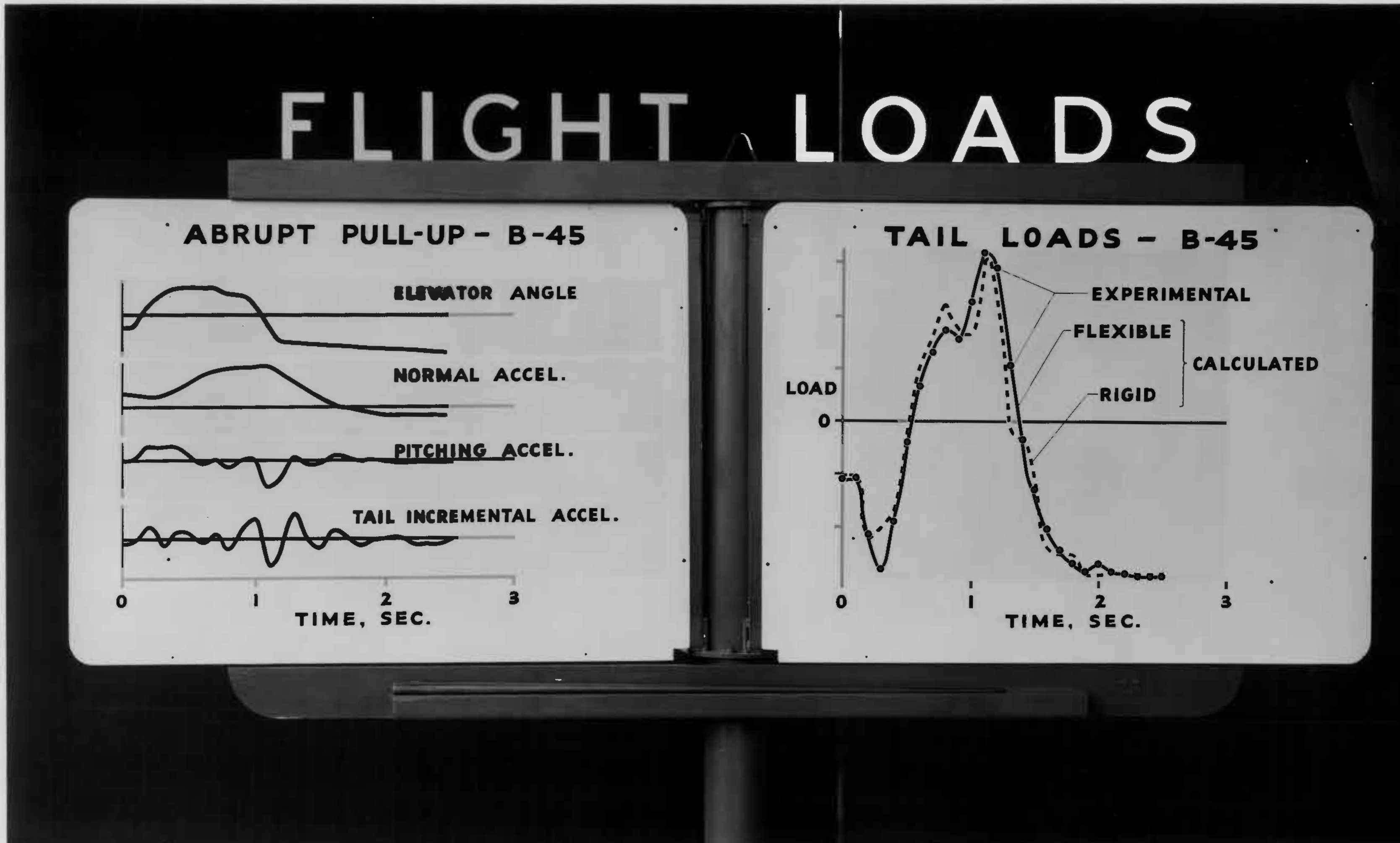
Another type of information that is being obtained in flight by means of strain gage measurements is the distribution of the load among the wing, fuselage, and tail of the airplane. It is important to know how much of the total load on the airplane is acting on the wing, how much is acting on the fuselage, and how much is acting on the tail. In this next chart is shown the distribution of the total airplane load among the wing, fuselage, and horizontal tail at two angles of attack for one of the current airplanes being tested. It can be seen that the fuselage carries an appreciable amount of the total load in both cases. At an angle of attack of 5° the wing carries about 73 percent of the total load, the fuselage about 25 percent of the load, and the tail about 2 percent. At an angle of attack of 20°, it can be seen that the fuselage carries a larger proportion of the load. Here the wing carries 60 percent, the fuselage 37 percent, and the tail 3 percent.

Some insight into the way the fuselage carries the load is shown in the next chart. Here the distribution of the load over the fuselage is shown at an angle of attack of 20 degrees. These data were obtained in the Langley 8-Foot High-Speed Tunnel by means of pressure distribution measurements. The dots on the fuselage indicate the location of the pressure orifices. It can be seen that the major contribution to the fuselage load is in the vicinity of the wing body intersection. Also shown is the load distribution over the body alone. It may be noted that the major portion of the load on the body with the wing present is caused by the effect of the wing on the body.

In the next chart are shown the spanwise distributions of the load over the wing and the body at two angles of attack. At an angle of attack of 8 degrees the loading is fairly uniform and the fuselage carries about 15 percent of the total load. At an angle of attack of 20 degrees, the load has shifted inboard, the tip losing load, and the inboard part of the wing and fuselage gaining load. It may be seen that the component of load carried by the fuselage is larger at the higher angle of attack in agreement with the trend shown by the previous strain gage results. The next speaker will now discuss the operation of the fatigue machine which was in operation when you entered this building.

NACA

LAL 70579



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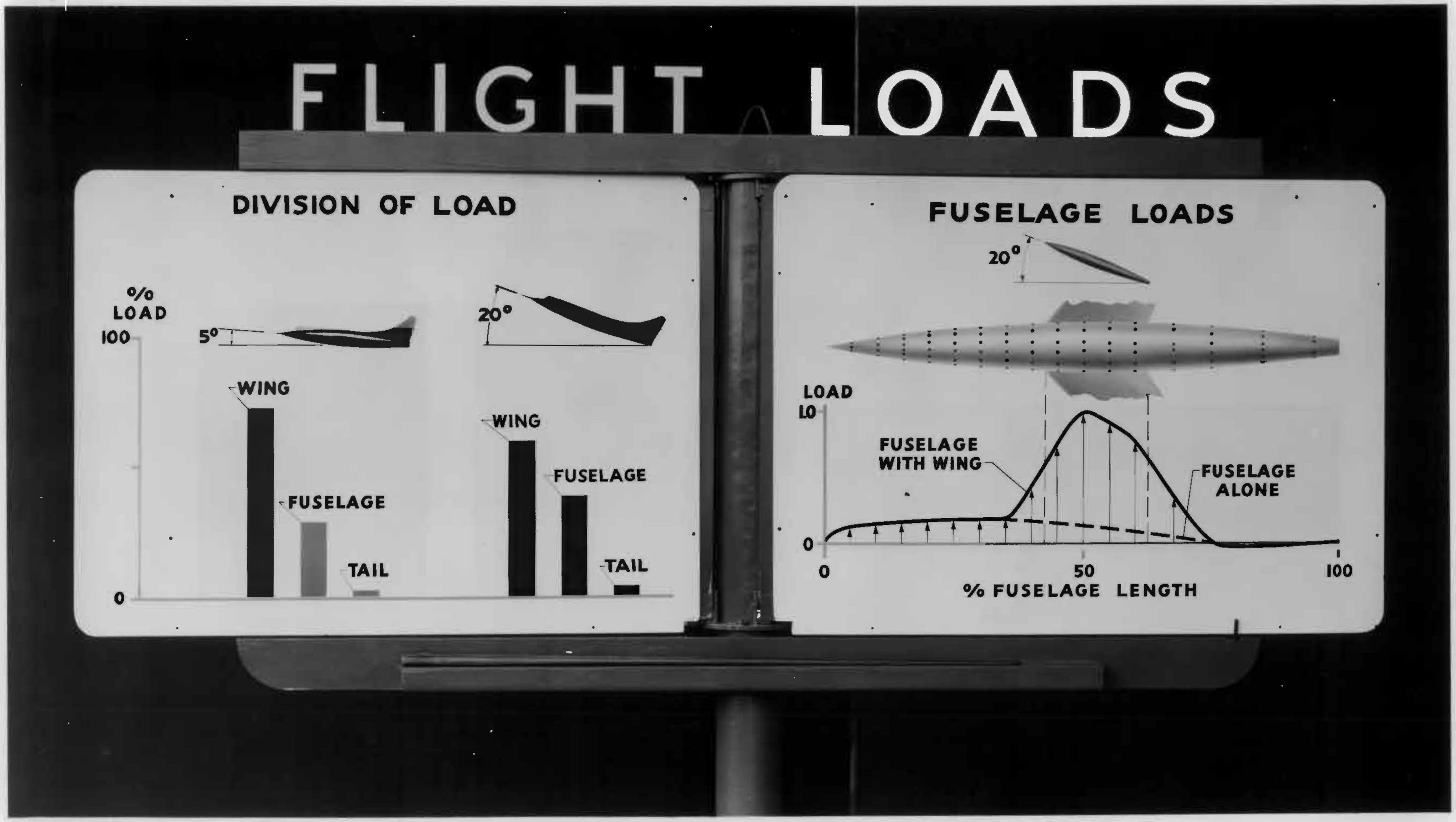

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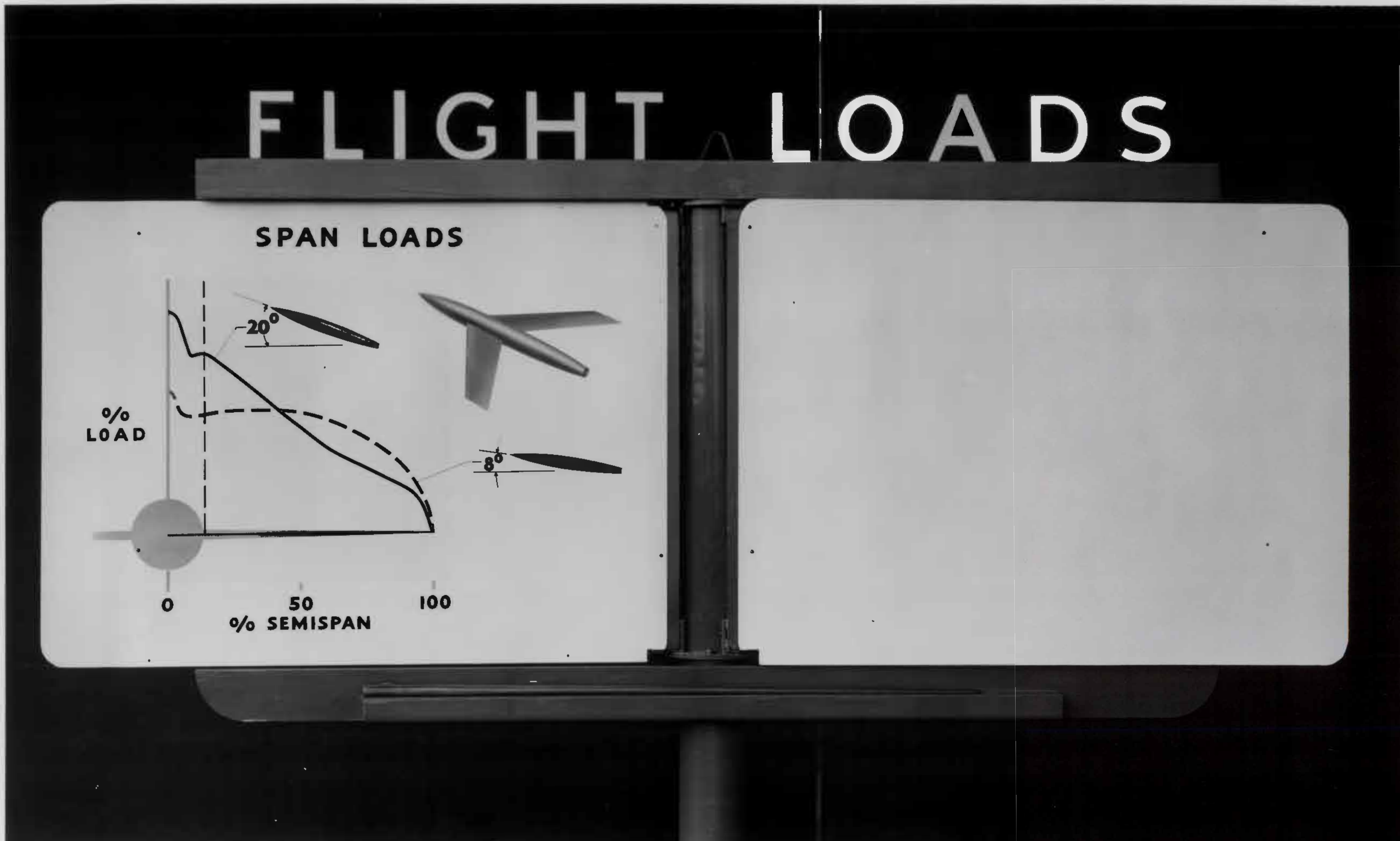


NACA
LAL 70585

Speaker - David [illegible] Bryan Alternate - Creighto[illegible]. Lee - Loads Calibration Lab.

1951 BIENNIAL INSPECTION

May 1951

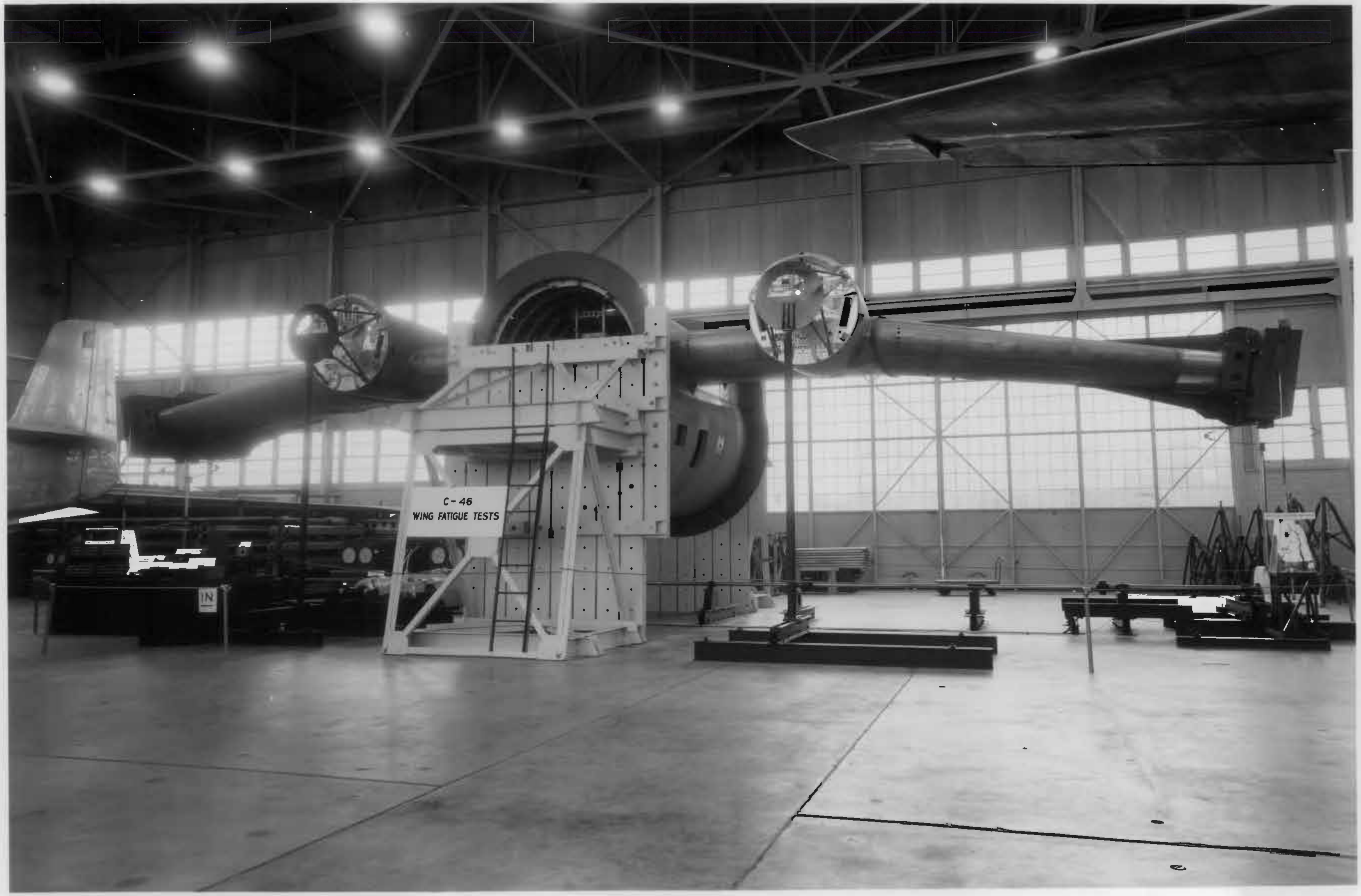
LOADS CALIBRATION LABORATORY

TALK NO. III

This laboratory in addition to providing facilities for the calibration of load measuring airplanes also is suitable for conducting other types of research. One of these projects is that dealing with the problem of fatigue in a full scale airplane wing structure. Fatigue is, as you may know, that phenomenon which causes the progressive fracture of a material under repeated loads. For many years it has been known that if a material is loaded at stresses which are considerably less than the ultimate for a sufficient number of times a failure will eventually occur. Why this phenomenon occurs has not yet been satisfactorily answered. The solution of such a problem will involve considerable research on small polished specimens such as you will hear described at another stop. However in addition there must be established the relationship between the results from the small polished specimens and those for completely fabricated wing structures. The primary objective of the fatigue study being conducted here is to establish a better practical knowledge and definition of fatigue as applied to full-scale airplanes.

The vehicle used as a test specimen is the C-46 cargo-type airplane obtained as surplus after World War II. The airplane is prepared for mounting between two backstops as you see on your left. The wings are fitted with weighted attachments to simulate the level flight loadings over a considerable portion of the wing. The repetitive loads which accumulate to cause the fatigue failure in the wing are applied by means of a resonant vibrator driven by an electric motor. Two of these fatigue machines are used for these tests. One appears here to your left and incorporates a very versatile loading mechanism for applying random type loads to simulate the flight history of an airplane, while the machine across the laboratory, which will be demonstrated later, applies loads of a more or less constant amplitude to the wing. Two specimens giving fourteen fatigue failures have been tested to date, and although the amount of data collected is too meager to draw broad conclusions, there are certain facts which seem worthy of note even at this time. These are first, that there is a relatively narrow spread in fatigue life of the specimens tested even though the points of failure in all specimens have not occurred at identical points in the structure, second, neither natural frequency nor damping appear to be changed by fatigue damage until after a fatigue crack has originated, and third, the rate of crack growth is quite small until the crack has included approximately 7.5 percent of the tension material of the wing after which the crack growth increases very rapidly.

At this time the fatigue machine near the back wall will be started up again and you will be able to watch the operation of the constant level machine. There will also be time while this machine is running for you to walk around and inspect the other airplanes on exhibit in this laboratory. A wing strain gage installation is illuminated for your inspection in the B-45 airplane on your right; and on the right in front of you is a F-82 airplane on which a strain gage calibration is now in progress.



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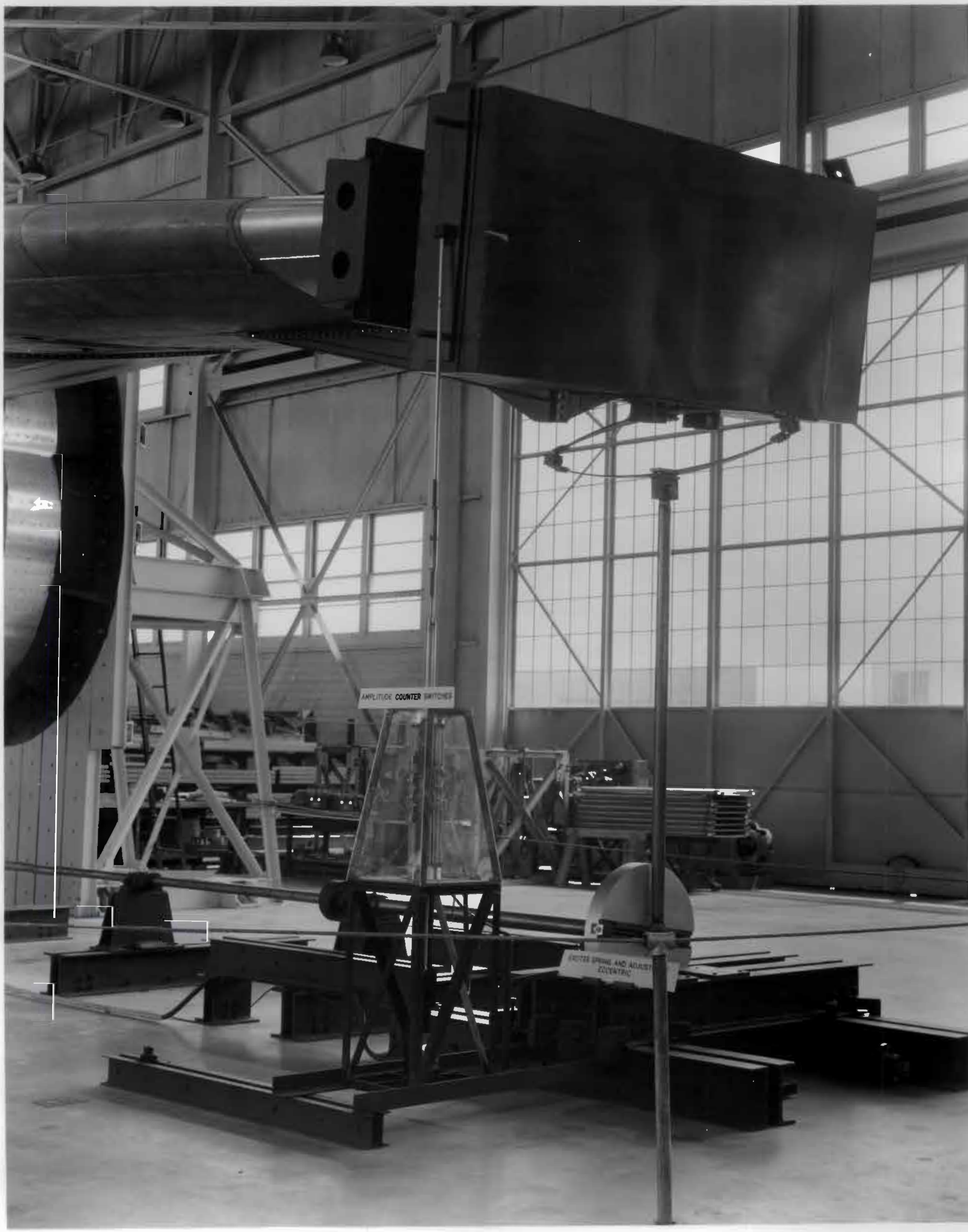

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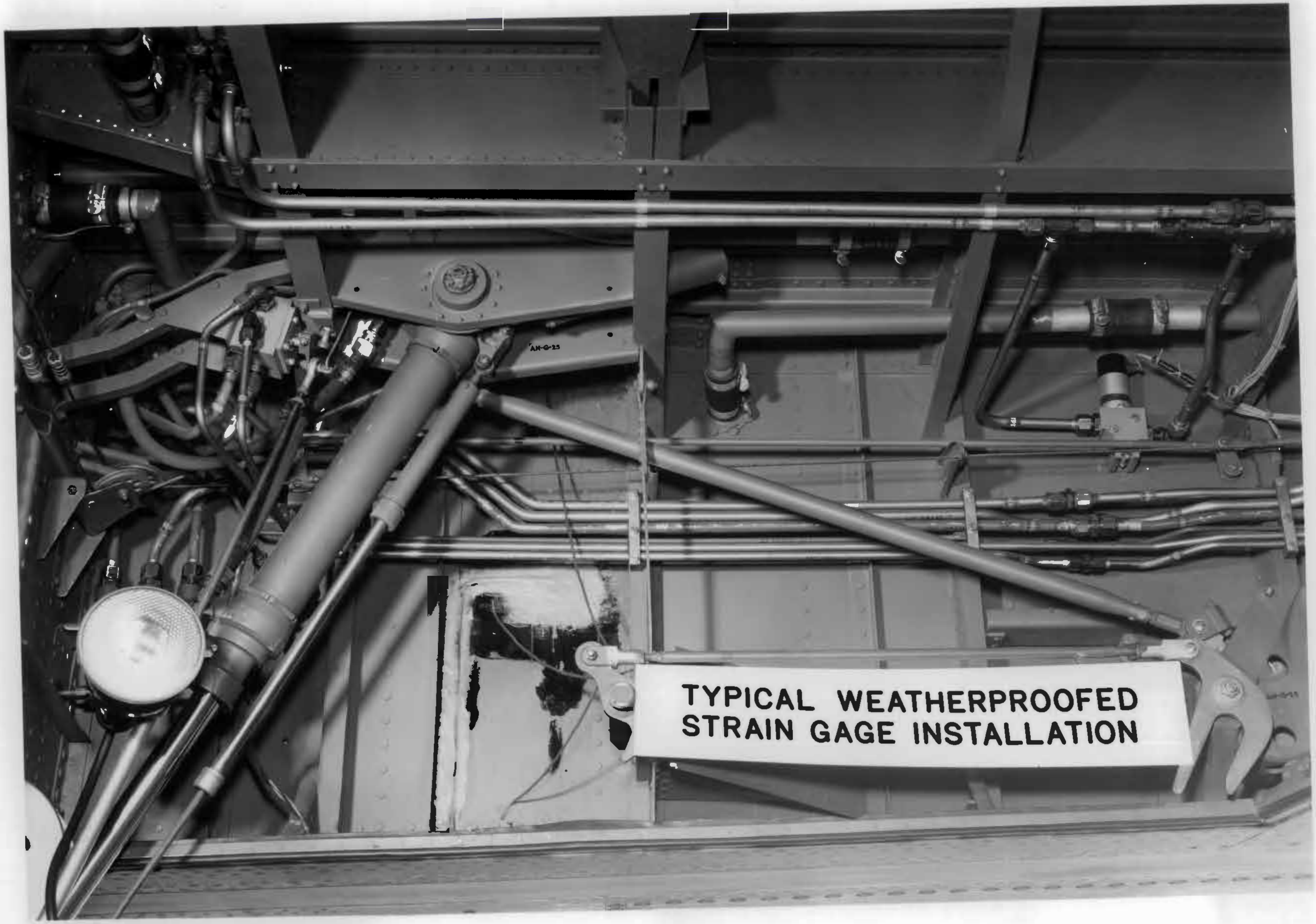

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1951 BI
GUST TUNNEL
Reisert

Talk for Biennial Inspection 1951

Gust Tunnel

By Reisert and Cahen

Gentlemen, today we're going to discuss some airplane operating problems and some recent information obtained from gust research. Atmospheric turbulence or gustiness poses a number of problems relating to the safety of flight. Many techniques are involved in studying these problems and one of the tools used is the gust tunnel. You see the tunnel running over here and since most of you have been here before, no doubt you're expecting one of our demonstrations which, as you know, consists of a loud bang and a model streaking by here so rapidly that hardly anyone can see its action in a gust. We realize this, so today we aren't going to demonstrate the equipment, we just have the tunnel running for ventilation. If we were going to demonstrate today we would fly two small models side by side through this gust. They would be identical except that one would be twice as heavy as the other and naturally they would behave differently in the gust. Now to show you what you should see, let's have some slow motion movies, in which we hope everyone will see how the models behave.

Movie.

These pictures are being shown at 1/8 speed.

The first shot shows the models flying side by side with no gust and you can see they are flying parallel paths.

The second shot shows the same models flying in a gust. Note that the heavy model, which is the one to your left, does not rise as much as the other but that it does pitch down a good deal.

(3rd flight) Now this is exactly the same flight, just to give you another look at it. (end movie)

This effect of wing loading is not something new but we thought it would make a good thing to show in order to give you an idea of how changing one of the parameters of an airplane might affect its behavior in a gust. Now, we study many problems with this equipment. One of our current programs is to study the airflow over swept wings in gusts. This morning at your first stop, at the full-scale tunnel, they presented a chart which showed that in steady flow at relatively high angles of attack on wings having certain degrees of sweep and leading edge radius, leading edge separation occurred in the form of a vortex. Now our problem is to find out if this same phenomenon occurs in the gust condition where the wing undergoes a very rapid change in angle of attack. In order to obtain this information we selected a model which according to steady flow data should generate a vortex. Then we glued tufts on the wing surface and photographed them as the model passed through the jet.

The chart I have here shows a comparison of the tuft behavior on this wing in the gust tunnel and in a wind tunnel. This picture shows the tuft behavior on the model in steady flight just before it enters the gust. This one shows how the tufts behave in the unsteady flow conditions of a gust, where the model undergoes a change in angle of attack from 6 to 15 degrees almost instantaneously. Now for comparison, this picture was taken of the model in the steady flow conditions of a wind tunnel at a corresponding angle of attack. In this picture at 6 degrees, the tufts are parallel and indicate a flow straight back. Now in these two at 15 degrees, if I place the pointer here, the tufts below the pointer are still parallel but those above the pointer indicate a lateral flow outward toward the tip. This type of tuft pattern has been identified with a leading edge vortex. Comparison of these two pictures shows that the flows are similar for the two conditions. This was contrary to our expectations because we didn't think that the vortex would have time to develop in the gust before the model reached peak load. Since this vortex pattern is associated with increased lift its appearance here in the gust has led to the tentative conclusion that it may be present on actual swept-wing airplanes in rough air and may result in increased gust loads. Further study of this problem is now in progress.

Introduce next speaker.

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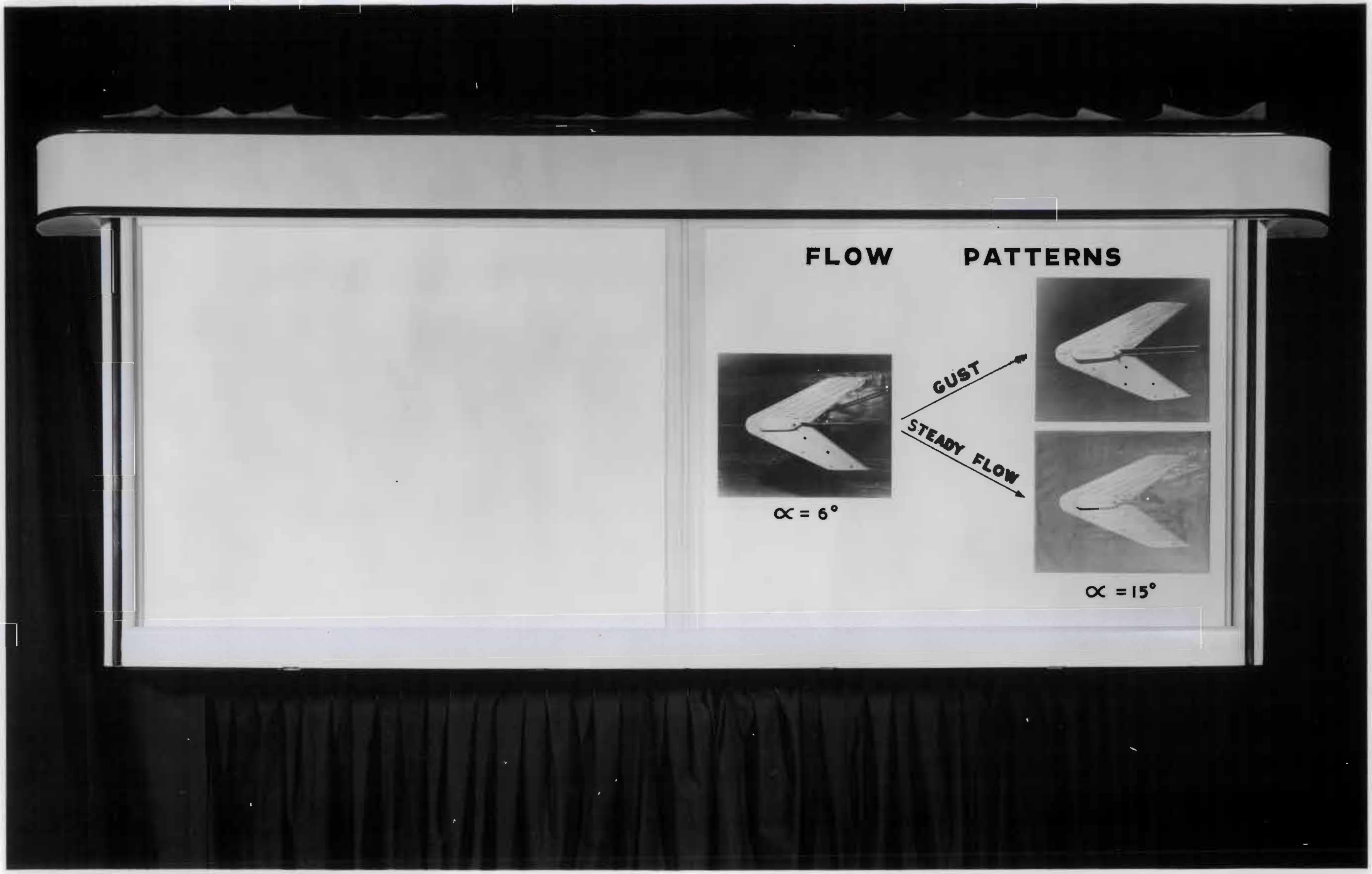

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Talk for Biennial Inspection 1951

Gust Tunnel

By Steiner and Coleman

Operating problems are those problems which arise when an airplane is used day in and day out to perform some mission such as transporting bombs, passengers, or cargo. As distinct from aerodynamic questions which involve increasing the speed of the airplanes, stability, and design problems, operating problems depend on how the airplane is used and handled. Work is under way at the NACA Laboratories on numerous operating problems. Some of these problems are noise, icing, landing conditions, and gust load experience.

Some operating problems require a minute to minute knowledge of airplane operations and therefore require that special instruments be installed in transport airplanes in regular service. One instrument which has been in use for a number of years on the airlines in gust research is the V-G recorder with which many of you are familiar. A sample record from this instrument is shown in the upper portion of the first chart. This record is an envelope of maximum positive and negative normal acceleration increments or loads against airspeed. The V-G record gives pertinent information on the large gust loads which might damage the aircraft from the application of a single load, but tells nothing of the events leading up to the load experienced or tells little concerning the numerous smaller loads, obscured by the larger loads, which contribute to structural fatigue and passenger discomfort.

As additional questions on operating problems arose it was apparent that more detailed information was required than that given by the V-G recorder. Special effort was, therefore, given to the development of an instrument of the time history type with a long recording time. This newer instrument is the VGH recorder. This instrument gives a time history of airspeed, normal acceleration and altitude.

As you can see, it is a compact instrument with a remote recording accelerometer. The instrument operates from the airplane's power supply and is turned on with the master switch of the airplane. It records photographically on a 200 foot roll of paper and a total of 90 to 100 hours of record time is available without reloading the instrument.

At the bottom of the chart is an illustration of approximately 10 minutes of a typical VGH record. The traces are shown here the same as they appear on the record. The lower trace, which is altitude, has a zero near the top of the record and increasing altitude is shown as a deflection downward. This record indicates therefore that the airplane was starting a descent from about 20,000 feet. The upper trace is airspeed, and on this record the airspeed varied between 250 and 300 miles per hour. The middle trace is normal acceleration. The peaks are gust accelerations and for the rough air encountered, the maximum acceleration increments were about ±0.5g. These peaks go to make up the envelope obtained on the V-G record.

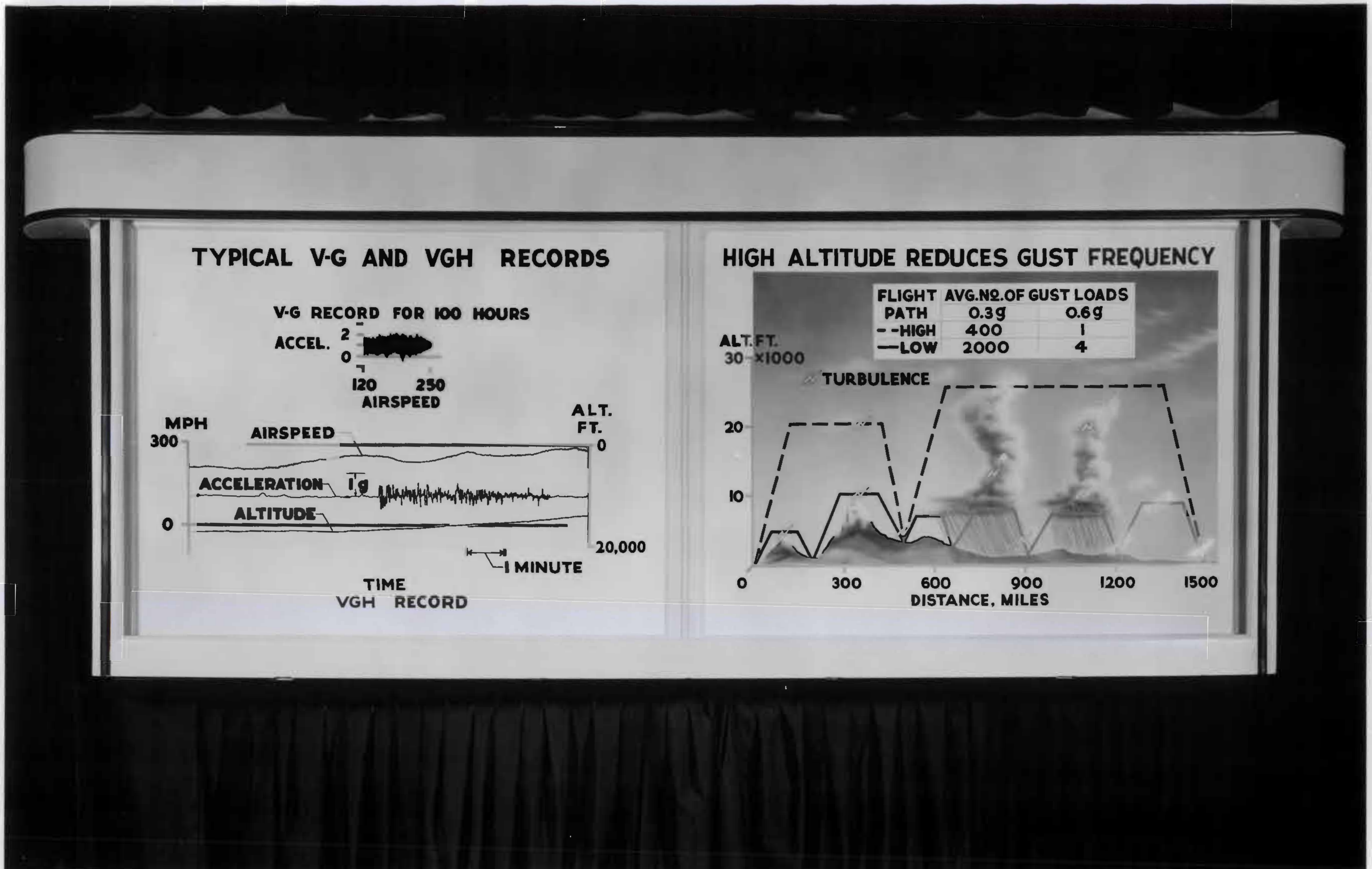
As an example of how we use the information obtained from these records some data obtained to date have been analyzed with respect to the problem of turbulence encountered by aircraft. In the study of turbulence we need information on the intensity and frequency of turbulence, and how and where the airplane is operated in turbulent air. Weather conditions which may exist along a route from the Midwest to the West Coast and some terrain features which might lead to the rough air experience of airplanes at high and low altitudes are given in the next chart. Low altitude operations are defined here as operations below 10,000 feet and high altitude operations as those from 20,000 to 30,000 feet. This mark resembling lightning is actually a symbol for turbulence. The flight paths in the chart show that an airplane which operates at low altitudes would be expected to encounter turbulence associated with mountainous regions, turbulence during landing and takeoff, and in flight through cumulus clouds or thunderstorms which could not be avoided. In contrast, the high altitude airplane could fly above many of the cumulus clouds, stand a better chance of avoiding thunderstorms, but may encounter some clear air turbulence at the high altitudes.

The average number of gusts, encountered on the low and high altitude flights of 1500 miles, is given in the table. Gusts causing acceleration increments of 0.3 and 0.6g were arbitrarily selected for comparing the gust experience on the basis that these values correspond to slight and to moderate passenger discomfort. We see that 2000 accelerations of 0.3g would be expected for the low altitude trip, but only 400 or 1/5 as many, on the high altitude flight. A similar reduction in the number of the large accelerations is also indicated in the table with 4 accelerations for the low altitude operations and one for the high altitude operations. These preliminary results indicate that an appreciable reduction in the frequency of gust loads will be obtained by operating at high altitudes.

This chart was an illustration of one turbulence investigation. While the VGH recorder was originally designed for the investigations of turbulence, the continuous records are useful in the investigation of many other problems. These problems vary from the study of airspeeds and Mach numbers to the determination of the relative lift of the wings at the time of touchdown.

At the present time we have only a few of the VGH recorders installed on commercial aircraft but have obtained the cooperation of several airlines for the installation of additional instruments.

Another operating problem, that of aircraft noise will now be discussed by .



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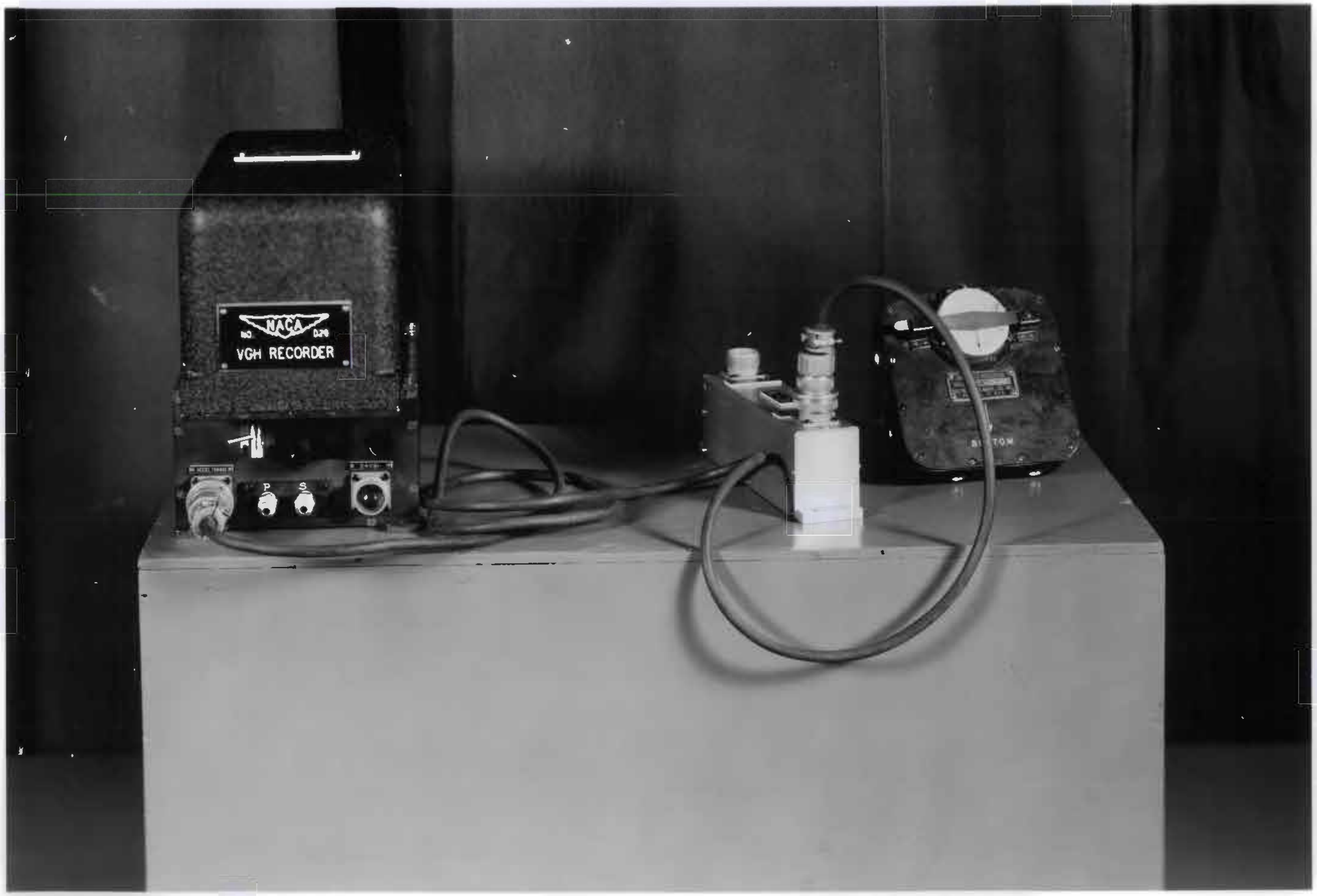

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1951 BI
GUST TUNNEL
Hubbard

1951 MAY INSPECTION

~~Vibration and Flutter Branch~~

by Harvey H. Hubbard and Leslie W. Lassiter

AIRCRAFT NOISE

Since noise considerations may seriously affect the design and operation of aircraft, the NACA is reexamining some aspects of the aircraft noise problem. A survey is now in progress and we will present some of the preliminary results. Our studies at the NACA have been limited to the physical characteristics of the noise. Some of the material on other aspects of the problem has been obtained from outside sources such as the Air Materiel Command, the Bell Telephone Laboratories, and various other agencies and aircraft companies.

Noise is also known to have serious effects on man and in recent years research at various agencies has shown that some of these effects can be predicted if the spectrums are known. This first chart, in which intensity is plotted as a function of frequency, will illustrate some of the intensity levels that are significant. This chart is oversimplified because some of the effects on man are a function of frequency as well as intensity.

This shaded area represents the ranges of speech. The level of 85 decibels is believed by many scientists to be the maximum level to which an unprotected person may be exposed without incurring some impairment. We will now demonstrate a noise of about this level.

Since the decibel is a rather abstract quantity we would also like to demonstrate a level of 100 db which is about here on the chart and represents an increase of 15 decibels above the first level. The noise you will hear, will be that of a supersonic propeller at a distance of a half mile. (Short burst of prop noise) For comparison now we would like to demonstrate rocket noise at about the same intensity level. (Rocket noise) At levels in the order of 120 db most persons experience discomfort. At higher levels more and more discomfort is experienced until in extreme cases, pain and damage may occur.

In current noise studies of propellers, rockets and jets we encounter two basic types of noise spectrums as illustrated in this next chart. These two figures represent frequency analyses of noise from a supersonic propeller and solid fuel rocket respectively. Intensity on the vertical scale is plotted as a function of frequency on the horizontal scale.

Supersonic propeller noise which is associated with steady aerodynamic forces on the blades can be described by a line spectrum such as shown here. (left figure) Only a few predominating frequencies are present, as indicated by these blips in the light trace, and each frequency component has a constant intensity. You will recall in the demonstration that the propeller had a characteristic tone as if it consisted of several pure notes sounded simultaneously.

The other type of spectrum encountered is associated with turbulence and hence is of a random nature. This type is shown in the right hand figure and is called a continuous spectrum. Here nearly <u>all frequencies</u> from the sub-audible to the ultrasonic range are present and each one is fluctuating in intensity. This spectrum is characteristic of rockets and many types of jets and corresponds to the last noise demonstrated.

These spectrums are useful generally in describing the noise generated by various sources, but for any given source they usually vary somewhat as a function of direction. Hence, we must also know the directional properties of the noise in order to fully describe it. This next chart illustrates some of the directional properties of two types of noise sources. The propeller noise is most intense near the plane of rotation and is a minimum near the axis of rotation. The jet noise on the other hand is a maximum near the axis in the rear of the engine.

These distributions suggest that for single engine airplanes, the crew is in a relatively favorable position and may not need much protection from these noise sources. For airplanes with engines on the wings the problem is more severe since the fuselage may intersect these radiation patterns near their maximum values.

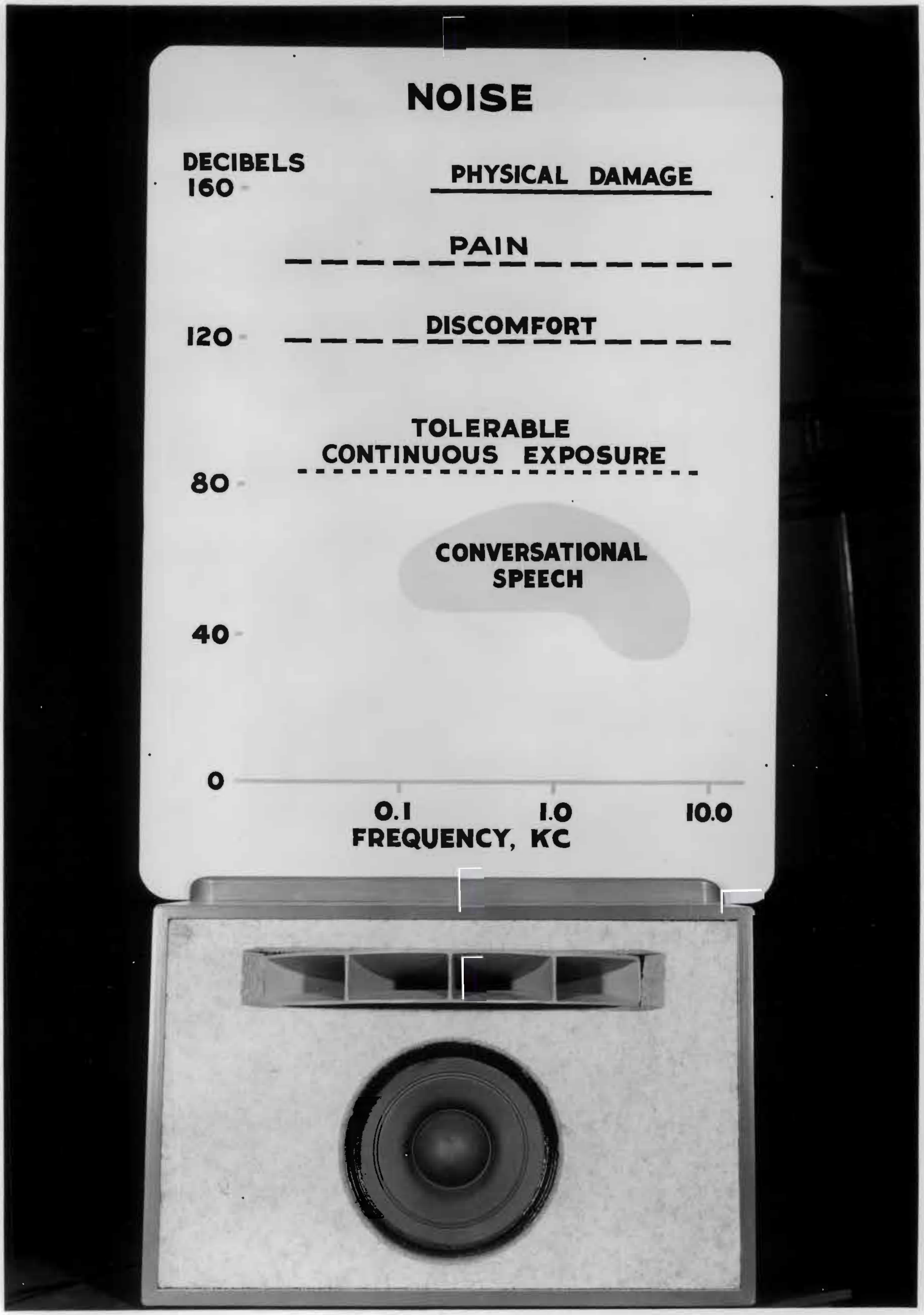
Service personnel and ground crews may not always be able to take advantage of these directional characteristics in the course of their work and hence the maximum values have significance. This next chart indicates the estimated maximum noise levels encountered for a distance of 30 feet and thrust rating or 10,000 lb. for these various units. Decibels are plotted along the horizontal scale. The levels associated with pain and physical damage from the first chart are shown here by these red lines. We see that all of these sources generate noise levels in the critical region. The fact that all these levels are so high suggests that some kind of personal protection should be furnished.

Personal protection for the range of speech frequencies is available in the form of ear plugs and helmets. Protection for the intense low frequencies which are felt by the whole body would probably be too cumbersome to be useful.

For in the interest of people inside the airplane it appears that satisfactory reduction may be obtained in the range of speech frequencies and above by conventional methods. Substantial reductions for the lower frequencies will probably necessitate the use of heavier cabin walls.

Intensive effort is being put into the muffling of jets on the ground and wherever a suitable structure could be built, satisfactory results have been obtained. The amount of noise reduction obtainable for a given amount of material is, in general, a function of the frequency; the higher frequencies being more readily attenuated than the lower ones. Where intense low frequencies are present, the resulting structures are large and massive.

The present programs of the NACA are aimed at an understanding of the physical characteristics of the noise. It is believed that a clear concept of this phase of the problem plus a further clarification of the tolerance levels are both necessary before a great amount of effort is expended in noise reduction.



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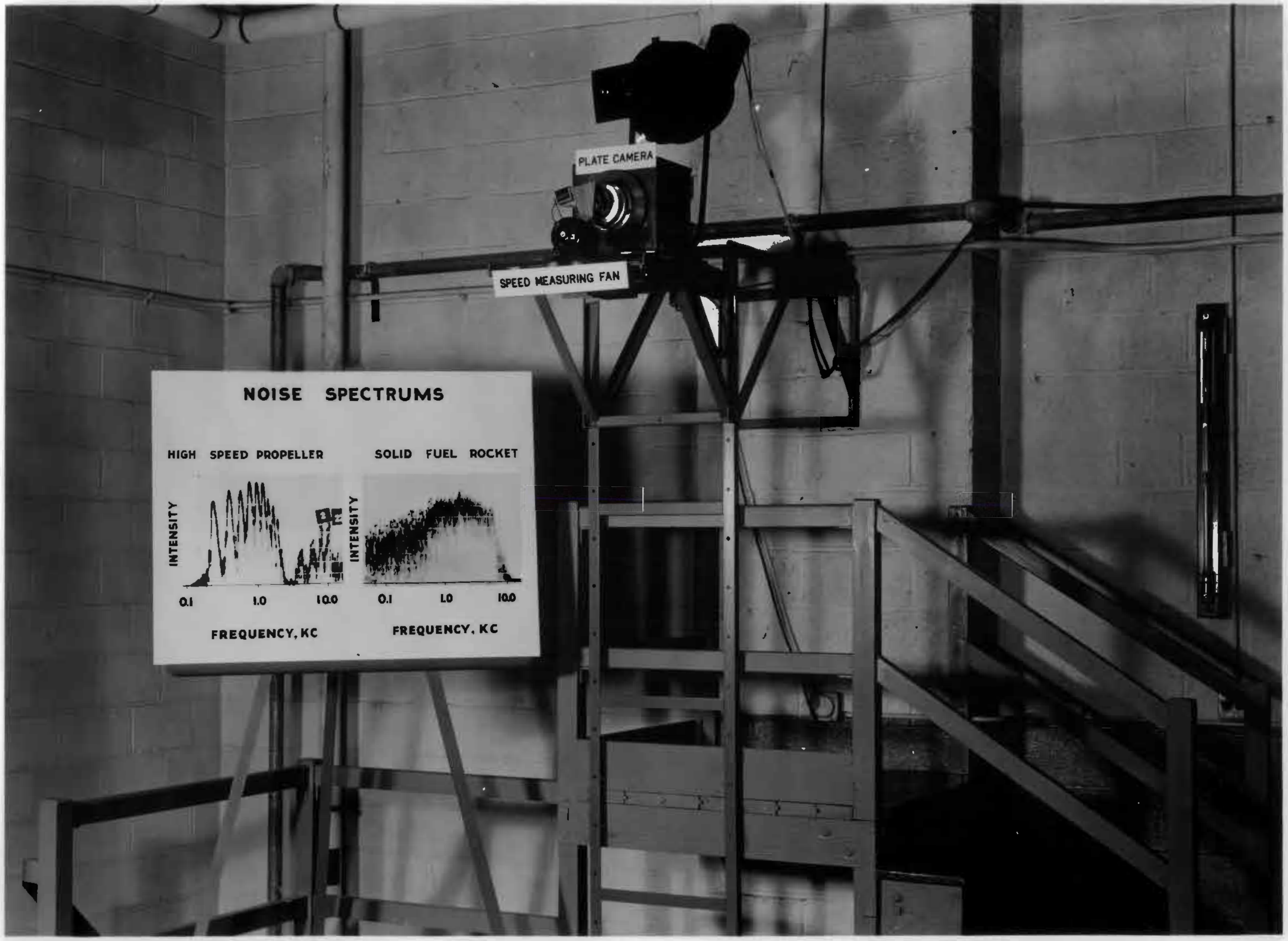

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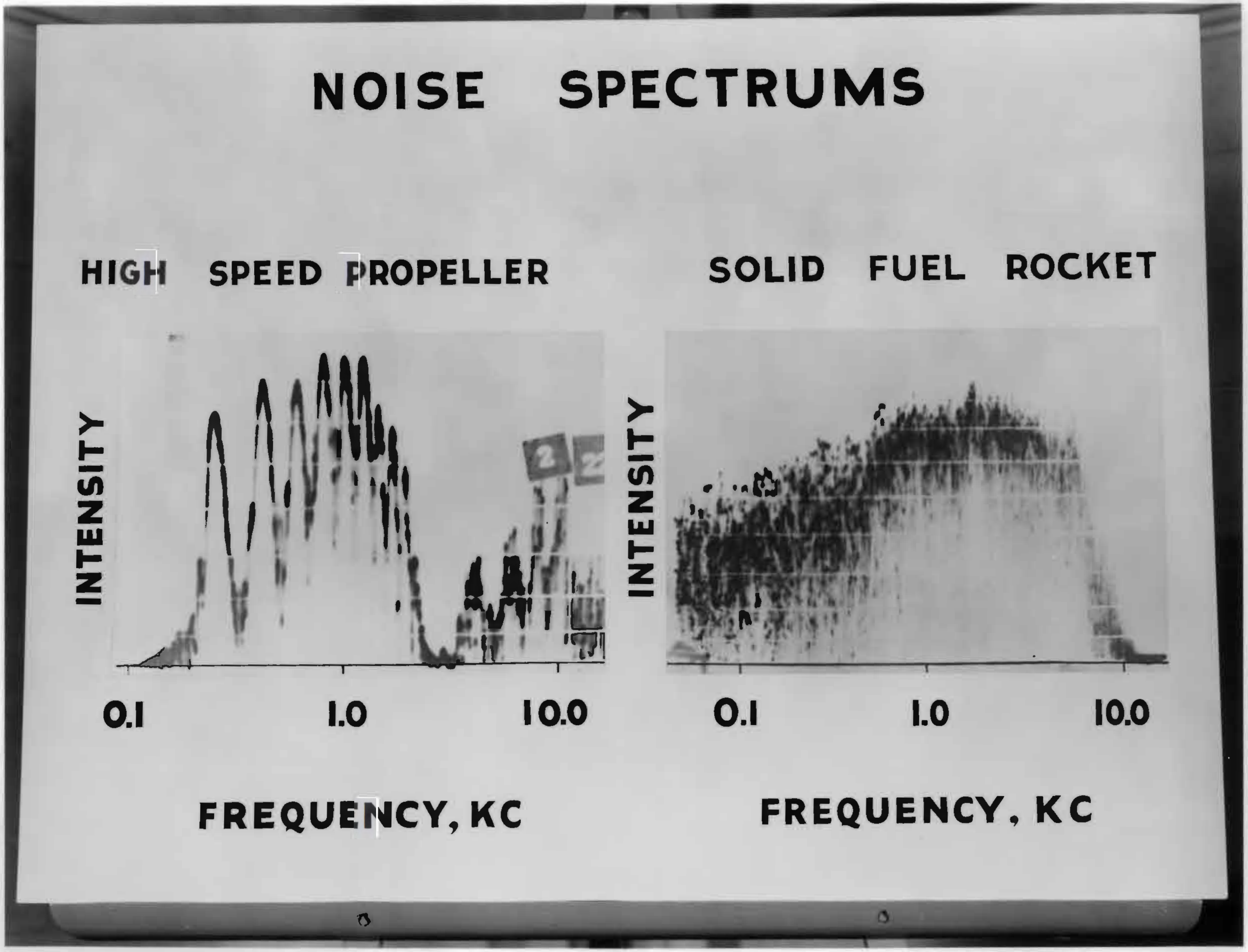

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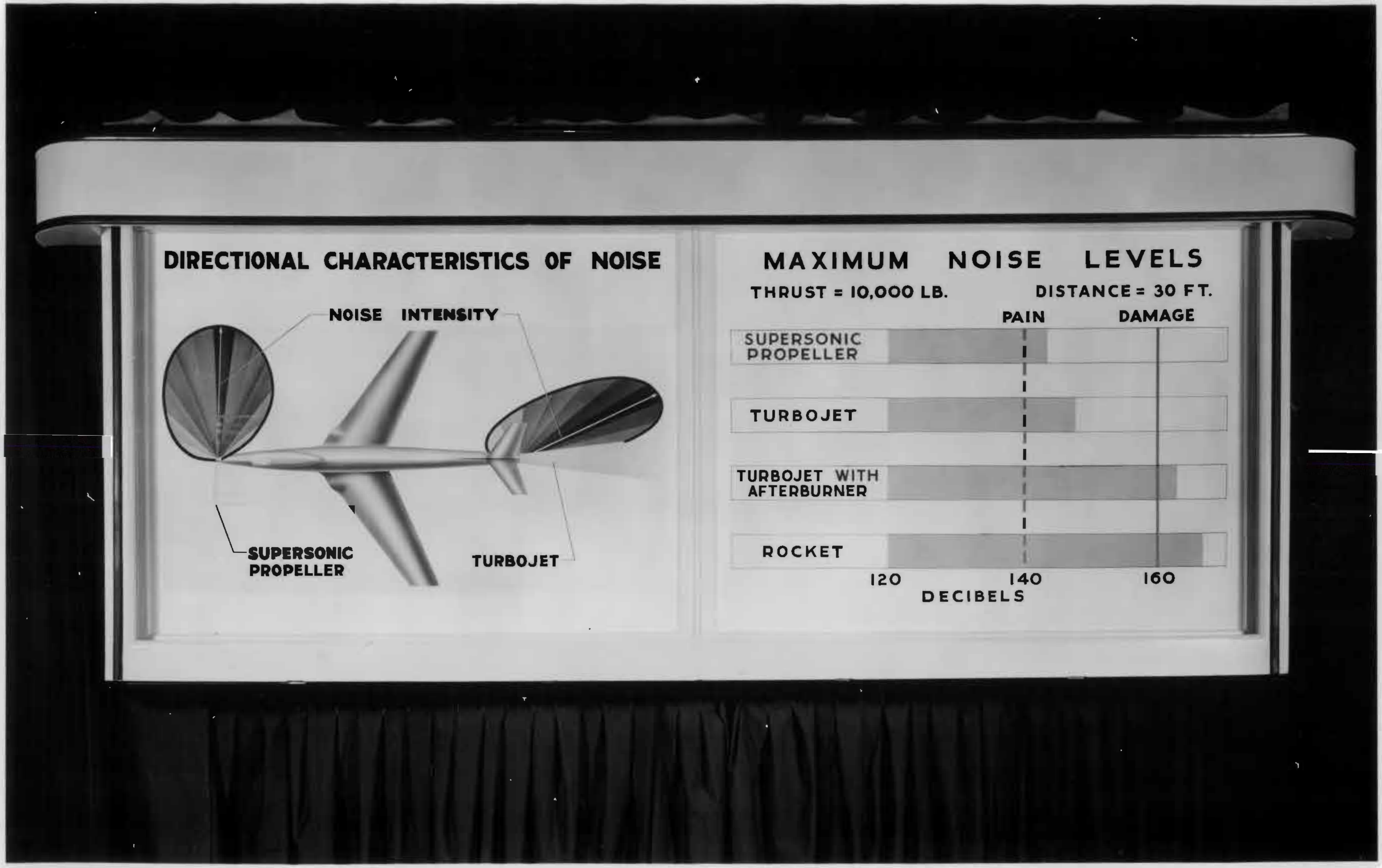

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7- by 10-Foot Tunnels Program

Talk No. 1 - Controls and Dynamic Stability

(To be given in test chamber of high speed tunnel)

Speakers WC Sleeman, WB Kemp Jr, JW Paulson, LR Fisher

Introduction to 1st Group

Gentlemen, on your way in through the shop you probably noticed the models on display. These models are representative of those used in the various wind tunnels of the Stability Research Division. You are now in the test chamber of the high speed 7- by 10-foot wind tunnel which is one of the facilities of this Division.

Introduction to 2nd Group

Gentlemen, this room is the test chamber of the high speed 7- by 10-foot wind tunnel.

We will discuss briefly some of the problems confronting designers of high-speed aircraft, relating to the design of controls and attainment of adequate dynamic stability at transonic speeds.

The first chart illustrates some lateral-control configurations for unswept, swept back, and triangular wings. These controls appear promising because they have been found to retain their effectiveness at transonic speeds, provided the wings are kept reasonably thin. The familiar aileron and spoiler controls which normally are located near the tips of unswept wings are found to be most efficient for swept wings when located farther inboard. Other possible arrangements for swept wings include an all-moving tip control and a trailing-edge tip control of the type shown at the right. For triangular wings, consideration is being given to the conventional trailing-edge control, an all-moving tip control, and a tip control hinged on a skewed axis.

In attempting to provide moderate control forces, to be handled either manually or by power boost, the designer is confronted with a control-balancing problem common to all of the configurations illustrated, with the possible exception of the spoiler controls. The general nature of this balancing problem is illustrated in the next chart. This chart shows the control force, associated with the aerodynamic hinge moment at a constant deflection, plotted against Mach number for controls having simple balances. This line shows the allowable force limit for manual operation. Curves are shown for a plain (or unbalanced) flap, an inset-hinge flap, and an all-moving tip control. The latter two are assumed to be hinged in such a manner as to provide complete balance at low subsonic speeds. Notice that the control force for these flap arrangements increases rather abruptly in the transonic speed range. This abrupt change in force results from a change in flap chordwise load distribution from the subsonic (or nearly triangular) shape to the supersonic shape, which tends toward a rectangular form. This change in load distribution which can be interpreted as a rearward shift in center of pressure will generally persist regardless of the means used to obtain aerodynamic balance. Preliminary results indicate that the familiar inset-hinge control does not provide balance in the supersonic range. Some reduction in control force at supersonic speeds may be gained through use of an all-movable tip control, hinged to provide complete balance at low speeds. The forces at supersonic speeds still would be many times higher than the allowable limit for manual operation. The force variation illustrated for the tip control is representative of that obtained for several balanced controls, including flap-type controls with geared tabs, horn balances, or paddle balances. Although controls that exhibit this type of force variation may not be suitable for manual operation, they can be used advantageously in connection with an irreversible system employing a power boost. For such a system, the control could be designed to permit overbalance at low speeds, in order to reduce the power requirement of the boost at supersonic speeds.

If manual control is desired, it appears that a more complex type of balance must be used. One possible device might be as illustrated by this model, which combines a spring tab with some fixed aerodynamic balance, in this case, a paddle balance. Another possibility is illustrated by this second model. This involves linking the pilots control to a semaphore-type spoiler. Drag on the deflected spoiler causes it to rotate backwards, which, through gearing, transmits rotation to the aileron. This particular arrangement represents a servo-type of control, for which the pilot is required to provide only the force necessary to project the spoiler into the airstream.

In concluding the discussion of controls, it is apparent that more research is needed on unconventional control arrangements such as these models, and others, to provide effective controls requiring moderate forces at transonic speeds. An important phase of aircraft stability is concerned with the longitudinal and lateral oscillations following a disturbance. A longitudinal oscillation, for example, will be damped if the oscillation dies out. If the oscillation builds up it is undamped.

Many present-day high speed airplanes are experiencing difficulties with undamped oscillations at transonic speeds. The problem of damping the oscillations of these aircraft is becoming more severe as wing loadings increase and the aircraft fly at high altitude.

The next chart summarizes some results on damping in pitch for several model configurations at transonic speeds. The damping in pitch coefficient is plotted against Mach number. Damping coefficients in this region indicate that the longitudinal oscillation will be damped and coefficients in this region indicate an undamped oscillation. These results were obtained from tests of free flight rocket models by the Pilotless Aircraft Research Division. The curve for the triangular wing model with 45° leading edge sweep, however, was obtained from wind tunnel tests and had been presented by the Ames Laboratory during the inspection held last year. This model showed unstable oscillations at Mach numbers near 1.0. The triangular wing model with 60° sweep, however, showed no loss in damping in this region. These results indicate that adequate damping of the longitudinal oscillations of tailless triangular wing airplanes may be attained provided the wings are thin and have sufficient sweep. The unswept wing and fuselage combination also showed instability near a Mach number of 1.0. It was possible, however, to obtain stability through the speed range by addition of a tail, thus overcoming the inherently poor damping characteristics of the unswept wing.

We would now like to demonstrate some of the equipment used in the high-speed 7- by 10-foot wind tunnel for investigating dynamic characteristics of airplanes. This model was used to study the build up of rolling moment following an abrupt deflection of the spoiler control. You may step into the test section, by way of the large door at your left to witness the demonstration.

Side Wall

This model illustrates the technique used for measuring damping in pitch. The rate of decay of the oscillation of the model is measured and is an indication of the damping in pitch.

Sting

The model on the sting in the center of the tunnel is used to determine the aerodynamic forces on aircraft configurations during a rolling motion. The operator will now roll the model. The model is driven by a hydraulic motor located in the sting support. The forces and moments on the model are measured by a six-component strain-gage balance contained within the model. The apparent eccentricity of rotation is caused by this bent sting which provides for an angle of attack of the model while still allowing the model to rotate about its center of gravity. Of course during testing, only one of these models would be mounted in the tunnel at a given time. This concludes our demonstration.

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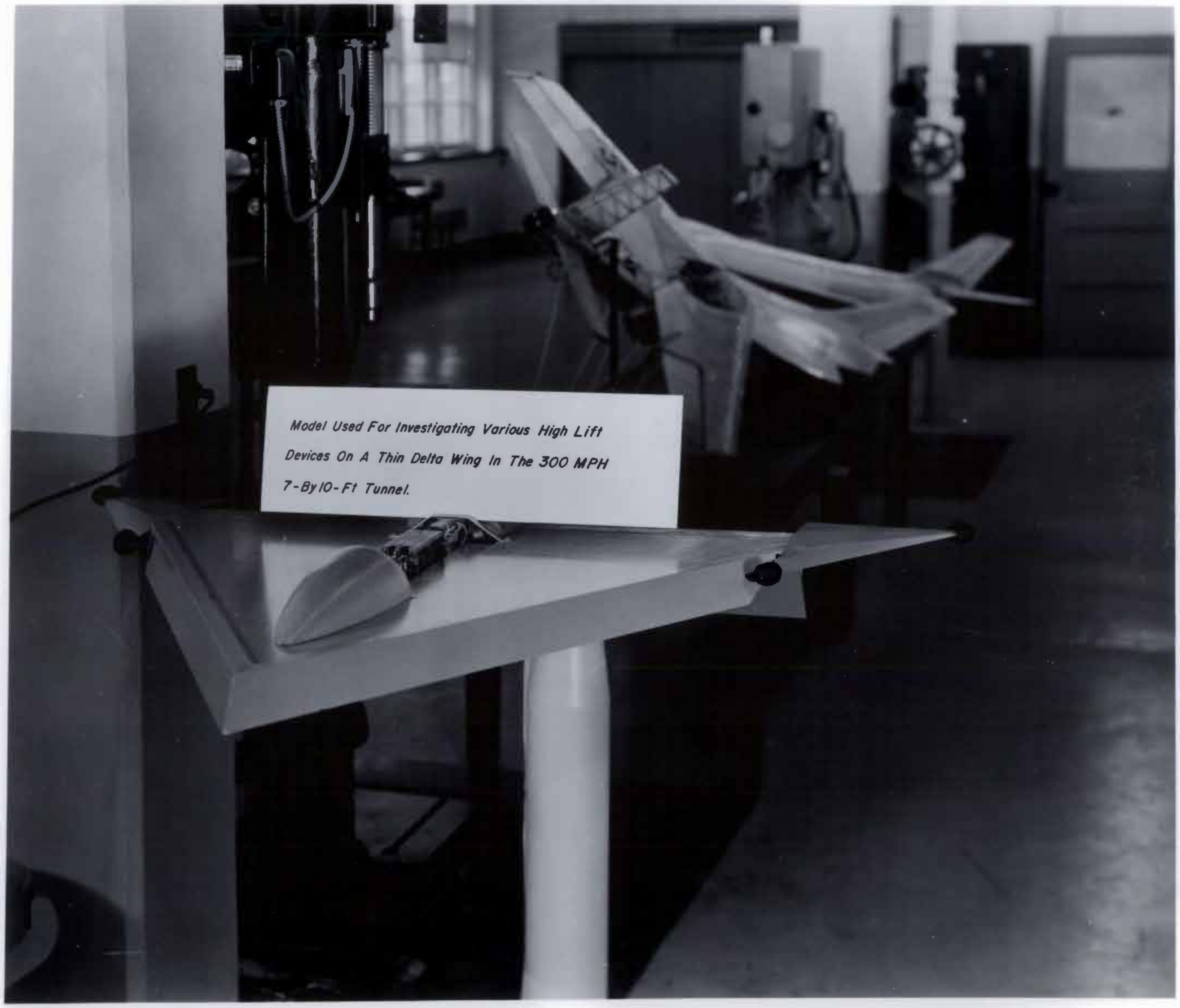

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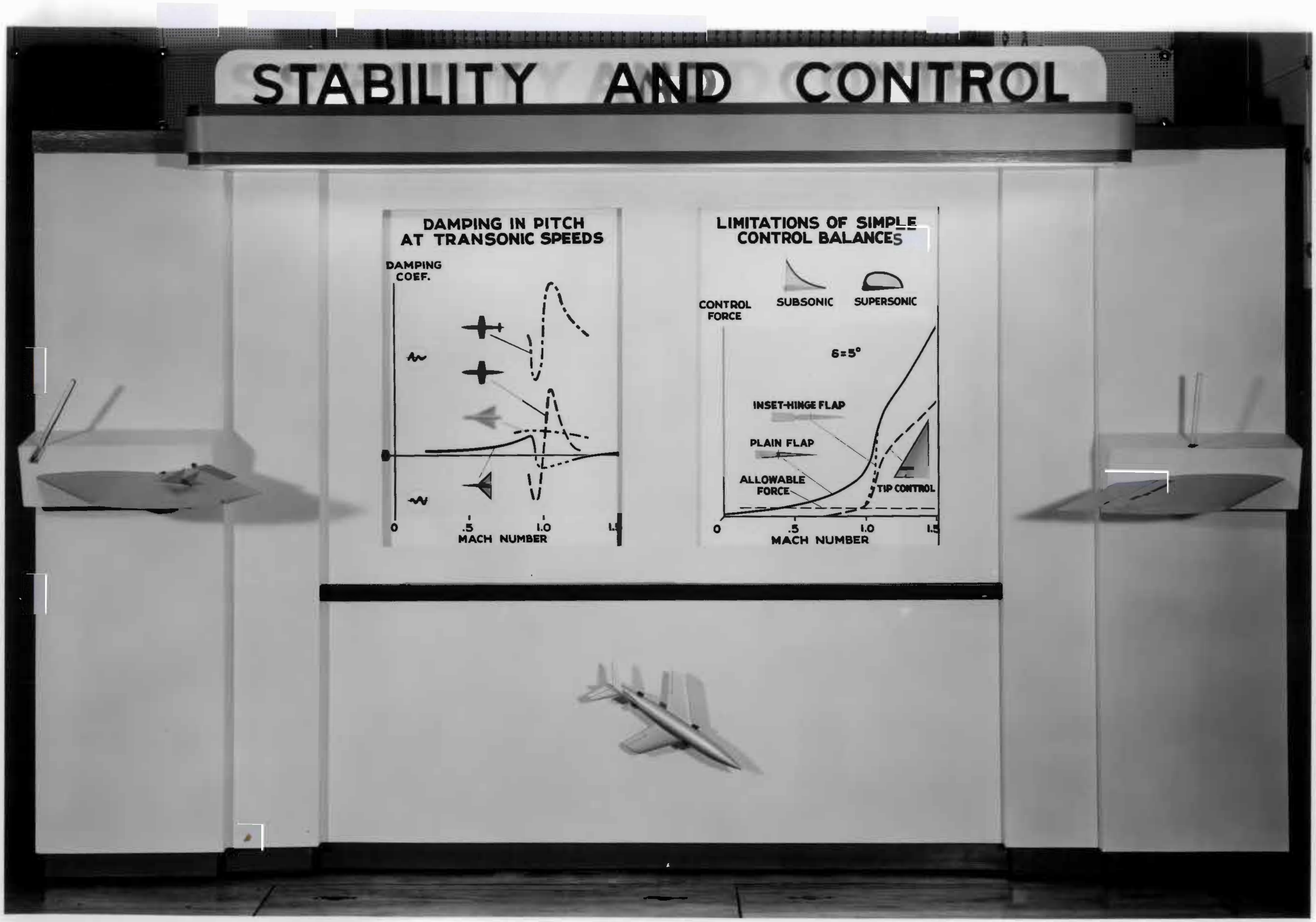

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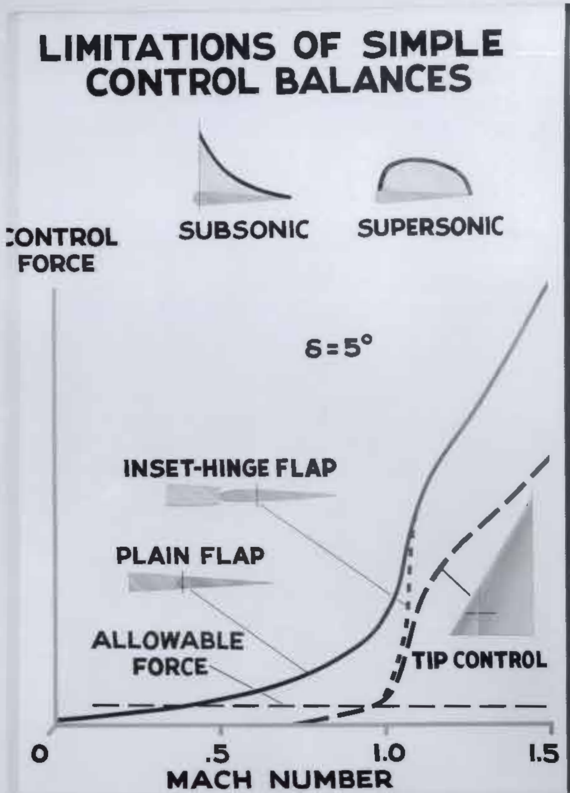

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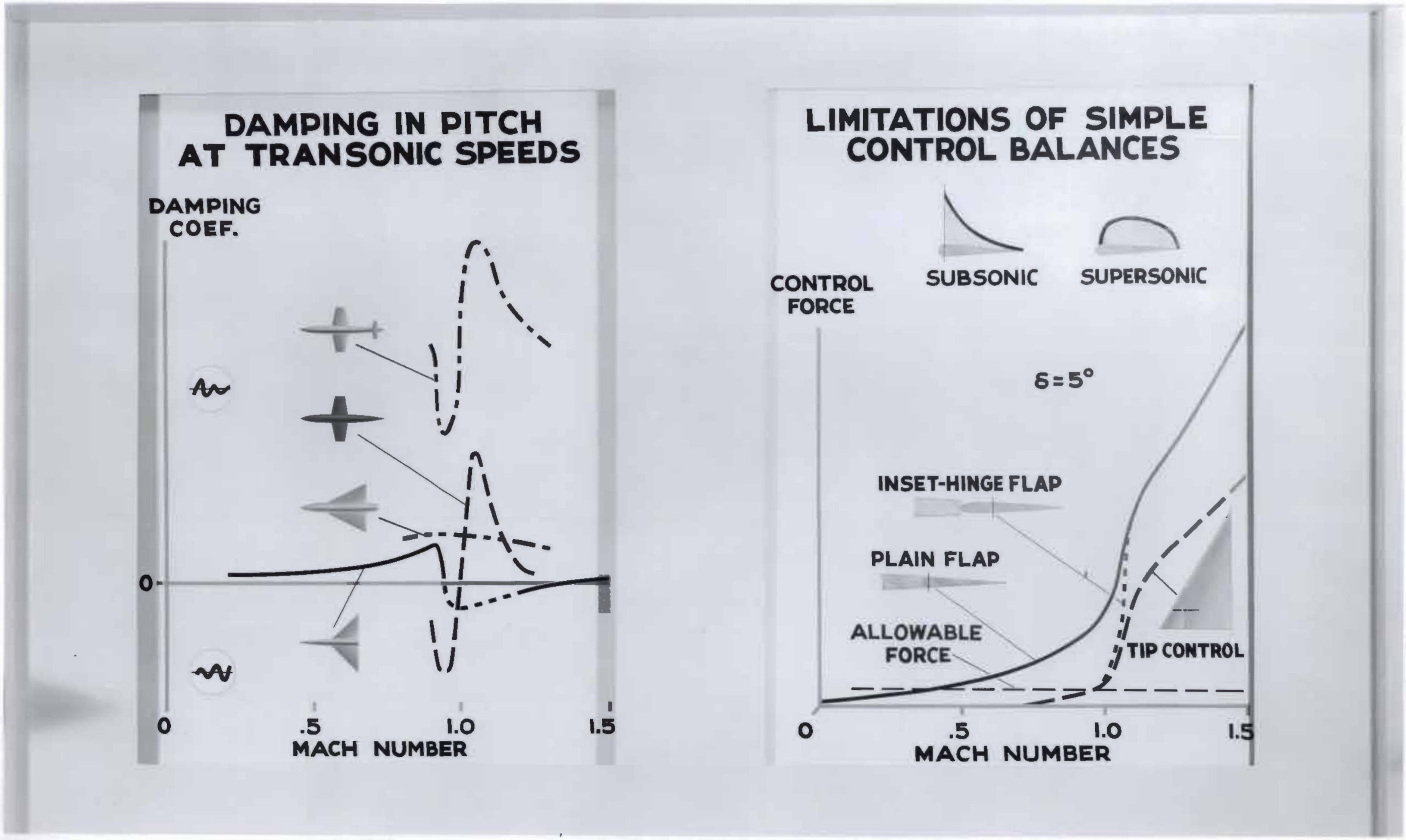

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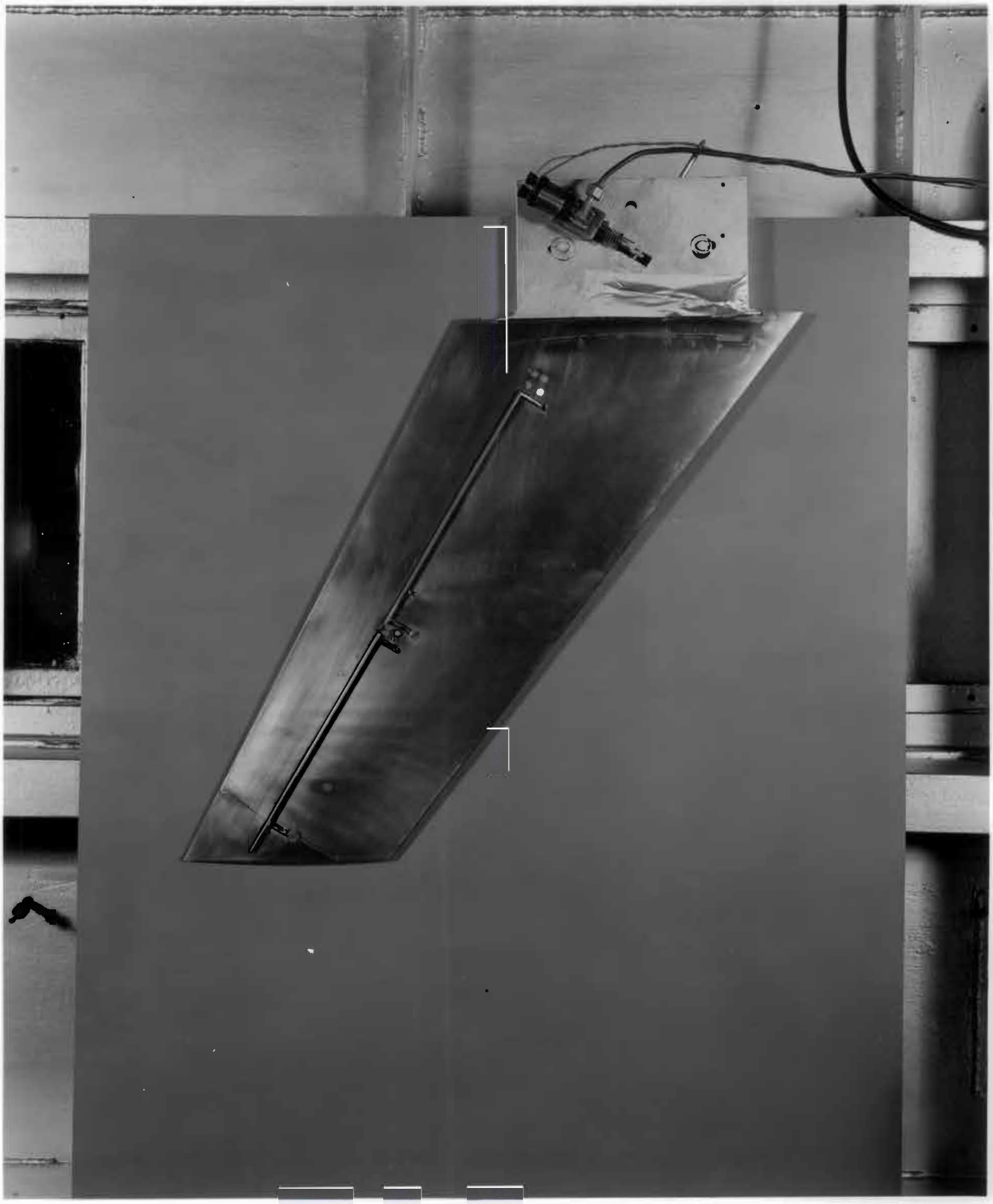

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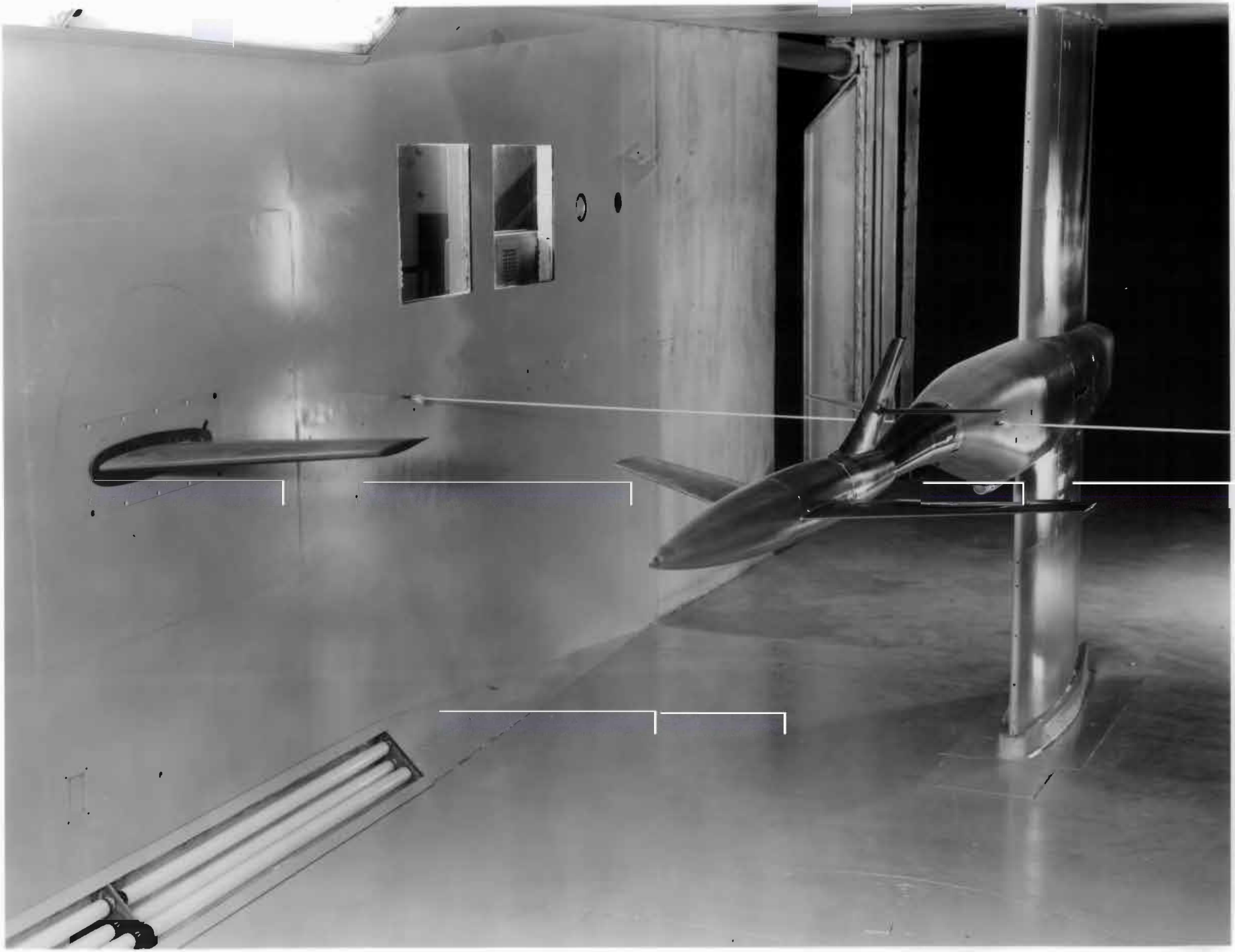

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7- By 10-Foot Tunnels Program

Talk No. 2 - Flow Field Studies with Tuft Grid

(To be given in test chamber of 300 MPH tunnel)

Speakers DR Riley, SH Scher, FS Malvestuto Jr, RL Naeseth

INTRODUCTION A

Gentlemen, before entering this room you passed through the shop, where you probably noticed a number of wind-tunnel models on display. These models are representative of the types used in the various wind tunnels of the Stability Research Division. The room in which you are now located is the test chamber of the 300 mile per hour 7- by 10-foot wind tunnel, which is one of the facilities of this Division.

INTRODUCTION B

Gentlemen, this room is the test chamber of the 300 mile per hour 7- by 10-foot wind tunnel.

One of the aerodynamic problems studied here concerns the interference between the various component parts of aircraft. The wing of an airplane, for example, leaves behind it a field of disturbance which alters the flow conditions in the region normally occupied by the tail. This chart simply represents an artist's conception of the wake portion of the flow field; actually, the entire flow field is much more complex and can not be represented by such a simple illustration. For wings having high aspect ratios, the effect of the flow field at the tail generally does not present a serious problem, since the disturbances leaving the wing tips are far apart and therefore the tail may move considerable distances, either vertically or laterally without encountering severe gradients in downwash or sidewash angles. When a tail assembly is used behind a low-aspect-ratio wing, however, the problem is considerably more complicated, since the highly disturbed regions, leaving the wing tips, lie close to the tail and therefore the tail may encounter severe changes in flow angularity even for small tail movements. This condition affects not only the static stability of the airplane but also the damping of oscillatory motions. The influence of the flow field on longitudinal stability can be largely avoided of course, if no horizontal tail is used. Problems associated with vertical stabilizing surfaces still exist, however, whether these surfaces are located on the fuselage, or attached to the wing.

I would like to discuss a very simple technique that recently has been developed for studying the flow behind a wing or any other airplane component. The set-up used in applying this technique is indicated on the next chart. This illustration represents a cut-away view of a portion of a wind tunnel showing the model mounted in the test section. Apparatus, which we call a tuft grid, is located behind the model. The grid consists simply of a steel framework on which fine wires are strung, both vertically and horizontally with woolen tufts attached to the wire intersections. When the tunnel is in operation, the air flows past the model and through the grid. At the same time, either still or motion pictures of the grid are taken by a camera located far downstream, while the attitude of the model is being changed. The next chart illustrates the information provided by a single picture. The camera picks up only the projections of the tufts and model in a vertical plane. The triangular shaped dark area on this chart for example represents a triangular-wing model at an angle of attack, as seen from the camera stationed far downstream; the base of the triangle representing the wing trailing edge. The various short dark lines represent the projections of the tufts. This one particular tuft has been magnified for the purpose of analysis. The vertical and horizontal projections are indications of the local downwash and sidewash angles of the flow. In the undisturbed regions, the tuft appears only as a small dot. We will now demonstrate by means of a short movie some flow studies made behind low-aspect-ratio wings in the Langley stability tunnel, where this technique was first developed.

The first pictures are for a rectangular wing having an aspect ratio of 2.61. The angle of attack is varied slowly from 0° to 24° while the yaw angle is held constant at zero. The solid white line that is apparent is the wing trailing edge and moves downward as the angle of attack is increased. The gray area immediately above the white line is the wing. Notice the formation of the trailing vortices at the wing tips and the increase in the flow angularity over the entire field. As the angle of attack is increased, the trailing vortices remain near the wing tips for this wing. The first evidence of stalling is near the wing center section.

The second set of pictures is for a 60° triangular wing of aspect ratio 2.31. The angle of attack is varied slowly from 0° to 34° while the yaw angle is held at zero. The trailing vortices again become evident first at the tips, but in this case they move inward as the angle of attack is increased. No abrupt evidence of stalling can be observed, since, for this wing the stall is progressive, being generated over a large range of angles of attack. Notice that a tail assembly located in about this position would be in a highly disturbed region, since the trailing vortices are very close.

In this third set of pictures a 60° triangular wing is oscillated in pitch. These pictures are for a one-cycle-per-second oscillation. Notice the relationship of the vortex pattern to the wing trailing edge and the effect of the oscillating wing on the flow field in general.

These pictures are for the same wing oscillating at four cycles per second. The wake pattern indicated by the grid appears to be somewhat out of phase with the model motion. Pitching oscillation studies such as these lead to a better understanding of the tail contribution to the longitudinal dynamic stability of complete airplane configurations.

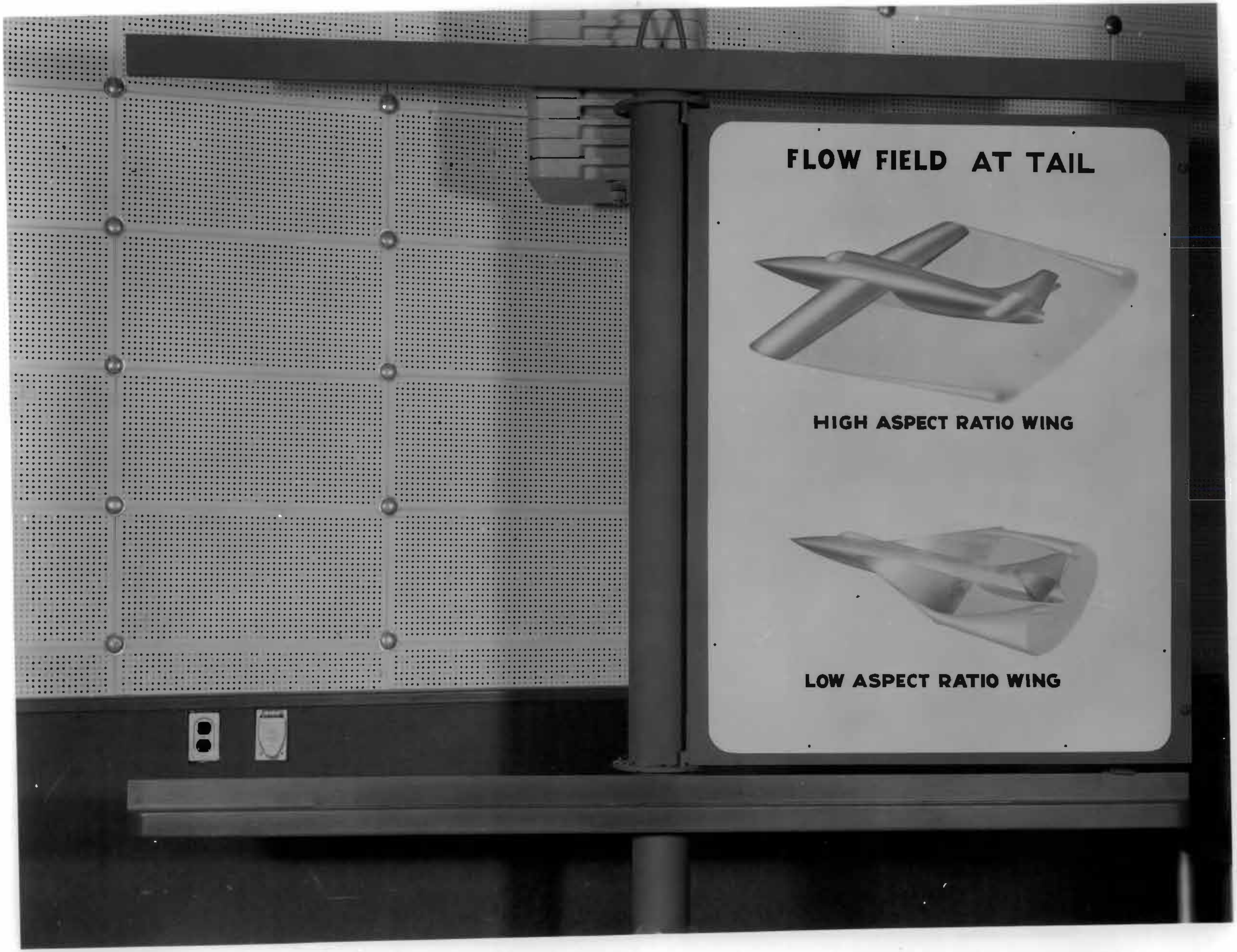
The last pictures show the triangular wing model at an angle of attack and being oscillated in yaw. These pictures are for a one-cycle-per-second oscillation. In this case, the model is mounted inverted in the tunnel as a matter of convenience. Notice that for this oscillation the vortices are not distinct throughout the cycle.

In the four-cycle-per-second oscillation there are two vortices existing at all times. The discrepancy between the one- and four-cycle-per-second oscillations is usually referred to as a frequency effect. Yawing oscillations studies of this nature provide information on the tail contributions to the lateral dynamic stability of complete airplane configurations.

This concludes the moving pictures, however, we have a similar setup in the wind tunnel and it will be operated briefly. You may observe the wake pattern through the large door toward the rear, or you may look through the window in the side wall where you can see both the wake tufts and tufts attached to the upper surface of the wing.

DEMONSTRATION

This concludes the demonstration. You may now cross the shop and enter the test chamber of the high-speed 7- by 10-foot tunnel where a second demonstration will be given.



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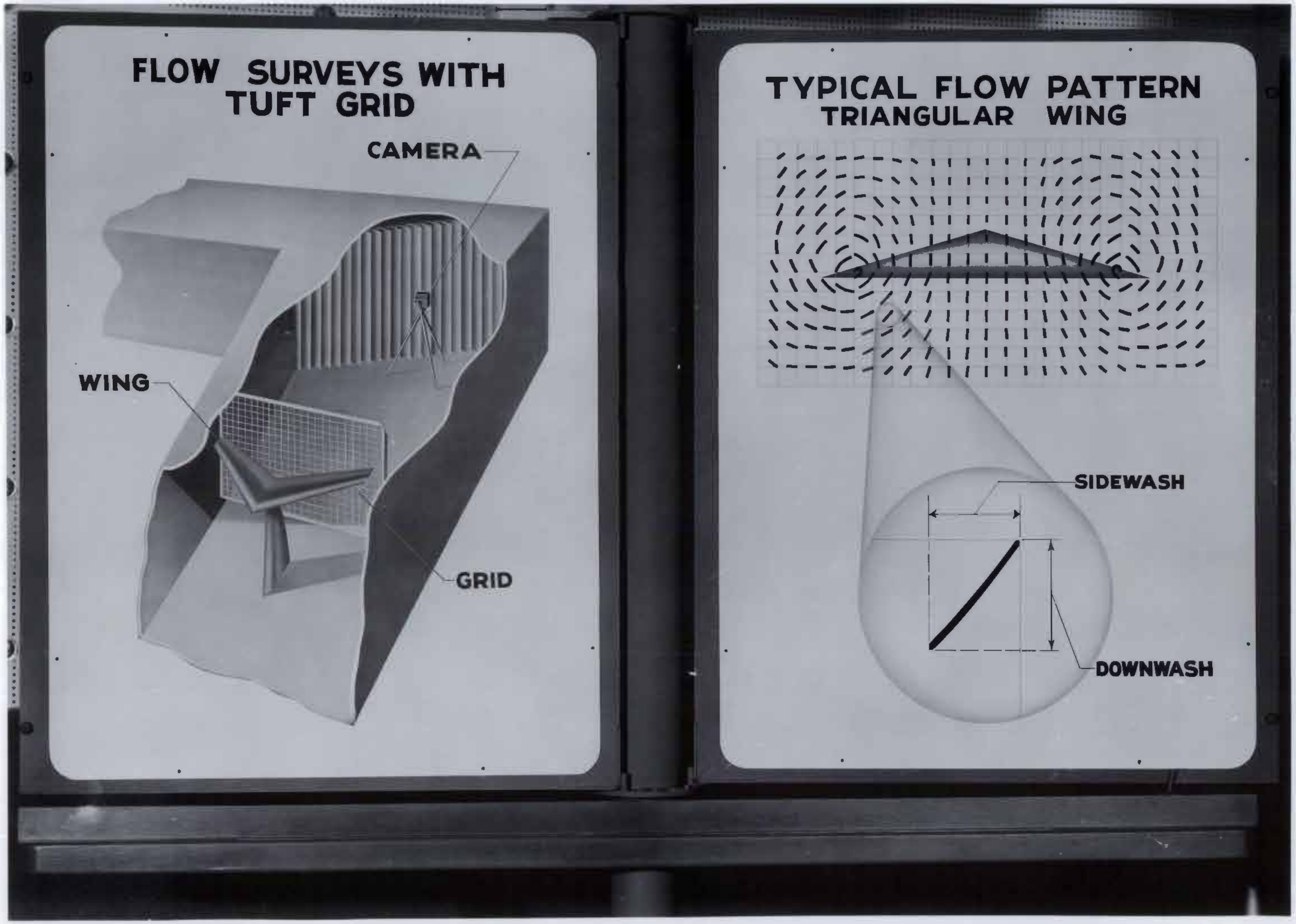

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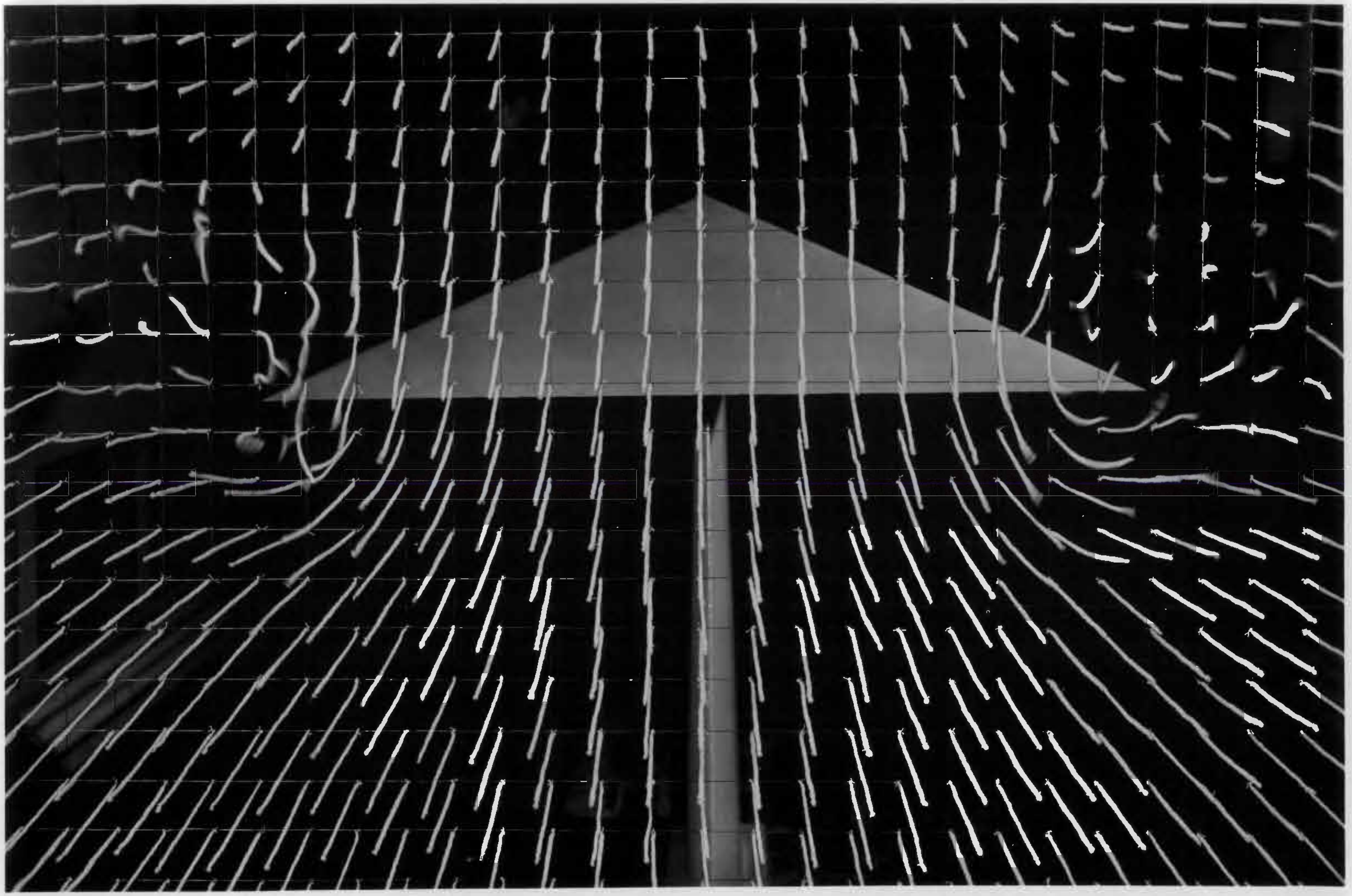

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4-FOOT SUPERSONIC PRESSURE TUNNEL

Speech at 1951 Biennial Inspection

MODELS AND TESTING TECHNIQUES OF THE 4- BY 4-FOOT SUPERSONIC PRESSURE TUNNEL

By Donald D. Baals

Also given by:
M. L. Spearman
J. H. Hilton Jr.

You are now in the test chamber of the Langley 4-foot supersonic pressure tunnel. On this pictorial drawing of the facility you are located about here. This is a variable density tunnel with a drive system totaling 60,000 horsepower. It permits simulation of full-scale conditions for many aircraft and missiles over a test Mach number range of 1.2 to 2.2.

This model, which was constructed for testing in the 4-foot supersonic tunnel, is shown here with its normal set of instrumentation. The model is equipped with a 6-component balance which is housed within the model and is connected to its load indicator above. The most important feature of this balance is that it measured the direct forces on the model itself. It does not include the large and unknown tare forces of the model support system that would have occurred had we used some external type of balance.

The various forces and moments measured by this balance can be illustrated as follows. This is the <u>LIFT</u> component. The <u>DRAG</u> component acts in the axial direction. Note that as I apply a pure LIFT load, there is no reaction on the DRAG. This the PITCHING MOMENT. This is a positive moment; this is negative. The moment of an applied force will be zero when I reach the pitch center - - - here. We normally design the model so that the pitch center and the center of gravity of the configuration are located at the same station. The three lateral components are <u>ROLLING MOMENT</u>, <u>YAWING MOMENT</u>, and <u>SIDE FORCE</u>. Note that any forces on the supporting sting are not included in the balance readings.

In order to study control effectiveness, the model is equipped with movable forward control surfaces and ailerons. To save tunnel time, the angle of the forward control surfaces can be varied during the tests by means of an electric motor housed within the model. The control position is indicated on the dial overhead. Note the control surface changing angle and the reading of change in the control position indicator. In addition, the hinge moments resulting from the aerodynamic loads on the forward control surfaces and the ailerons are indicated on separate balances . . . . . here.

This model is illustrative of one of the types of work which can be accomplished in the 4-foot supersonic pressure tunnel. This model and its instrumentation will permit evaluation of the general aerodynamic and stability and control characteristics. By tests of the various components alone and in combination the general interference effects may also be evaluated. The variable pressure feature of this tunnel permits study of another important field of work - the problem of boundary layers. The next speaker, ____________________, will discuss some of the boundary layer problems of aerodynamic heating and skin friction at supersonic speeds

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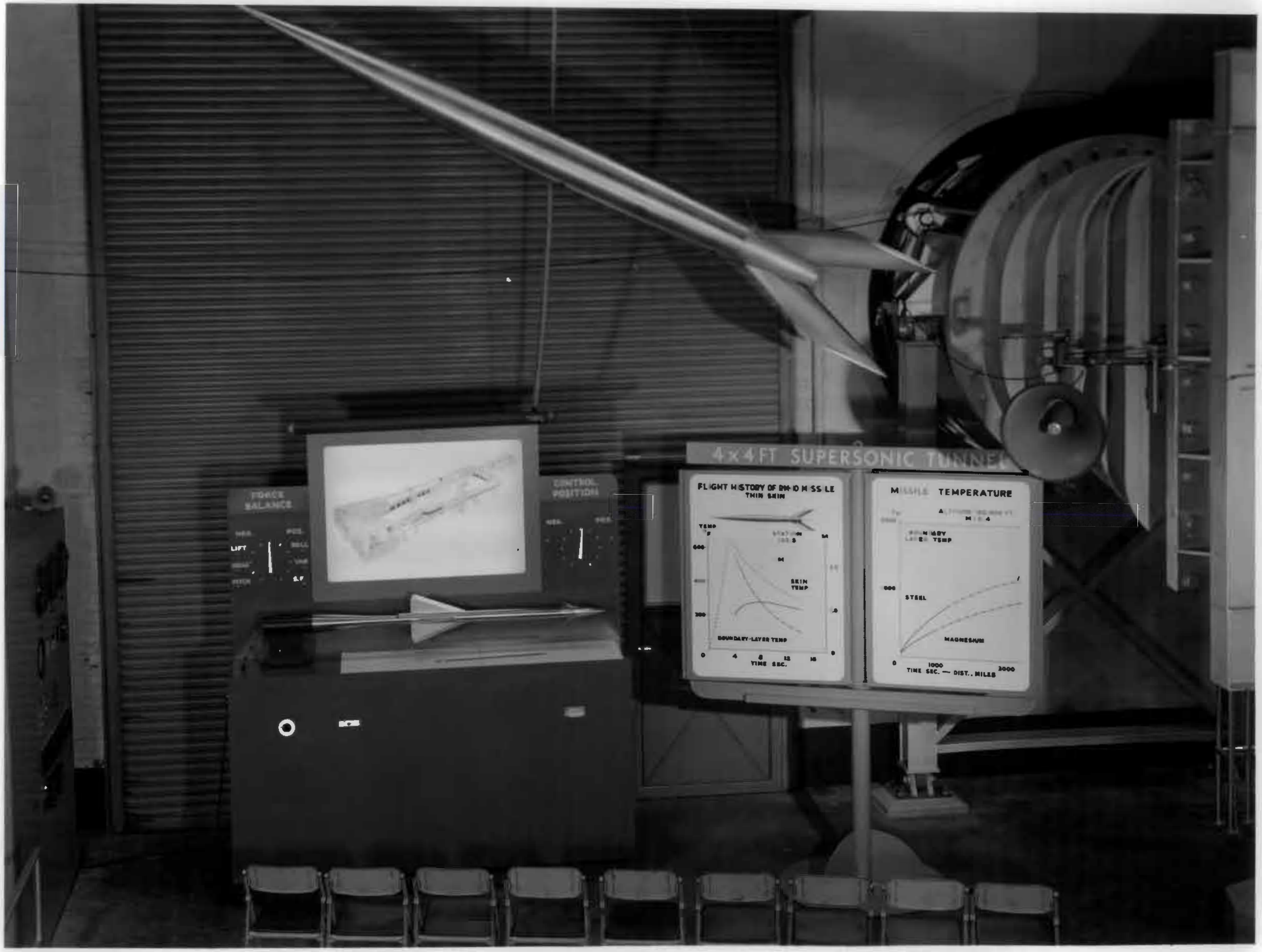
Talk by Dr. Rubert on Aerodynamic Heating and Skin Friction.

On display for your inspection are a number of exhibits. On your right - and the missile model overhead - are exhibits illustrating the technique of measurement of heat transfer in wind tunnel and in flight. You may go up on the platform at the rear and inspect the model in the test section. On your far right is the tunnel control room. Staff members are on hand at each exhibit to explain and answer any questions.


FORCE BALANCE
LIFT
CONTROL POSITION
4x4FT SUPERSONIC TUNNEL
FLIGHT HISTORY OF RM-10 MISSILE
THIN SKIN
TEMP °F
600
300
SKIN TEMP
BOUNDARY-LAYER TEMP
0 4 8 12 16
TIME SEC.
MISSILE TEMPERATURE
STEEL
MAGNESIUM
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TIME SEC. — DIST., MILES

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TECHNIQUES FOR
HEAT TRANSFER
MEASUREMENTS
THERMOCOUPLES
FLUID OUTLET
FLUID INLET

LAL 70520

NACA - Langley

Internal Aerodynamics Section

Speech at 1951 Biennial Inspection
Given at 4- by 4-Foot SSPT

SKIN FRICTION AND AERODYNAMIC HEATING OF SUPERSONIC MISSILES

By Kennedy F. Rubert

A missile in supersonic flight experiences resistance of several kinds, much of which originates in the boundary layer. This is the layer of air in immediate proximity to the surface of the missile. There are two important aspects of this boundary-layer resistance - the actual friction drag to be overcome and the associated frictional heating. It is about these two aspects of supersonic flight resistance that I am going to talk.

On this first chart we show an actual flight history of a supersonic missile identical to this. The missile was rocket-launched to its maximum speed and temperature data were recorded in the period of coasting flight. Mach number, boundary-layer temperature, and skin temperature are plotted against time in seconds. Now this missile accelerated to a maximum Mach number of 2-1/2 in slightly less than 4 seconds. It did not remain long at this high speed, however, but slowed down rapidly as soon as the launching rocket was dropped. Here is a record of the boundary-layer temperature, which, because it depends principally upon the flight Mach number, decreased rapidly as the speed diminished. This is the record of the skin temperature. Because the skin of this missile was very thin, it had little heat capacity and heated rapidly at first (about 50° F per second). However, the boundary-layer temperature dropped so fast that soon it was below the skin temperature and the skin began to cool off. So while the thinness of the skin accounts for the rapidity of the initial rise - for if the skin had been thicker it would have heated more slowly - the fact that the missile did not stay for long at high speed is what really kept it from overheating. Six seconds of sustained top speed would have overheated the skin.

It is appropriate therefore to examine means by which this rapid heating of the missile skin can be retarded. One rather obvious way is to operate at higher altitudes, where the thinner air is less effective in heating the missile. Another way is to transfer as much heat as possible from the surface to the interior of the missile. Here in the ideal case, it would be necessary to heat the entire missile uniformly with the skin. In order to show how effective such measures could be, temperature-time histories for a typical missile, calculated assuming this ideal condition, and high-altitude operation, are given in the next chart. It should be appreciated that examples such as this are of necessity oversimplified and give values that are limiting rather than truly attainable. Flight is at a constant Mach number of 5.4 at an altitude of 100,000 feet, at which conditions the boundary-layer temperature is approximately 2000° F. The airspeed is just 1 mile per second, so the horizontal scale can be read in either seconds or miles.

This picture is much more optimistic than the preceding one. Despite a Mach number and boundary-layer temperature much greater than the values of the preceding example, the time rate of temperature rise is much less, being initially of the order of $1/3^{\circ}$ per second. The solid line has been interrupted at a point where the temperature has become undesirably high for magnesium or aluminum alloy construction, after about 1000 seconds or miles. It is of some interest to note that the advantage of a higher limiting temperature possible with steel construction is, in the case where the over-all weight is the same for either construction, largely offset by the lower specific heat of steel which causes the steel missile to heat up faster.

The real key to aerodynamic heating lies in the boundary layer itself. Let us consider the kinds of flow which we find in the boundary layer. To demonstrate these flows we have set up a missile forebody model in such a way that a simulated boundary-layer flow will be rendered visible by the schlieren technique. At the very tip of the missile the flow is smooth, that is, laminar. Now this is a desirable state, in which friction and heat transfer are small. Such a flow is, however, unstable and tends to break down into a violently disturbed, that is, turbulent, state at some distance from the nose. In this turbulent state there occurs a violent scrubbing action which greatly increases both friction and heating of the missile.

Let us digress for a moment to consider what governs whether the flow is this desirable laminar or that undesirable turbulent type. The distance from the nose of the missile to the breakdown or transition zone depends principally upon the airspeed, density, and viscosity. These four factors - distance, airspeed, density, and viscosity - are combined in an index of flow conditions called Reynolds number. When this Reynolds number is sufficiently small the flow is laminar, when it becomes sufficiently large, then the flow will be turbulent.

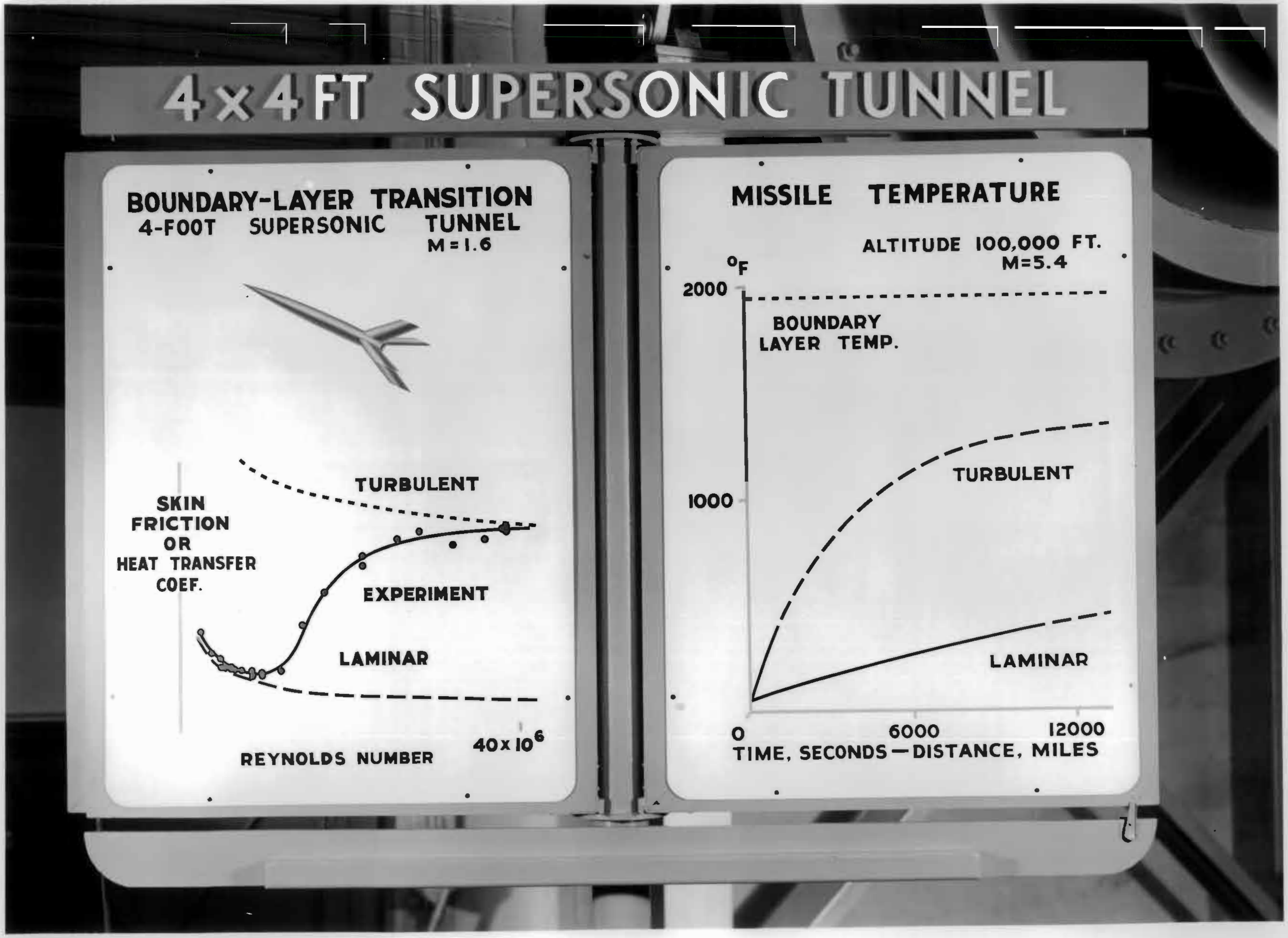
Although laminar and turbulent boundary-layer flows have been the subject of much research at low speed, actually very little is known about this subject at supersonic speeds. In the next chart we have for you some very recent data on transition from the desirable laminar to the undesirable turbulent state, taken here in the 4-foot tunnel on a missile model at a Mach number of 1.6. In this figure the measured skin friction and derived heat-transfer coefficients are plotted for a broad range of test Reynolds number. The right-hand end of the scale corresponds to flight of a missile as large as this at $M = 1.6$ at an altitude of 40,000 feet. At low Reynolds number the skin friction coefficient values and trends correspond to current theory for laminar flows. Soon the coefficient begins to rise, indicative of the appearance of transition on the afterbody of the model. The rise continues as the transition zone moves forward. Finally the values and trend swing into agreement with those of current turbulent flow theory, when turbulent flow prevails over practically the entire length of the missile. This figure illustrates dramatically the advantage of the desirable laminar over the undesirable turbulent boundary-layer condition. Even though skin friction is not the sole source of drag at supersonic speeds, still, attainment of fully laminar flow in place of turbulent suffices to cut in half the over-all drag of the missile tested.

Such performance as shown in this chart is ordinarily possible only with ideally smooth surfaces. The slightest roughness or even a deposit of dust on the surface causes the flow to become turbulent, with consequent high drag, even at low Reynolds numbers. This difficulty has thwarted attempts to obtain in practical subsonic aircraft the benefits of laminar flow, as many of you are all too aware. Why then are we now interested in laminar flow again, this time for supersonic flight? As we shall see in the next figure, it is because in supersonic flight we find conditions, favorable to the laminar state, which were not present in subsonic flight.

In this next figure the previously discussed missile temperature-time history, which was calculated for fully turbulent flow, is reproduced to a compressed time scale. It is noted that the missile temperature is much lower than that of the boundary layer. Such large differences are not encountered in low-speed flight. Theory has indicated that when such large differences do occur, they tend to stabilize the boundary layer and induce the desirable laminar state. Perhaps this action could be used to obtain laminar flow over the entire length of the missile, even at large Reynolds numbers. If such is found to be the case, then aerodynamic heating will be so greatly lessened that for the example under consideration, overheating would only occur if it were possible to sustain flight half-way around the earth.

Of course, there will be practical limitations on how closely we can approach the assumed ideal condition of temperature uniformity throughout the missile. Furthermore, aerodynamic heating is only one of the many problems, including propulsion, control, stability, and guidance, all of which must be solved before such long ranges are within our grasp. Nevertheless, the goal is certainly such as to encourage us to continue the current vigorous prosecution of supersonic boundary-layer research at large Reynolds numbers under typical heat-transfer conditions.

(Given at 4-Foot Supersonic Tunnel,
Alternate speakers: F. Bloetscher and B. H. Little, Jr.)



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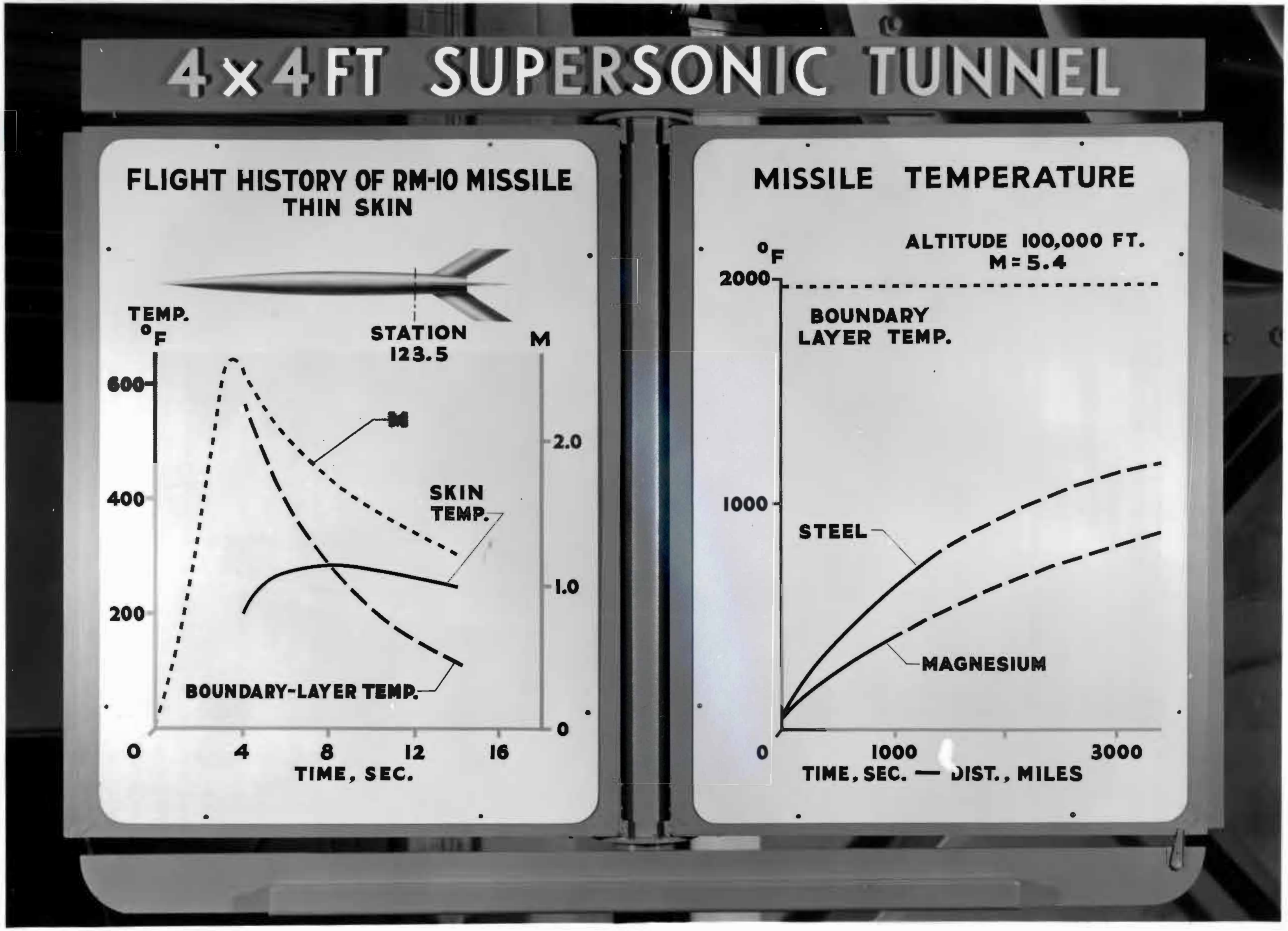

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16-FOOT TRANSONIC TUNNEL LANGLEY INSPECTION

By

Blake W. Corson, Jr. and Julian D. Maynard

Presented By: Blake W. Corson, Jr., Julian D. Maynard, Robert M. Pinkerton, Robert W. Milling, Albert J. Evans, Louis W. Habel, Wilbur H. Gray, and William B. Igoe

at the Langley Biennial Inspection

LANGLEY AERONAUTICAL LABORATORY

May 1951

1. At former Langley inspections we exhibited the 16-foot tunnel as a typical large high-speed tunnel. The drive power then was 16,000 horsepower and top speed was 520 miles per hour. Since that time the tunnel has been altered and the drive power increased to 60,000 horsepower and its speed increased to low supersonic values. It is one of the transonic tunnels mentioned in the introductory talk at the base theater this morning.

CHART 1:

2. This upper chart shows a planview of the 16-foot transonic tunnel. You got off the bus here, entered the tunnel building, and are now seated at this location in one of the shops. These black arrows indicate the direction of air flow through the tunnel. Of the original tunnel most of the steel shell and the air-exchange tower remain. The drive end and test section are new. Adjacent to the wind tunnel are several buildings containing auxiliary equipment: the tunnel drive control building, the 6000-horsepower propeller dynamometer (which can be mounted either here for ground tests, or in the wind tunnel), and the electrical control equipment for the dynamometer.

3. At the drive end the two 30,000-horsepower motors are located on the outside of the tunnel and are directly connected to the fans by shafts about 60 feet long. There are no countervanes of any type in the drive-fan system, but the fans rotate in opposite directions so that no rotation remains in the air stream after it has passed through the fans. This feature provides smooth air flow at the test section and results in a high fan efficiency. The aerodynamic efficiency of the fans is 95 percent.

4. In increasing the tunnel power from 16,000 to 60,000 horsepower we expected some increase in tunnel noise and consequently made considerable effort to minimize noise in the repowered tunnel. The steel shell of the original tunnel has been reinforced and the drive end where most noise is generated has been made very massive. Also, rigid connections between the drive end and the remainder of the tunnel have been avoided to prevent vibration generated in the drive end from being transmitted to other parts of the tunnel. At the inlet and exhaust openings of the air-exchange tower acoustical baffles have been installed to reduce the noise which normally issues from these openings. These measures have proved to be highly effective in minimizing tunnel noise, so that the revised tunnel is more quiet than the original one.

5. The test-section design is such that models can be tested over the entire speed range including the transonic speed range simply by changing tunnel drive power. On the tour you will notice that certain features of the test section walls have been covered with plywood, because details of these features are considered as classified information. We regret that we cannot describe these features to you, but security regulations do not permit it.

6. On this second chart an airspeed calibration is presented to show the excellent uniformity of flow in the test section. The charts shows the variation of Mach number with axial distance through the test section. At all speeds air flow in the test section is uniform over a length of more than twenty feet indicated by the shaded portion on this chart and also on the upper chart. The velocity variation is about ± 1/2 percent as indicated by the scatter of the points; the diameter of the points represents about 1/2 percent on the Mach number scale. I would like to emphasize the fact that the tunnel airspeed can be varied smoothly through the sonic value with no discontinuity in the velocity distribution.

CHART 3:

7. In order to check the validity of the test data obtained in this new transonic tunnel, it was necessary to compare our results with data obtained in free air at transonic speeds. Such data can be obtained by dropping models from high altitudes. We therefore built the model displayed here, which is identical to one used in drop tests. This next chart shows a comparison of the pressure distribution obtained from flight research drop-test data and data obtained from tests of this model in the new 16-foot tunnel test section at Mach number one. The solid line shows the distribution obtained from the wind-tunnel tests, and the points are the data from the free-air drop tests. By pressure distribution we mean the variation of the static pressure

coefficient along the length of the model as measured at these orifices. The vertical scale has been expanded to emphasize differences in the data, and the generally good agreement of the two sets of data indicates the validity of the wind-tunnel results.

8. The 16-foot transonic tunnel is suitable for many types of investigation. A part of our work will deal with investigations of the aerodynamic characteristics of airplane models. You will see mounted in the test section of the tunnel a generalized airplane model with a swept wing for the study of wing-body interference.

CHARTS 4 and 5:

9. Also part of the tunnel time will be devoted to investigations of high-speed propellers such as the one displayed here. This next chart shows a photograph of the 6000-horsepower propeller dynamometer mounted on the outdoor test stand shown here on the upper chart. This ground-stand equipment is used for testing full-scale propellers under conditions which simulate ground and take-off operation. These same dynamometer units can be removed from the ground test stand and installed in the test section of the 16-foot transonic tunnel as indicated in this final chart. With this combined equipment high-speed and supersonic-type propellers can be tested at large scale over the entire speed range up to low supersonic speeds. Preparations are well under way for the investigation of the aerodynamic and vibration characteristics of a supersonic propeller.

10. On the tour through the tunnel which follows, we will enter the air-exchange tower and proceed upstream through this set of turning vanes to the fans at the drive end. From there we will go through another set of turning vanes to the test section here. We will leave the test section through a hatch in the floor and go through the control room. From the control room we go downstairs and outside where you will again board the bus.

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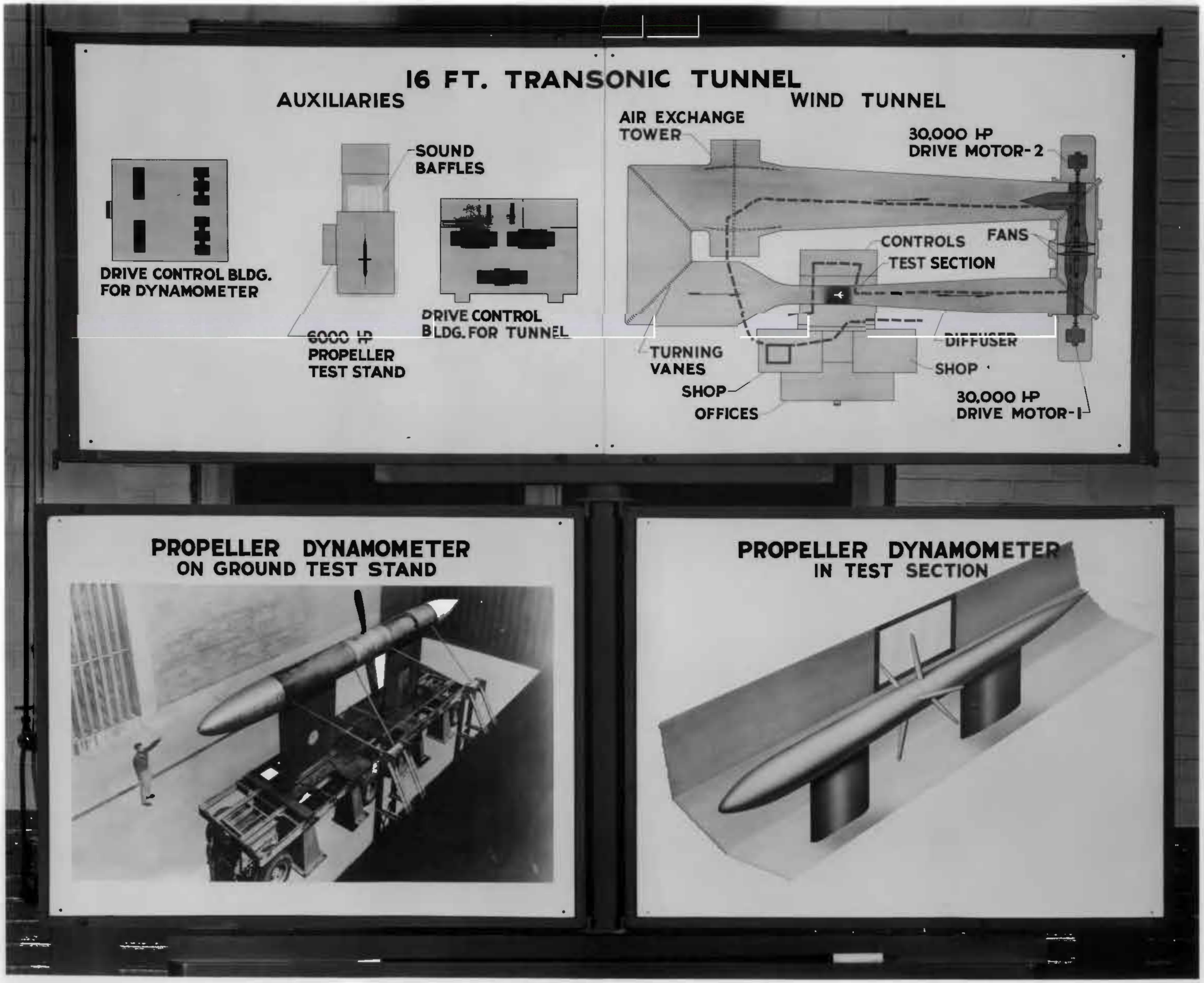

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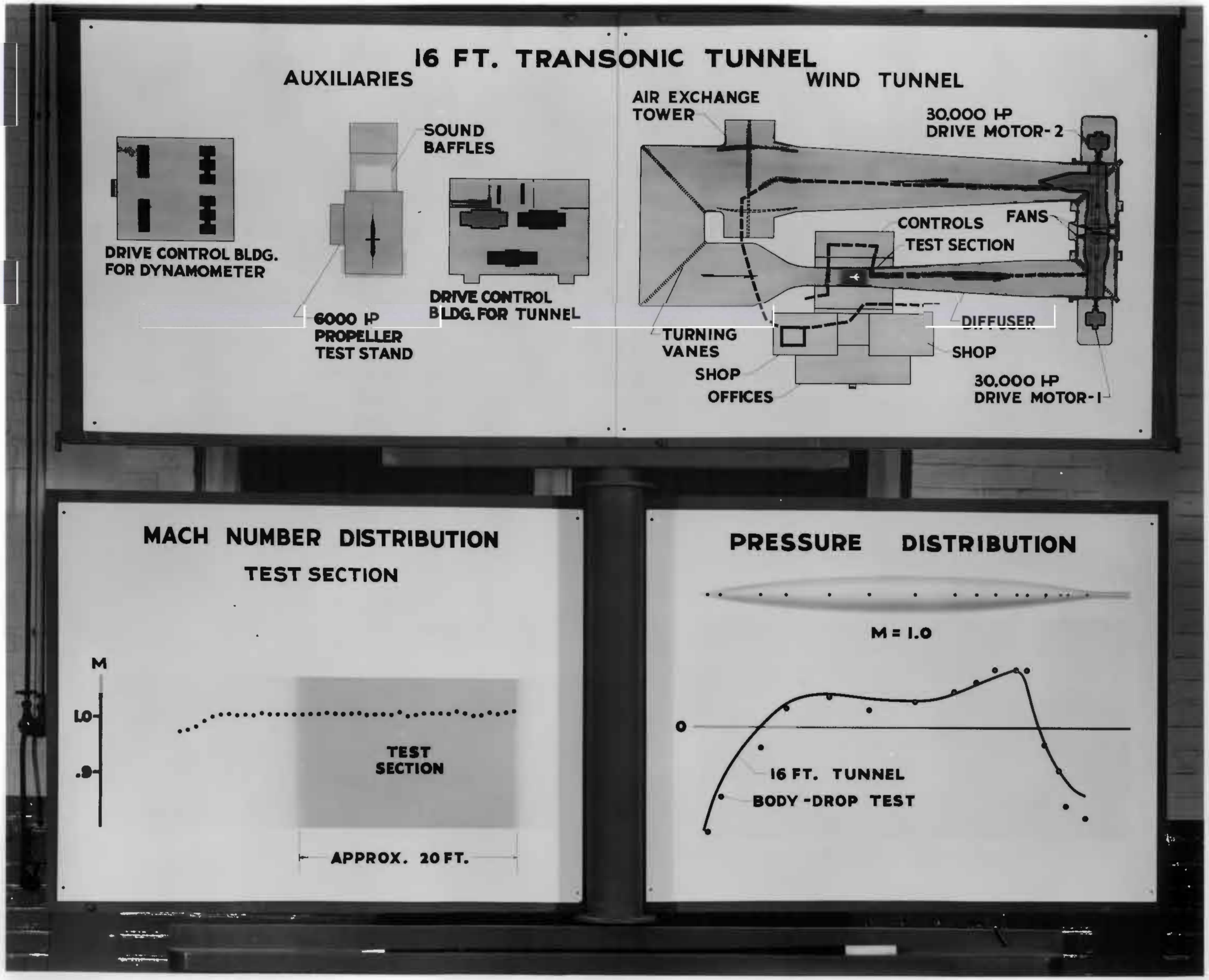

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16 FT. TRANSONIC TUNNEL
AUXILIARIES
WIND TUNNEL
DRIVE CONTROL BLDG FOR DYNAMOMETER
DRIVE CONTROL BLDG. FOR TUNNEL
PROPELLER TEST STAND
PROPELLER DYNAMOMETER

LAL 70490.1


AIR EXCHANGE TOWER
SOUND BAFFLES
AIR FILTER
COOL AIR
COOL AIR
AIR FLOW

LAL 70490.2

1951 BIENNIAL INSPECTION

FATIGUE OF AIRCRAFT STRUCTURES

Presented by

Norris F. Dow
Herbert F. Hardrath
Charles B. Landers
Arthur J. McEvily, Jr.

Most of you have ridden in airplanes and experienced the disagreeable forces associated with flight through rough air. Those same forces which you felt as a passenger were also felt by the airplane as stresses in its structure.

It is well known that repeated stressing of material may eventually cause the material to fail even though the stresses are far below the ultimate strength of the material. This type of failure is known as fatigue failure. Although the reasons why materials fail by fatigue are not yet fully understood, many factors affecting the fatigue life of structures are known. For example, fatigue cracks generally start in the vicinity of so-called stress raisers such as notches, holes, or fillets, which interrupt the uniform flow of stresses through the structure. The action of such a stress raiser will be demonstrated with a specimen like this one, but 12-feet-long, in the one million-pound-capacity testing machine. The specimen contains a notch at the middle of each side edge. Electrical wire strain gages have been attached to the specimen across the section between the notches. These gages are connected to this strain indicating apparatus. The operator will apply tension loads to the ends of the specimen. The strains are indicated by these standpipes. The strains immediately adjacent to the notch, where the stress is highest, are indicated by the end standpipes, the strain in the center of the panel by the center standpipes, thus producing a bar graph representing the strain distribution across the specimen. Note that the strains at the edges are approximately four times those near the center where the stress is uniform. Accordingly, we would say that the stress concentration factor for this specimen is four. The operator will now release the load from the specimen.

The relation between the stress concentration factor and fatigue strength is affected by the absolute size of the specimen. Fatigue tests are usually run on small specimens like this rather than the size of the one in the testing machine. Consequently, in order to utilize the tests on the small specimens for designing full-scale structures, the size effect must be taken into account. We have found from tests of steel specimens that this empirical formula can be used to correlate fatigue results for specimens of different sizes. The fatigue stress concentration factor, K_n , is given in terms of the elastic stress concentration factor, K_t , determined for large specimens, and a ratio A/R ; where A is a critical dimension associated with the material itself and defined by this curve, and R is the radius at the base of the notch. While these results for the study of size effect have been obtained only for steel, work is under way on a similar study for aluminum alloys.

In the conventional type of fatigue test the repeated stresses are of constant amplitude and frequency as indicated by these plots of stress against time.

In flight, however, the stresses in the airplane structure depend on the gusts that are encountered and are consequently variable in amplitude and frequency. This curve is characteristic of stress records taken during flights in rough air.

In order to design airplanes to withstand the variable amplitude type of loading we must evaluate the cumulative effects of such loading.

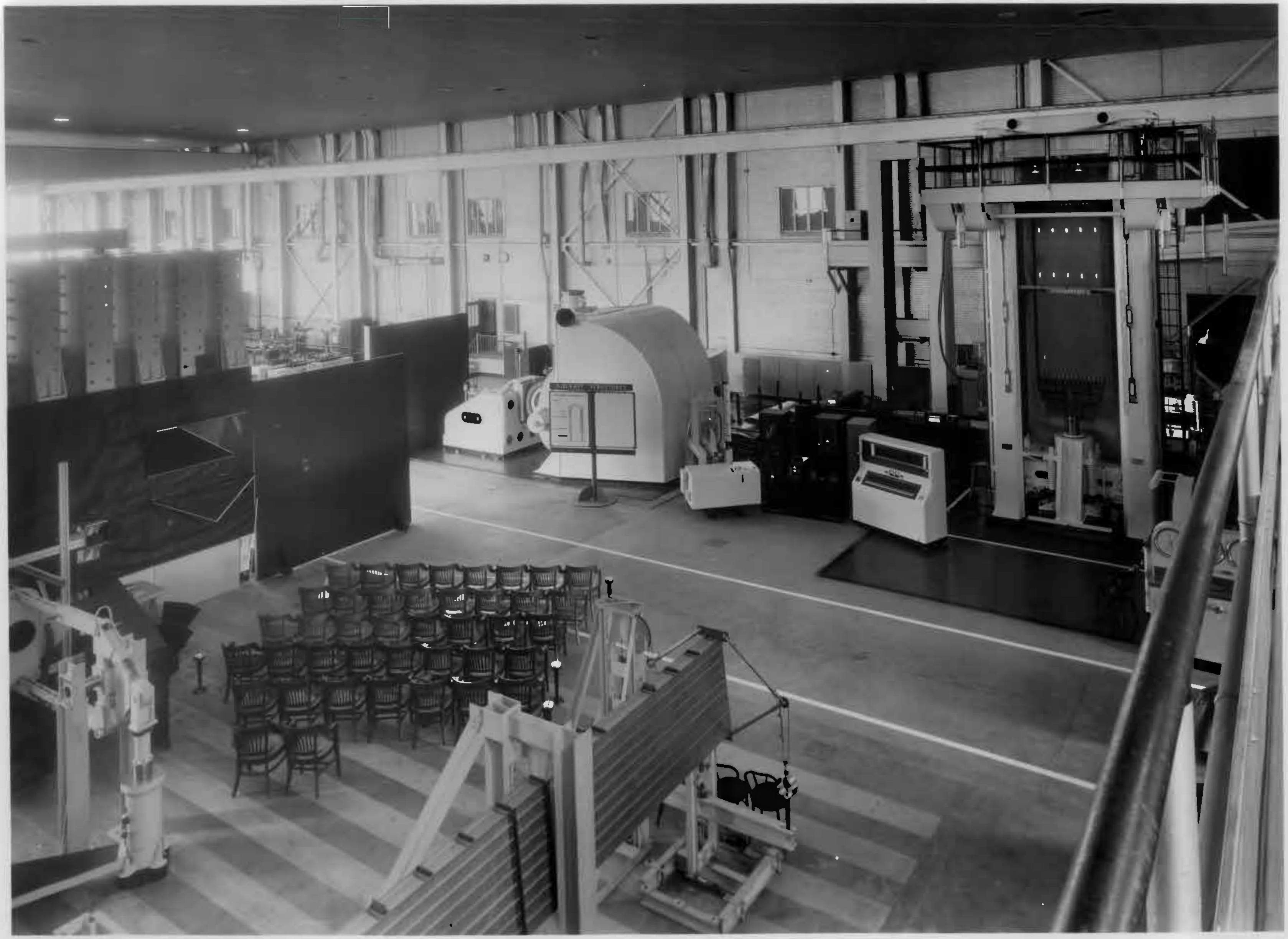
One basic study on the effects of cumulative damage is being conducted with rotating beam type machines. These machines apply a given stress 10,000 times a minute and are equipped with motor driven cams which vary the applied load slowly. The stress pattern is therefore of the type schematically shown on this sketch.

Another fatigue testing machine which we are developing is capable of more closely simulating the variable stresses that actually occur in airplanes, such as those shown here. This machine applies a steady load corresponding to the load on an airplane wing during steady flight through smooth air. Then oscillating loads of 16 different amplitudes are superposed on the steady load. The amplitudes and the number of oscillations at each amplitude are selected before each test. Very complicated load patterns can thus be applied, and, in use, we adjust the pattern to agree with the statistical distribution of rough air loads.

This machine will now be demonstrated for you. Vertical loads will be applied to the specimen by this beam which is actuated by a hydraulic mechanism inside this box. The loads are controlled by the electronic apparatus in the tall black cabinet. Any desired sequence of application of dynamic loads may be obtained by appropriately punching the teletype tape which schedules the test. I will now start the machine.

The specimen in the machine is representative of one of the spars in a wing. The load is applied at the center and at both ends of the beam. The magnitude of the load at any time is indicated by the flashing lights in this column. The green light representz the mean load.

The wrinkles in this beam are somewhat more severe than those that occur in aircraft. The stresses, however, are not as severe as you might expect. This specimen has been loaded like this many times and I trust it will last for a number of additional demonstrations.



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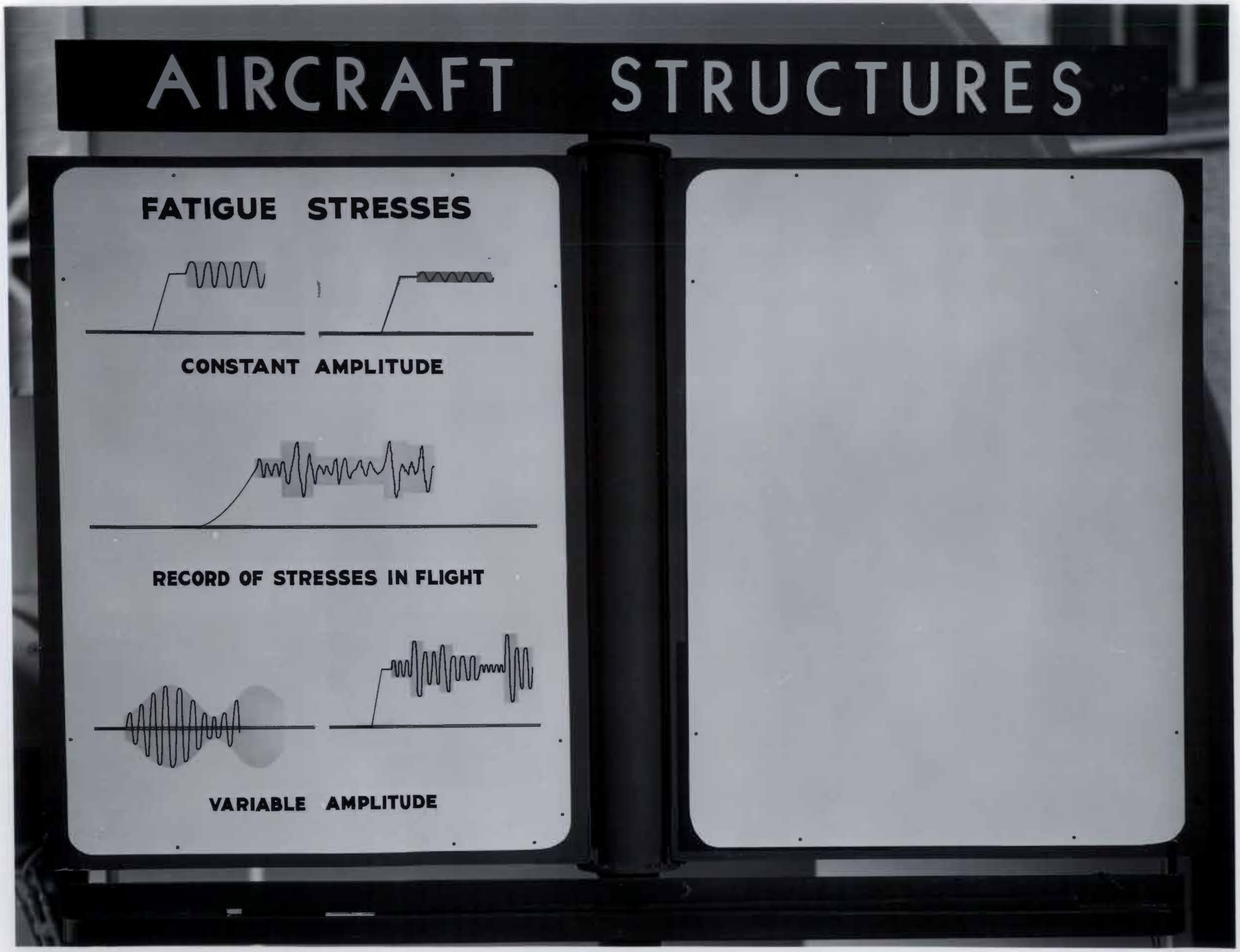

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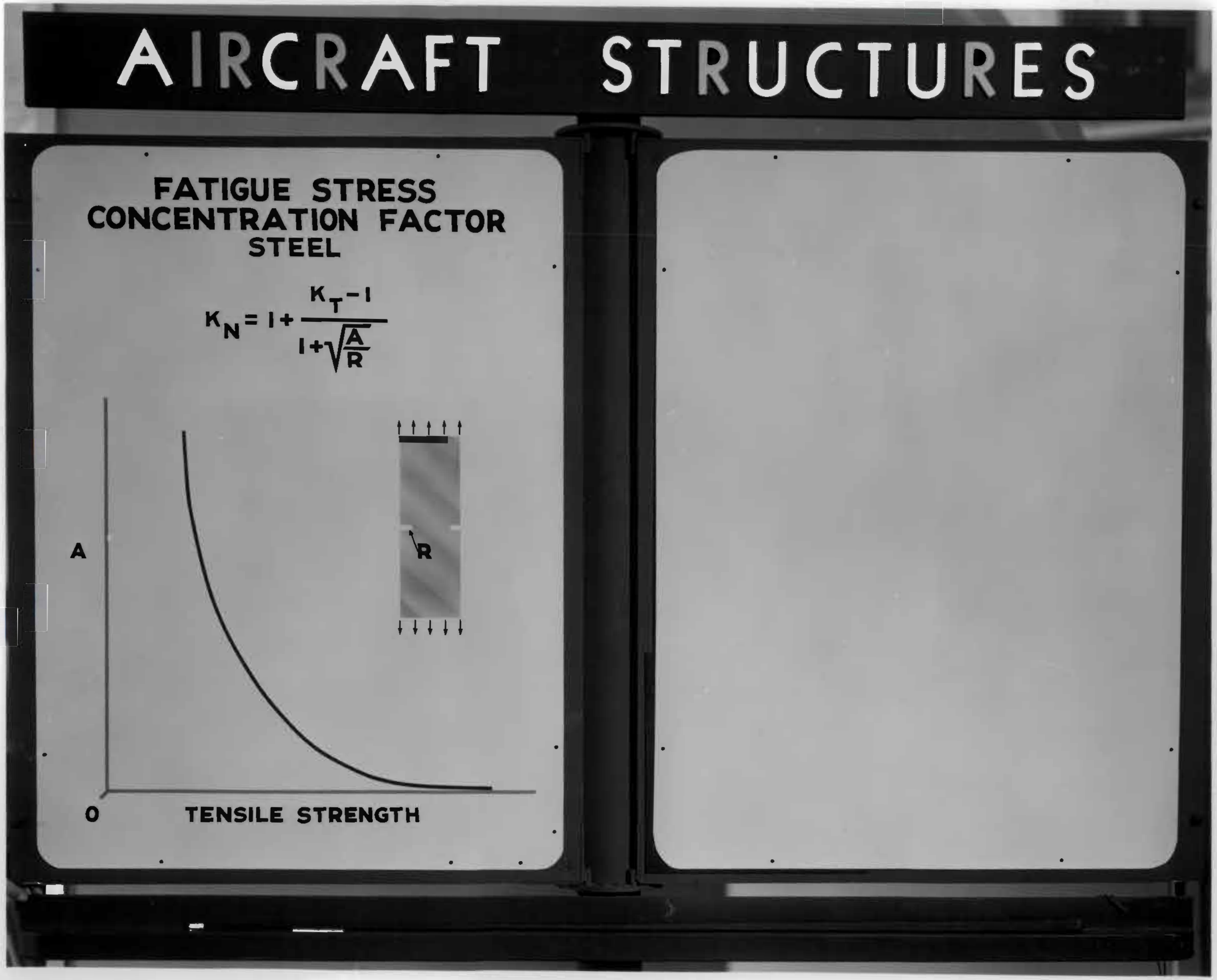

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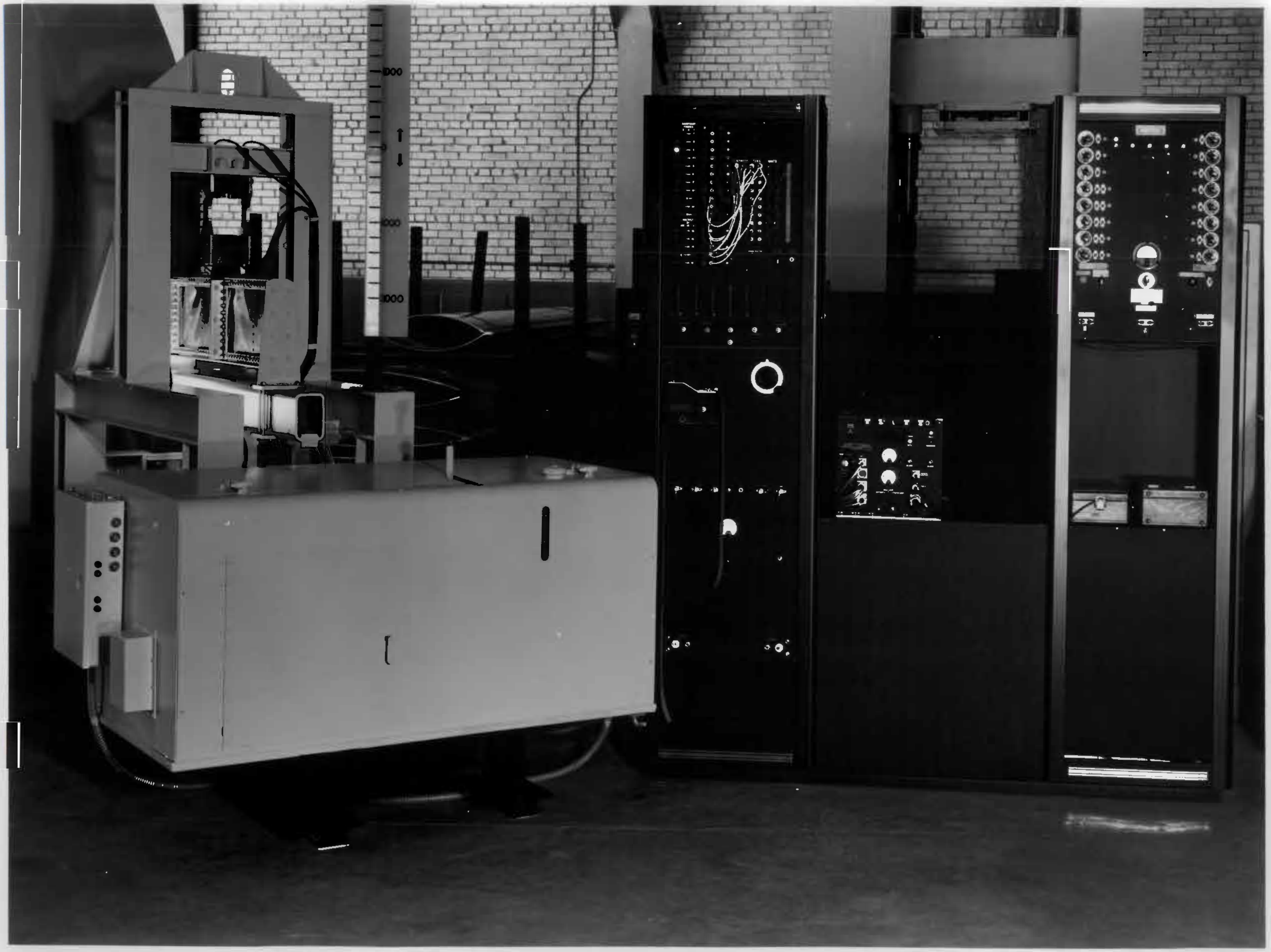

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1951 BIENNIAL INSPECTION

SELECTION OF MOST EFFICIENT STRUCTURAL MATERIALS FOR USE AT ELEVATED TEMPERATURES

Presented by

Charles Libove
Richard A. Pride
George E. Griffith
William M. Roberts
Aldie E. Johnson, Jr.

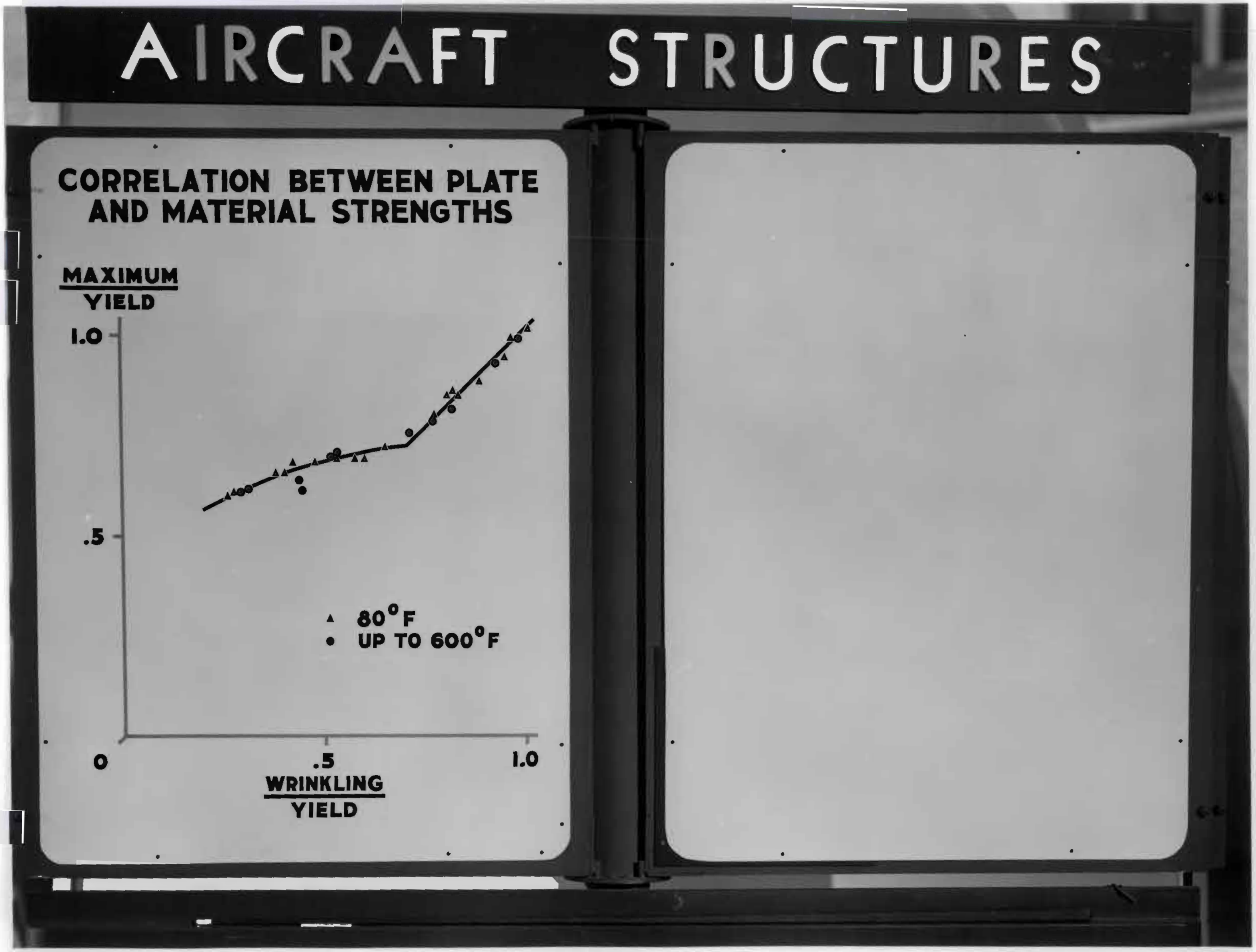
The effect of temperature on the material strength of several structural alloys is indicated in the upper part of this chart. The yield strength - i.e., the load the material is capable of carrying without exceeding a certain permanent deformation - is plotted against temperature. The aluminum alloys currently used in aircraft have lost a good part of their strength at 600° F. The titanium alloy and the stainless steel hold up much better. Stainless steel seems to have a marked superiority to titanium alloy according to this chart. The superiority is not so great, however, when we consider that steel is about 70 percent heavier than titanium. Saving weight is so very important for aircraft that we should really compare materials on the basis of strength per unit of weight. When this is done by dividing yield strength by the density of the material we see that stainless steel and titanium alloy are more nearly equivalent, with titanium being better at the lower temperatures and stainless steel somewhat better at the higher temperatures. 75S aluminum alloy now is comparable with the titanium alloy up to about 300° F.

A chart such as this gives the answer to the problem of material selection provided the material is put to a structural use in which it can develop its full yield strength - e.g., in a tension member such as the lower surface of a wing. In a compression structure like the plate elements in the upper skin of a wing the full material strength often cannot be realized because the skin tends to wrinkle. When the skin is thin this wrinkling can occur long before the material itself has been stressed to its capacity. After wrinkling occurs the plate elements can still take load but their maximum strength is no longer related in a simple way to the strength of the material.

For this reason another phase of our research has been devoted to establishing a correlation between the strength of a structural element that wrinkles and the yield strength of the material from which it is made. Such a correlation for plate compression elements is shown in the next chart. Here a single curve gives the strength of a plate element in terms of the yield strength of the material. This curve was established by extensive tests on many materials. Tests on one material were carried up to 600°. To enter the chart, we first have to compute the wrinkling stress of the plates which is easily done by methods well established in recent years.

If now we add considerations of weight to the information given by this chart, we can pick out the best material to use for the plate compression elements. The results are shown on the next chart. At temperatures above 800° stainless steel is the best of the several materials compared, the titanium alloy becoming superior in the intermediate temperature range. At the lower temperatures any one of three materials, titanium, aluminum, or magnesium, may be most efficient, depending upon the particular design conditions. For comparison we have shown on the right-hand side of the charts the previously discussed results for members in which the full yield strength of the material could be utilized such as tension members. As we recall, stainless steel is superior over most of the elevated temperature range. At temperatures up to about 300° aluminum alloy and the titanium alloy are about equally efficient. This chart illustrates that no one material is universally superior to all others for use at elevated temperatures. Rather, the choice of a material depends on its structural use.

Material-selection studies of the kind described are being extended to cover other high-temperature resistant materials and various structural elements; the objective being to enable the designer to select the most efficient materials quickly in the early design stages.



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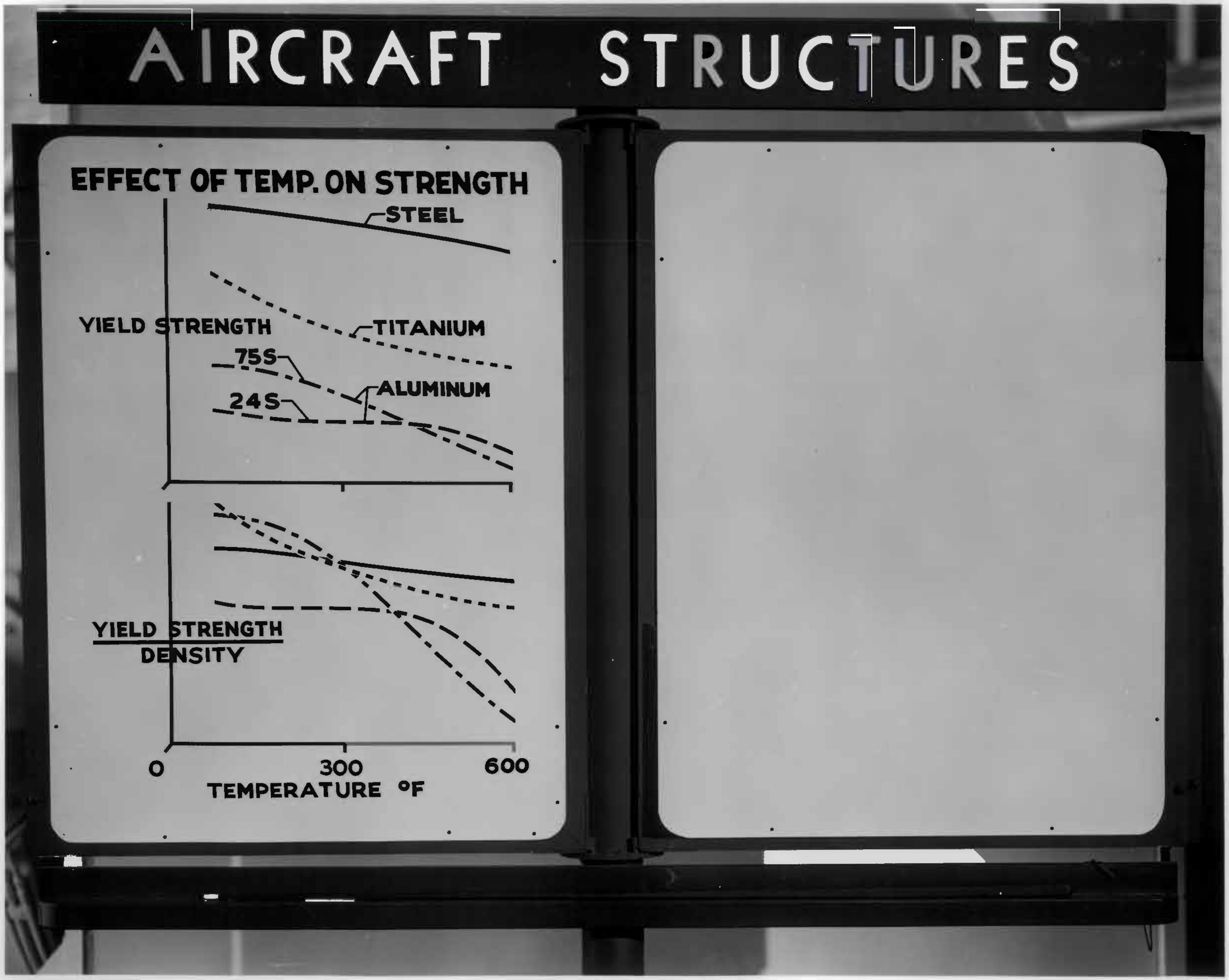

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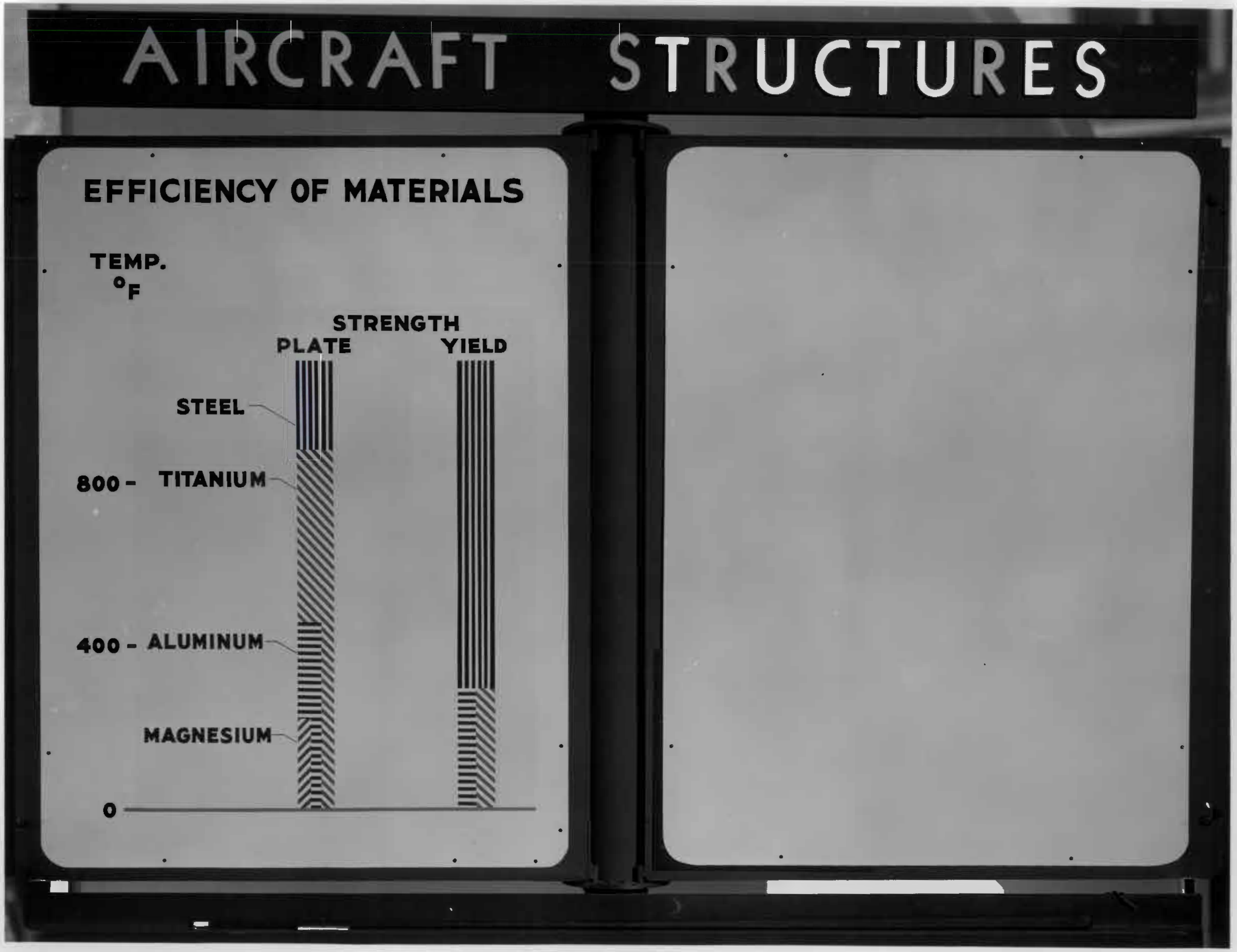

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1951 BIENNIAL INSPECTION

THE VIBRATION OF DELTA PLANFORM WINGS

Presented by

J. E. Anderson
Eldon E. Kordes
J. N. Kotanchik
Edwin T. Kruszewski
Manuel Stein

Many of you are no doubt aware that the wing configurations of very high speed aircraft are tending to become quite different from those to which we have become accustomed. The requirements of high speed flight are dictating the use of planforms such as delta wings, arrowhead wings, and very low aspect ratio swept wings. Although the wing shapes may be new, the old dynamic and aeroelastic problems such as flutter, landing impact, and gust loads still remain with us, and indeed their importance for very high speed airplanes may be accentuated. It is necessary therefore that we be able to analyze accurately the dynamic behavior of wings of the delta type. The analysis of such wings presents us with a whole new problem because the structural deformations of delta or arrowhead wings are very much different from those of the more conventional straight wings.

An ordinary straight wing vibrates very much like a long, slender beam - that is, it bends up or down, or it twists, or it does combinations of bending and twisting. These simple concepts of bending and twisting vibrations of a beam are not applicable to wings of the delta type, such as the one you see here. Structurally a wing of this type behaves like a flat plate rather than a beam. In a wing of this type each element of the plate, such as the squares which we have marked on the wing surface, can be undergoing a bending and a twisting motion about the spanwise direction or about the chordwise direction, and at any given instant the bending and twisting action of one element may be appreciably different from that of its neighboring elements or of more distant elements in the plate. We will demonstrate this bending and twisting action very shortly.

From a theoretical point of view we are fortunate in that there does exist a fairly well established theory for bending of plates. Although the theory leads to extremely difficult calculations we have made progress in various approximate approaches that incorporate the plate theory but yet approach the level of simplicity of beam theory, with which most engineers are familiar.

In order to show you the deformations that a delta wing undergoes we will vibrate this wing in its first three natural modes of vibration. The first natural mode looks like a simple up and down bending motion; actually there does take place a twisting action but it is too small to be observed.

Now we will produce the second mode of vibration. The vibratory forces are applied by a mechanical oscillator which is attached to the top surface of the wing. In order to give you the effect of a slow motion picture of the deformations in this mode of vibration we will illuminate the lower surface of the wing with a stroboscopic light which flashes on and off at a frequency slightly different from the frequency of the wing vibration.

In this second mode of vibration at any instant that the inboard portion of the leading edge moves upward, the tip moves downward, thus there exists between the tip and the inboard portion a point of no vibration. The action of the trailing edge is similar to that of the leading edge with the point of no vibration located here. These two points of no vibration are at the ends of a line of no vibration, called the nodal line. The existence of this line will be demonstrated more clearly later.

Note that the square elements in the tip portion of the plate are experiencing a bending and twisting which is noticeably different from that of elements in other parts of the plate.

If you will now direct your attention to this one white chordwise line and compare it with reference to the straight edge you will observe that the plate deflects into a simple upward or downward curve. This type of deformation may be important from the aerodynamic point of view because it affects the flow of air over the wing.

We will now increase the frequency of the vibrating forces and develop the third mode of vibration. In this third mode of vibration note that at any instant the entire leading edge is moving upward or downward. The action of the trailing edge in this mode, however, is similar to that of the second mode with the point of no vibration located here. The nodal line extends from this point through the center of the plate and into the root.

Again notice the dissimilar bending and twisting actions of square elements in various parts of the plate.

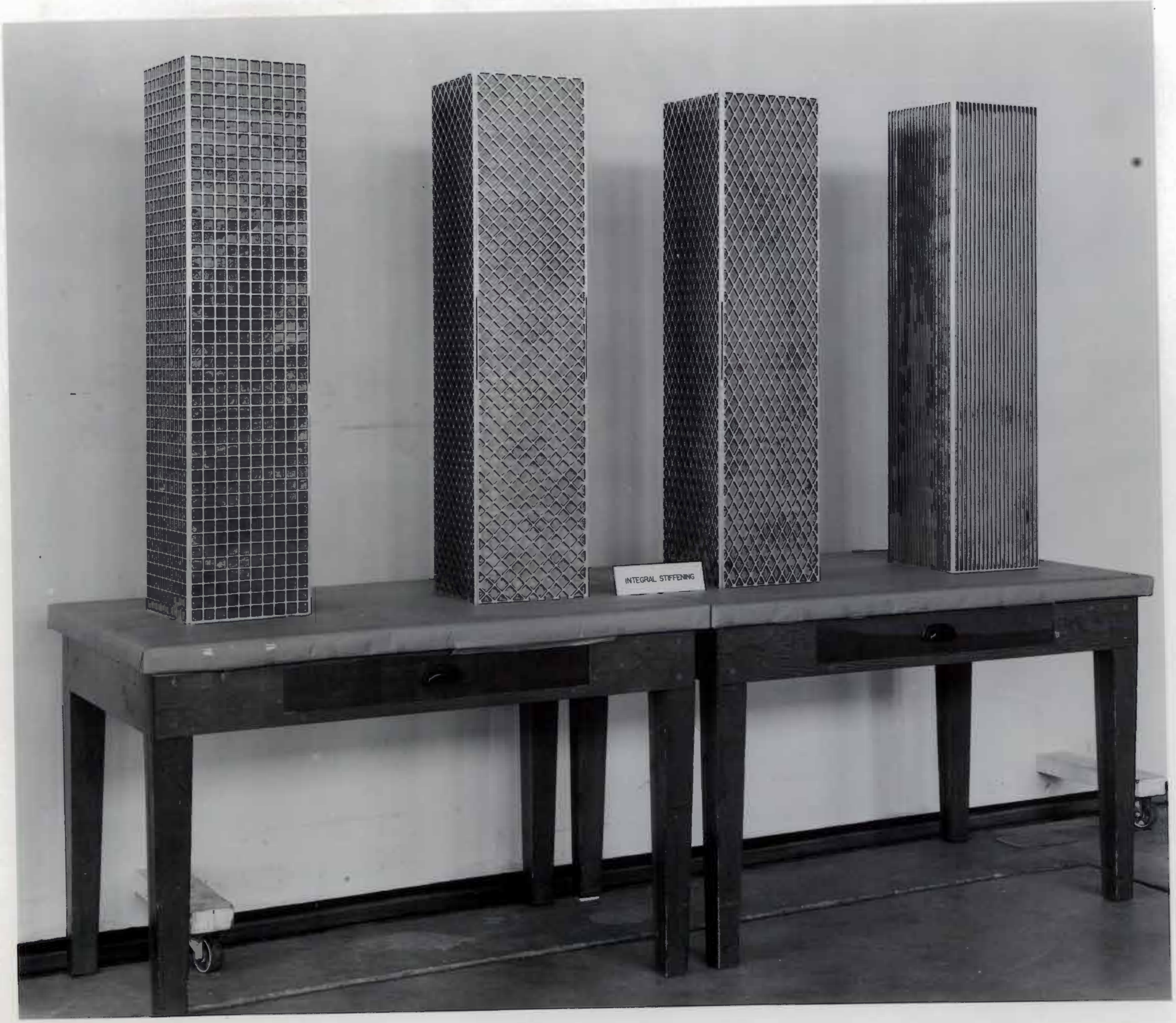
The straightedge now indicates that the plate is bending in an S-shape rather than a simple curve.

In order to show more clearly the presence of the nodal line, sand will now be sprinkled on the top surface of the plate; observe in the mirror above the wing that the sand bounces off the vibrating portions and collects along the nodal line.

We will now lower the frequency of vibration to obtain again the second mode of vibration. Observe in the mirror that the sand will move to a new position on the wing surface and define the nodal line for this mode of vibration.

It is only by understanding the distortions such as those we have shown you in this demonstration that designers can proceed with greater confidence in the design of safe and efficient structures of the delta type.

Gentlemen, this concludes the program in the Structures Research Division. Please follow your group leader out this way.



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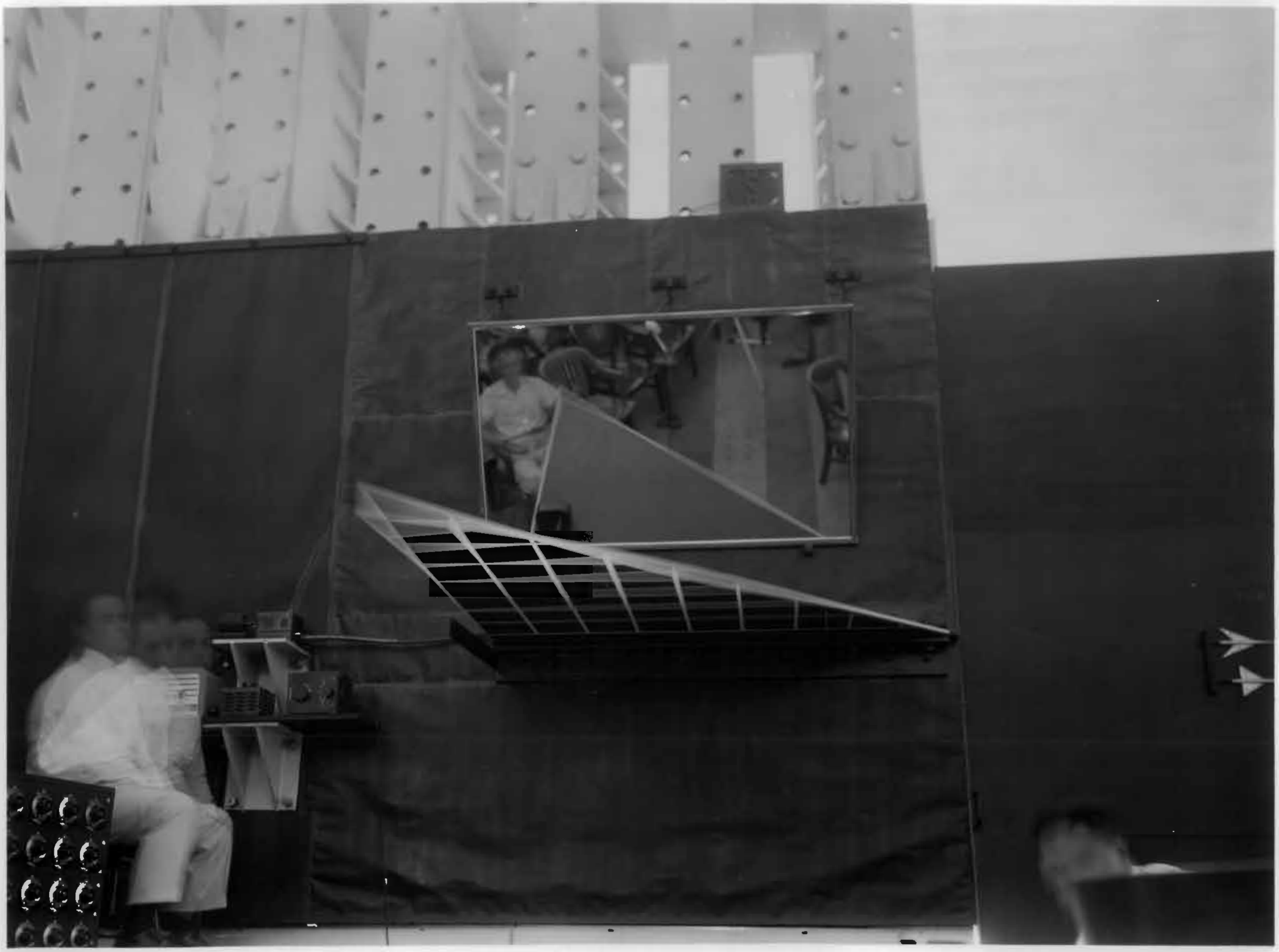

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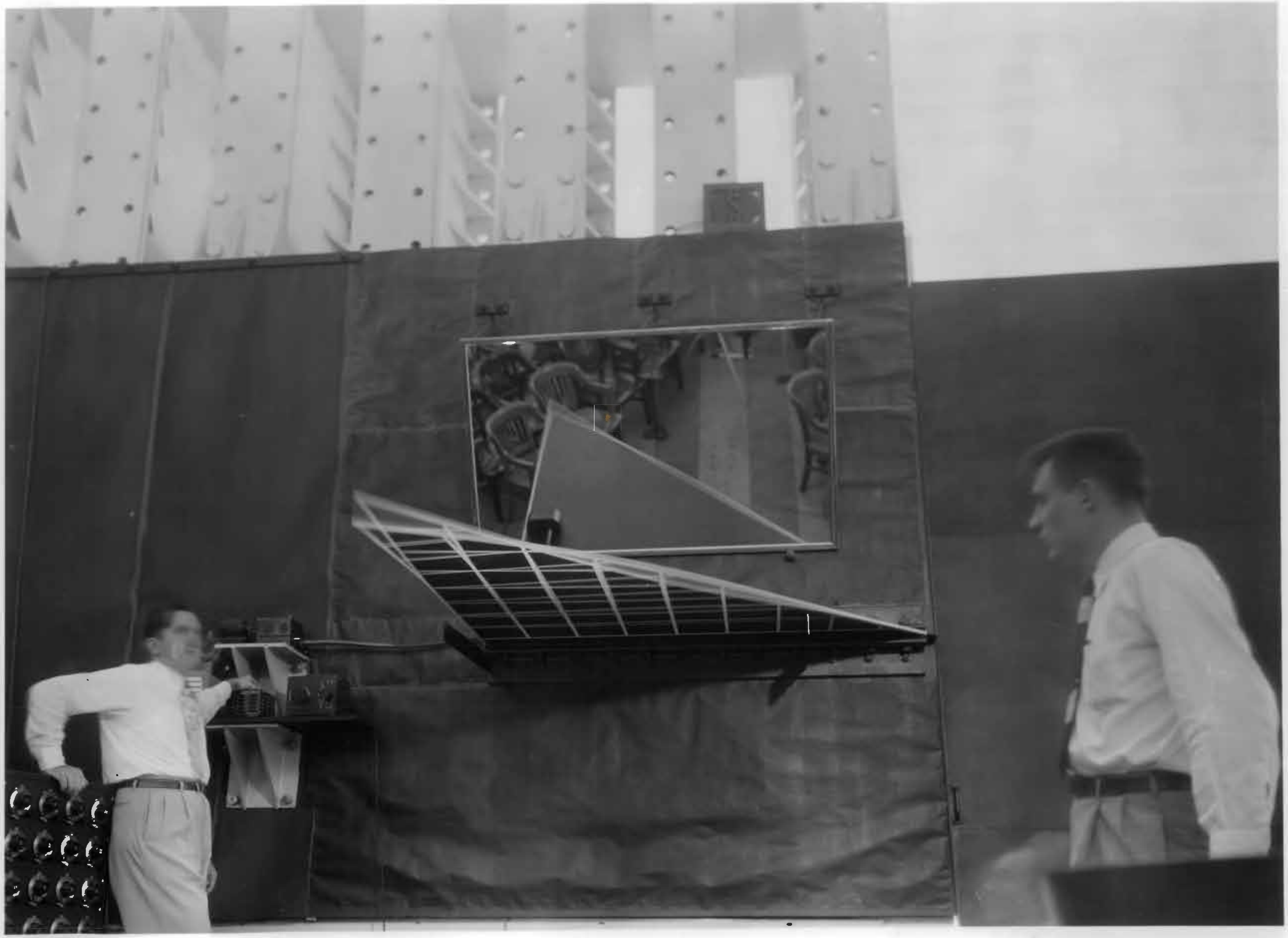

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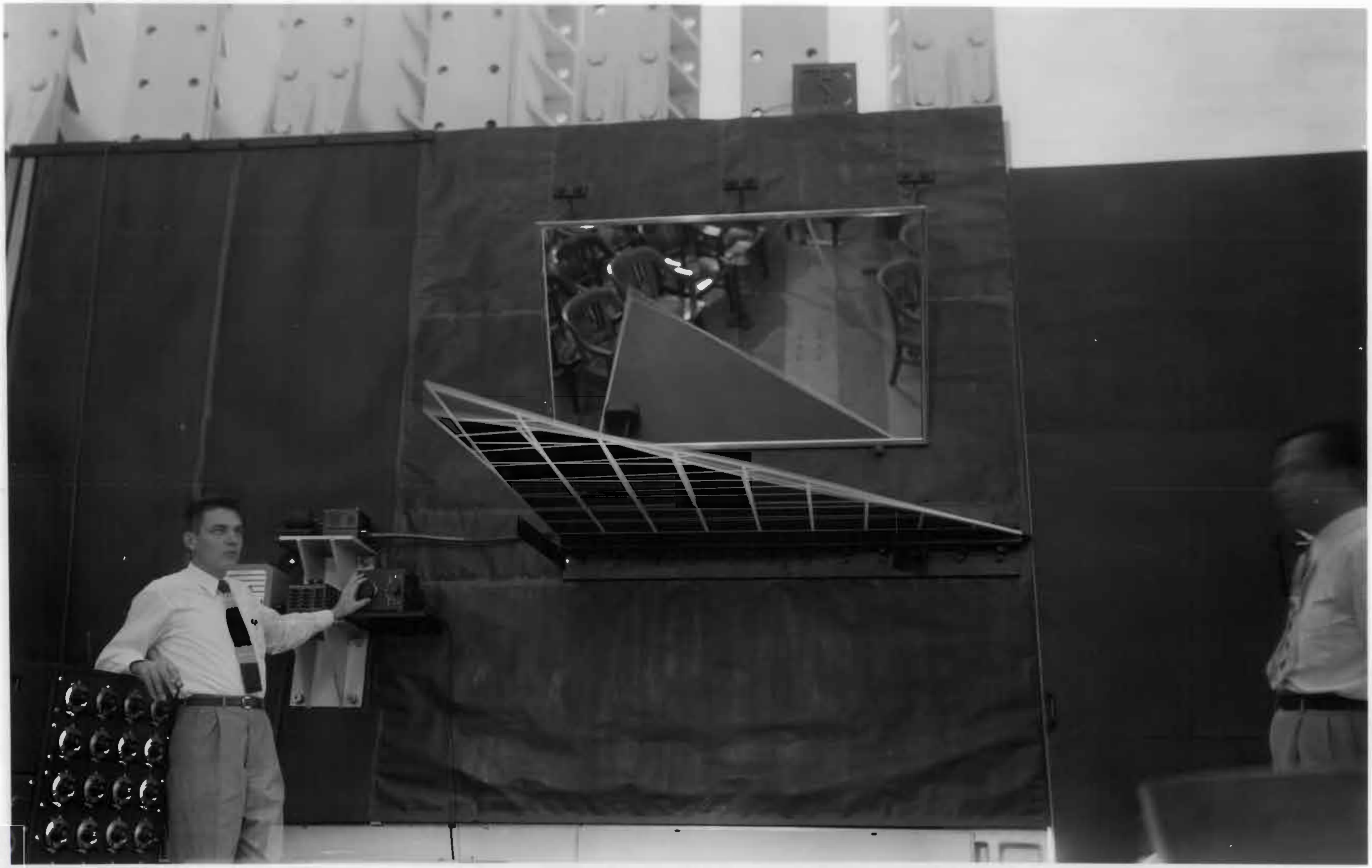

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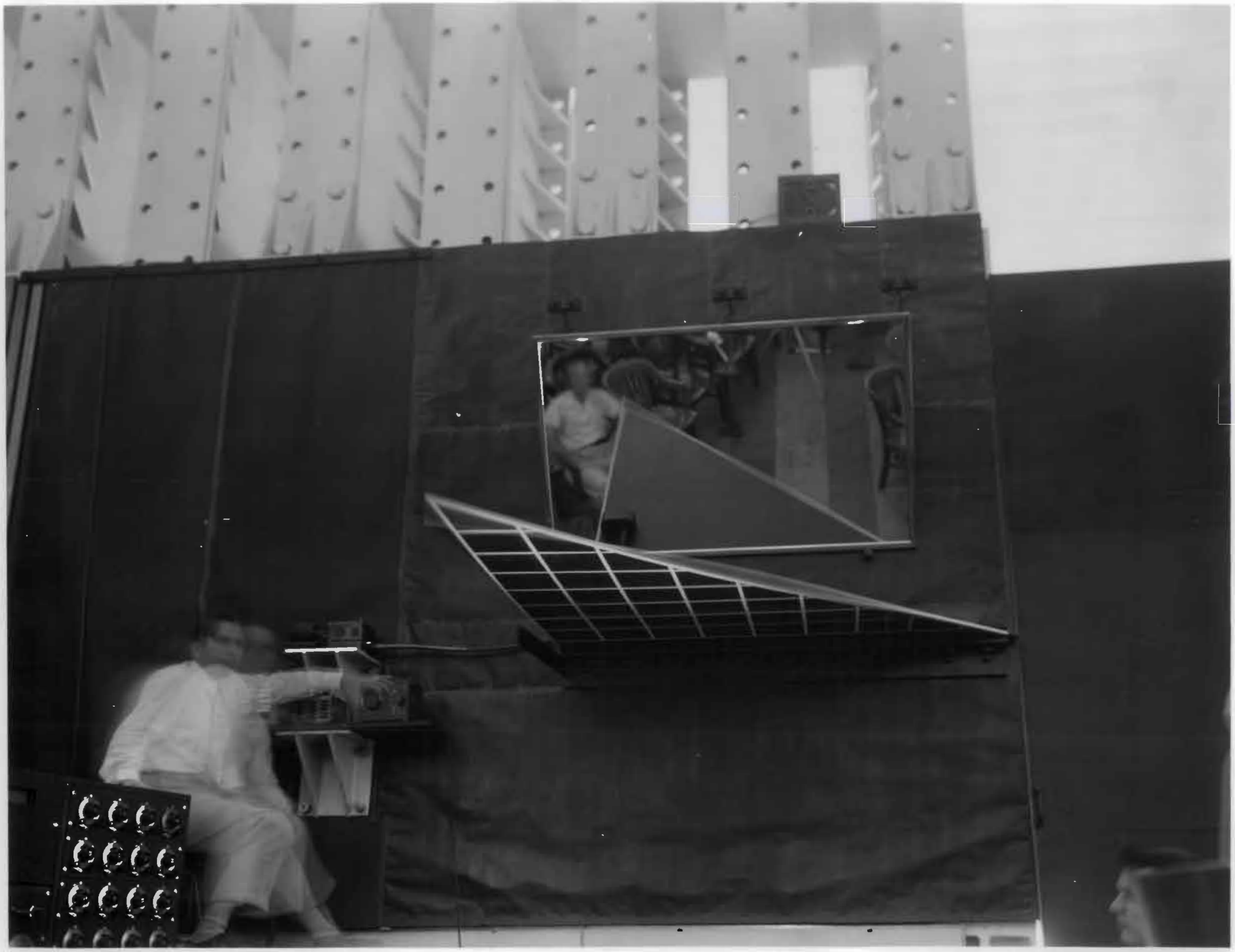

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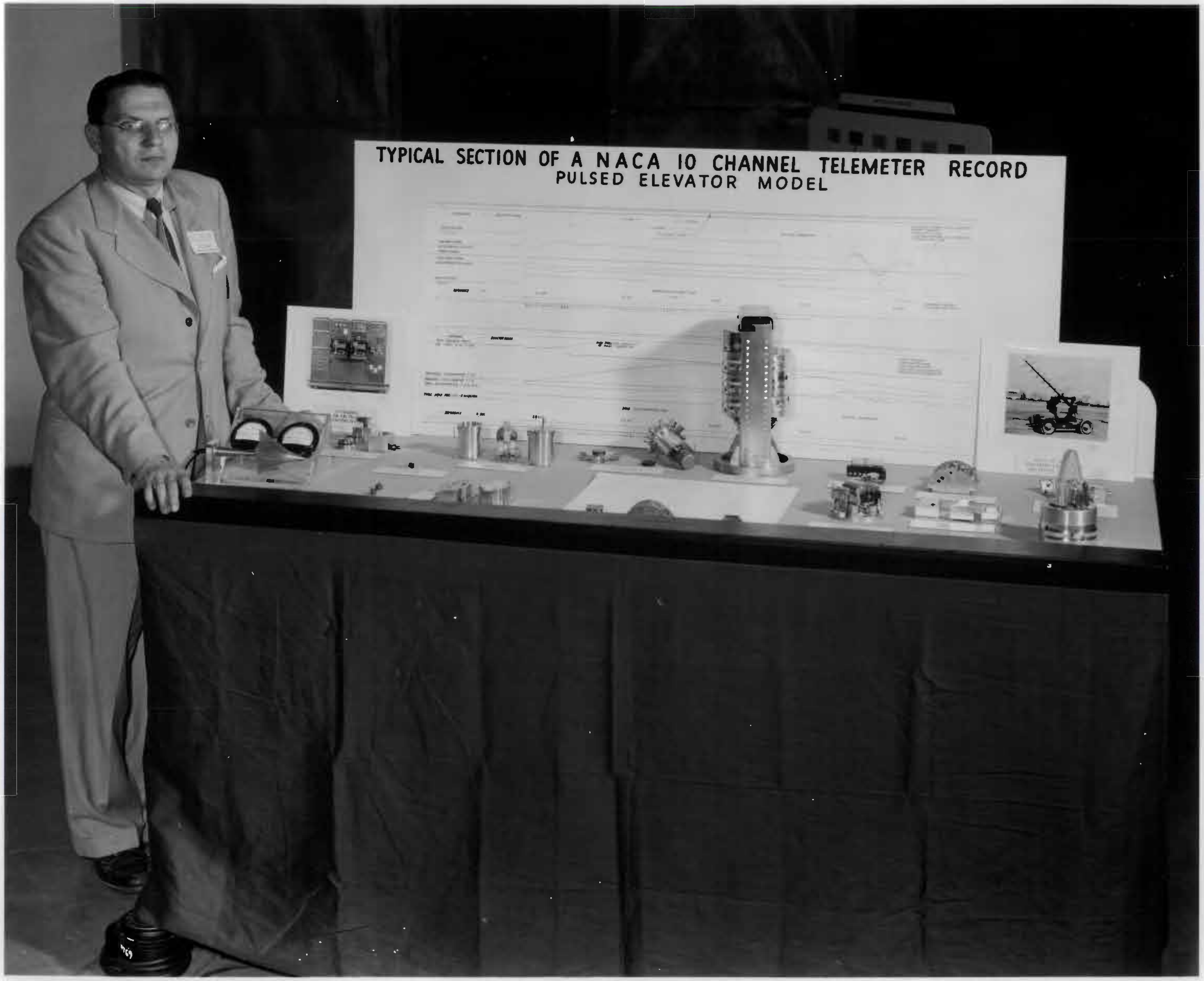

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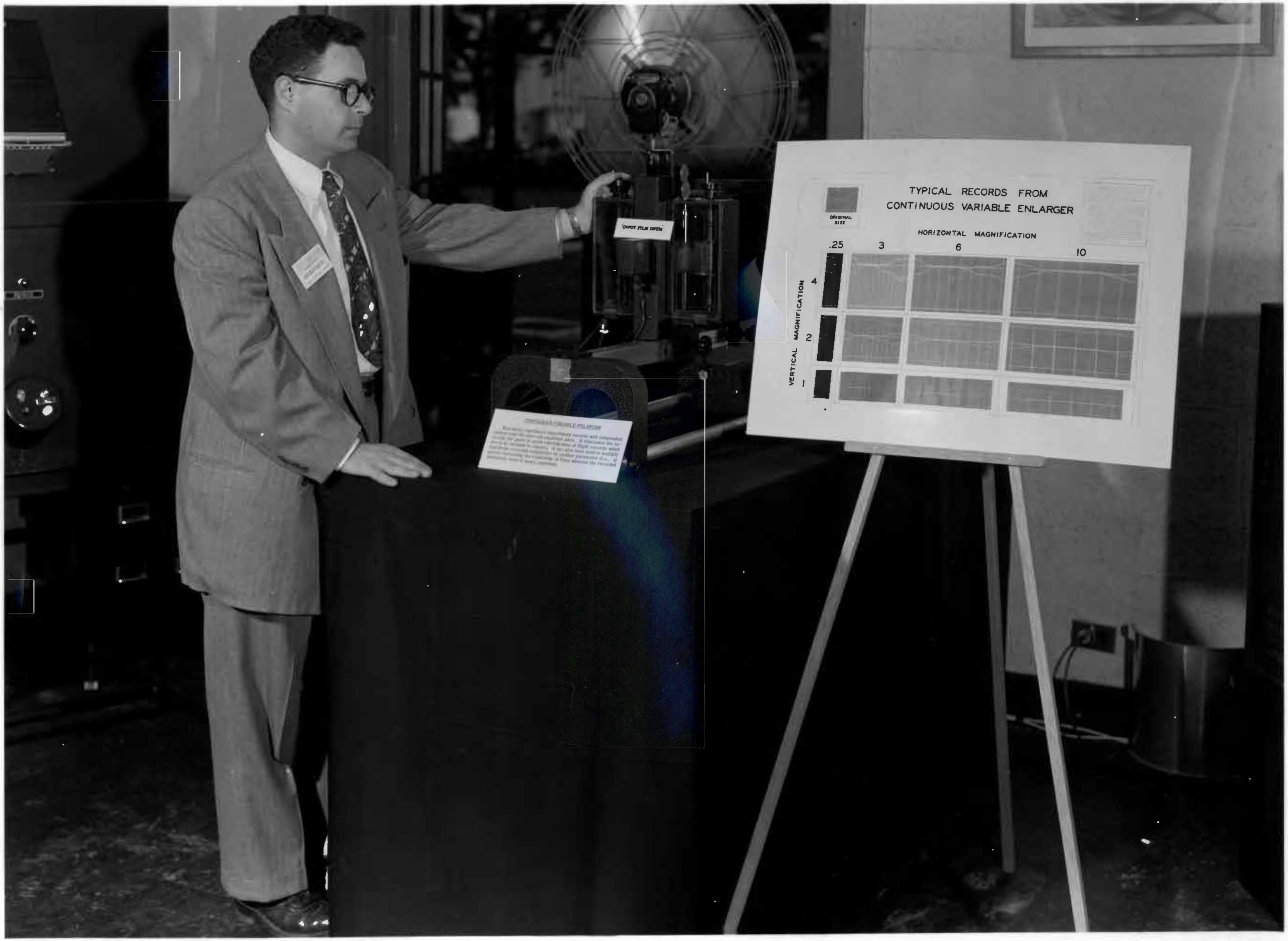
DATA REDUCTION DISPLAY

Set Up in Lobby of Activities Building



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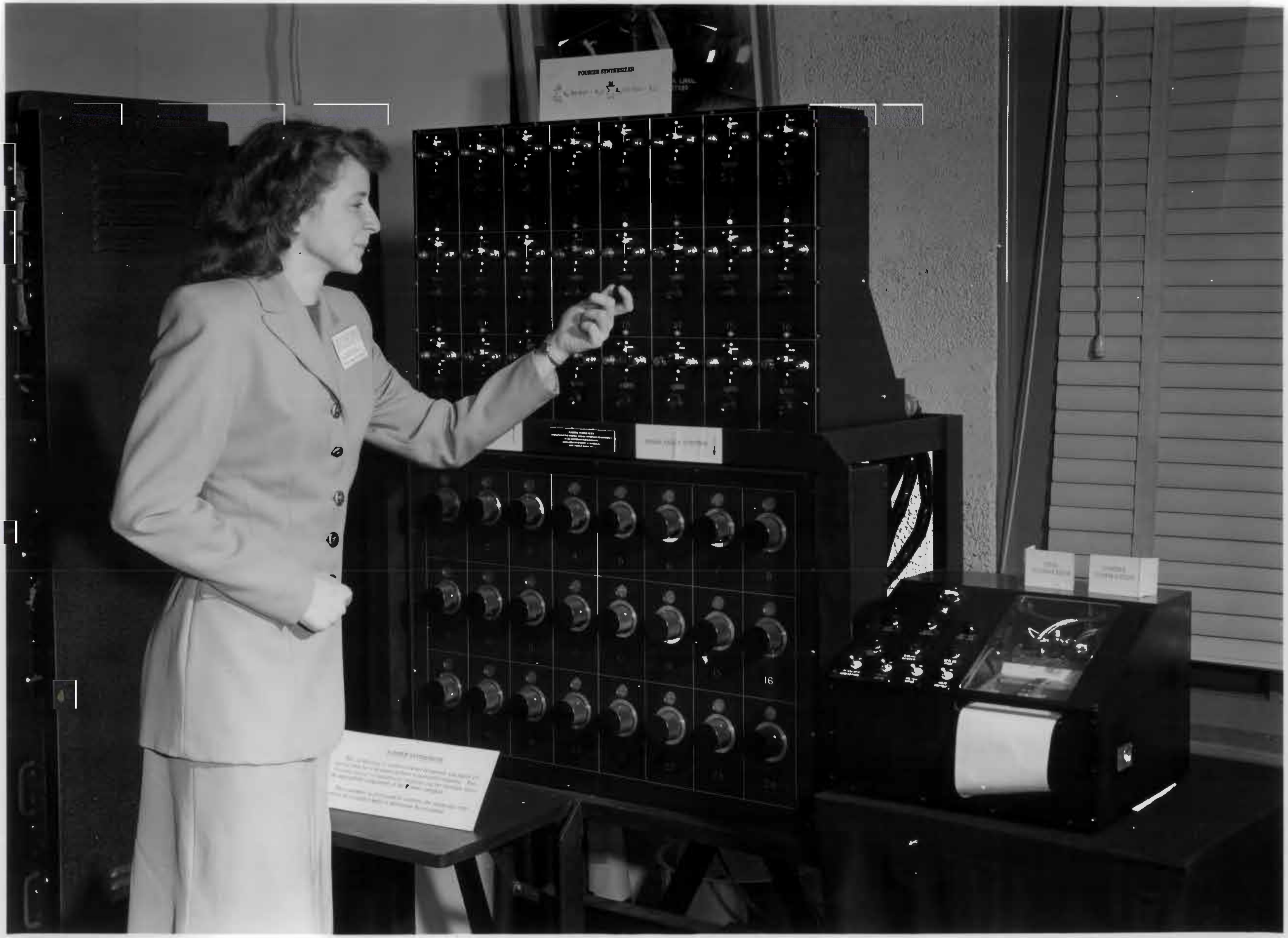

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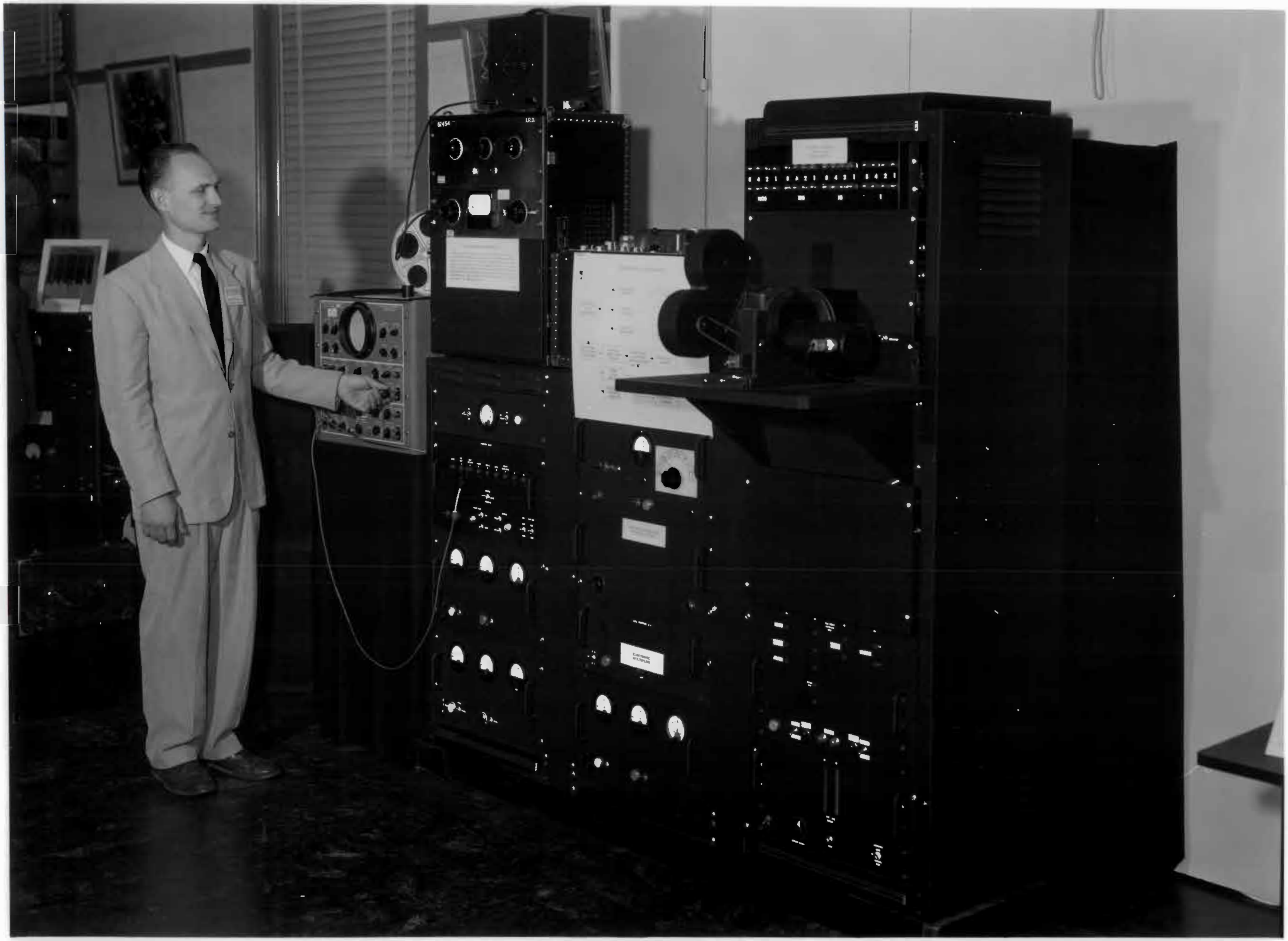

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THIS PLOTTER WAS DESIGNED
DEVELOPED AND BUILT BY
THE NACA AND IS FED BY
STANDARD IBM EQUIPMENT

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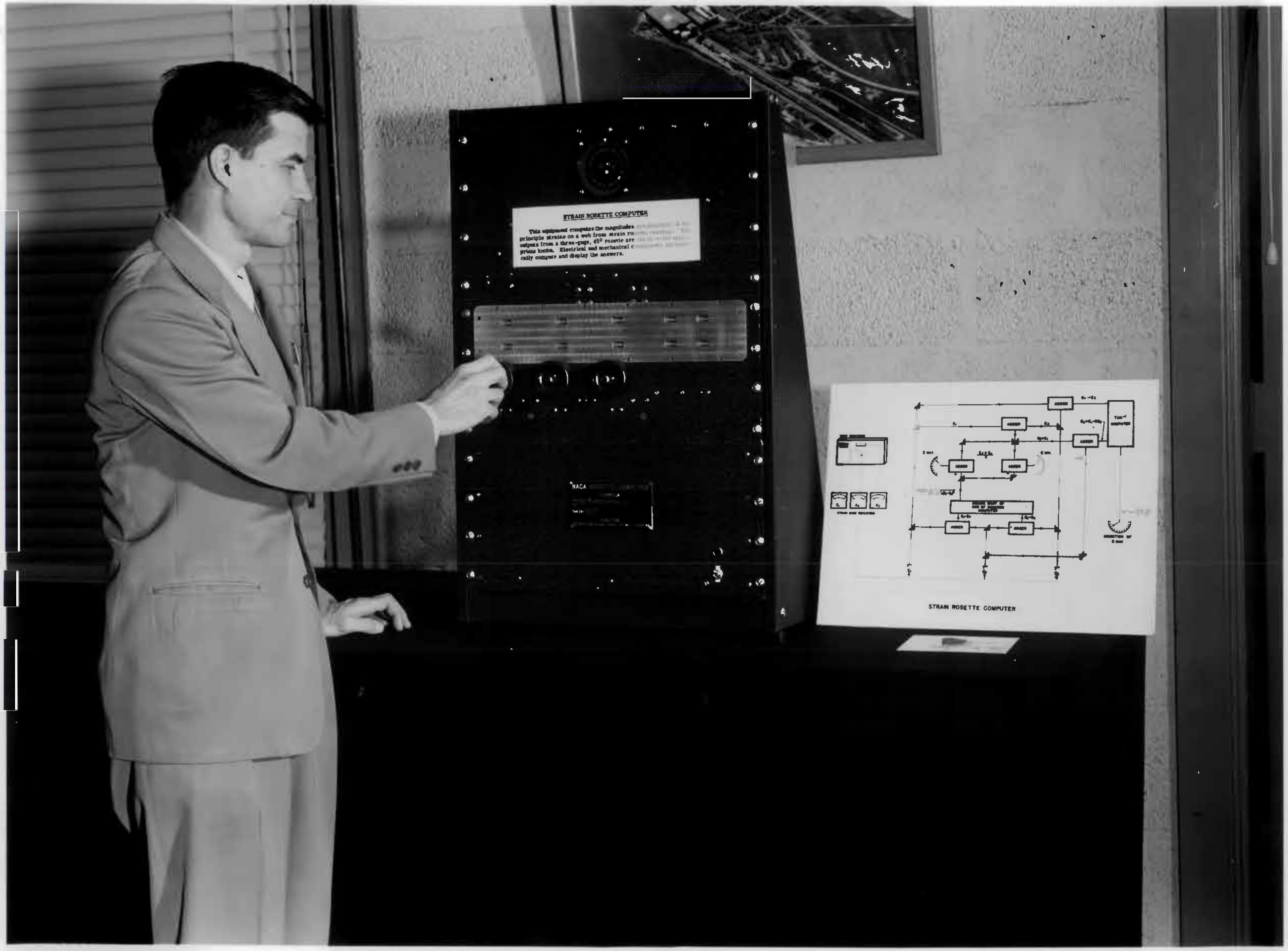

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Bailey
Sawyer

1951 BIENNIAL INSPECTION

FLIGHT RESEARCH LABORATORY

Most of the research equipment seen during your inspection of the Laboratory today is used for testing models. Development of these model test techniques is very important, of course. But a large part of the knowledge used in airplane design can only come from measurements made on full-scale airplanes in flight.

Measurements on airplanes in flight are the primary source of knowledge as to the loads that will be imposed on an airplane by the pilot in accomplishing his mission, or by the turbulence of the atmosphere. Measurements on airplanes in flight provide virtually the entire basis for current design requirements as to the degree of stability and control that an airplane must have to insure that it can be flown with precision and safety, either by human pilots or by automatic control systems.

Measurements on airplanes in flight are also necessary to provide a final check on the practical significance of conclusions reached in model tests, where exact duplication of all the actual conditions is seldom possible.

The range of subjects being investigated here in Flight is quite broad. As you entered the hangar you probably noticed the B-29 airplane being used to study the way accelerations are distributed along the wing span in turbulent air.

You may also have noticed several jet fighters which are being used to study the damping of lateral oscillations. Here we are going to show sample results from two representative flight investigations, one on the air loads on a wing during buffeting, the other on the effect of friction in power control systems.

As you leave this corner of the hangar you will pass two airplanes being used to study boundary layer control by suction thru porous surfaces. In the opposite corner of the hangar you will see representative samples of the research being conducted on helicopters. At your last stop in this building you will see a short film that shows the actual operation of some of the airplanes and equipment used in conducting flight research in the transonic speed range at our High Speed Flight Research Station at Muroc.

Now I'd like to introduce Mr. Huston, who will describe a recent development in flight research on buffeting, Mr. Huston.

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Speaker - W. B. [illegible]ton Alternate - Harry L. Goga[illegible] Maneuver Loads Branch

1951 BI
Flight Research
Laboratory

GENERAL FLIGHT RESEARCH

TALK ON BUFFETING

2 Movie Sequences - 2 charts - 5 minutes

Buffeting is a shaking of the airplane due to unsteady lifting forces. It occurs only under certain conditions of flight, but it limits the top speed of high performance airliners or bombers, and it is a very severe restriction on the maneuverability and gunfire accuracy of any transonic fighter airplane. The unsteady conditions responsible for buffeting are illustrated in a movie made with high-speed Schlieren aparatus in one of the wind tunnels, which shows the air flowing over an airfoil.

M O V I E   O N

The flow direction is from the bottom of the screen to the top. The airfoil is at an angle of attack, the upper surface is to your left, the Mach number as shown by the indicator on your left is constant at approximately 0.84. The conspicuous bright line moving back and forth on the upper surface in a somewhat random fashion is a shock wave. The boundary layer, which is the V-shaped region, is very badly separated, and large vortices are being shed into the wake, disturbances which would shake the tail if it were in the extension of this region. Note the extremely disturbed condition of the entire flow field surrounding the airfoil. These disturbances produce large loads on the airfoil.

M O V I E   O F F

It is important to have a technique which will measure the loads imposed on the airplane by these disturbed flows under actual flight conditions. A special pressure distribution manometer has been developed here at Langley which makes such studies possible. There is an opportunity to examine the details of this manometer at lunch. The instrument is small and compact and as shown on the chart it can be placed out in the wing of a fighter-type airplane right at the wing section where a pressure distribution study is to be made. Each pressure measuring cell can then be connected to an orifice in the wing with a short length of tubing, a very desirable feature when pressures are changing rapidly.

Inside the instrument thirty mechanical-optical pressure measuring cells are arranged just as the orifices are spaced along the chord. Each cell reflects a light beam onto a ground glass screen, so that the vertical position of the light spot is proportional to the pressure.

To illustrate some of the preliminary results obtained with this manometer during buffeting, we will show a short movie obtained by photographing the pressure diagram on this ground glass. As you will see it on the screen, the air is flowing over the wing from your left to your right. The leading edge of the wing chord is here, and the pressures over the upper surface from leading edge to trailing edge are shown by these upper dots. Pressures on the lower surface are shown by the lower line of dots. Changes in pressure are shown by up or down movement of the dots. The movie was made during a 5g pull-up from a dive at a Mach number of 0.78, the kind of maneuver which a fighter pilot would frequently make.

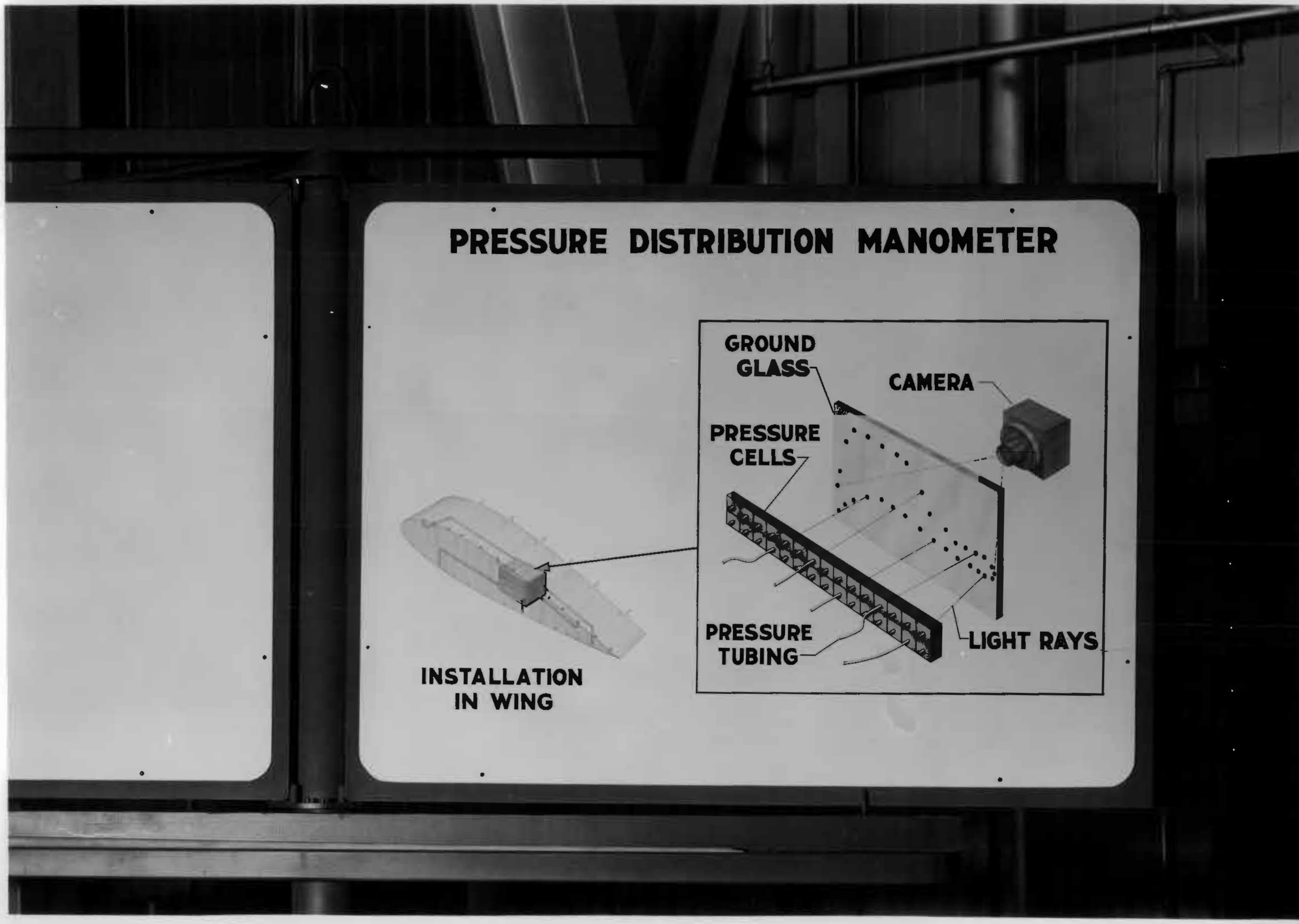
M O V I E   O N

Here we have the pressures during the high-speed dive before the pull-up begins. The pressure fluctuations will be associated with the shock on the upper surface, here evident by the sharp increase in pressure at about 50 percent chord on the upper surface. As the lift increases in the pull-up, the area between the two lines of dots increases, fluctuations around the shock increase in violence, the shock moves forward. These fluctuations represent local changes in pressure of about 200 pounds per square foot. As the airplane recovers to level flight again, the oscillations subside.

M O V I E   O F F

The fluctuations in pressure over parts of the airfoil section are violent. The loads actually imposed on the airplane wing can be determined from the data of the movie. This has been done and the results are shown on the next chart as a plot of wing load against time in seconds. The wing load was obtained on the assumption that loads at the representative section are applicable to the entire wing. In this case the biggest change was some 65 percent of the airplane gross weight in about one tenth second, or a load of nearly three tons, with repeated blows of over two tons which adds up to an exceedingly rough ride for the pilot. Loads of this size are confirmed by other measurements on the airplane, which also establish the fact that although the tail is disturbed by the wake, the principal buffeting loads originate on the wing, the only surface large enough to provide loads of this magnitude.

A comprehensive buffeting research program is under way at the various laboratories of the NACA, using these techniques and others, coupled with theoretical studies. Considerable progress is being made, and it appears that with future airplanes, buffeting can be made a less serious limitation than it has been in the past. This concludes the presentation at this stop and your next stop is on the far side of the hangar directly to your rear.



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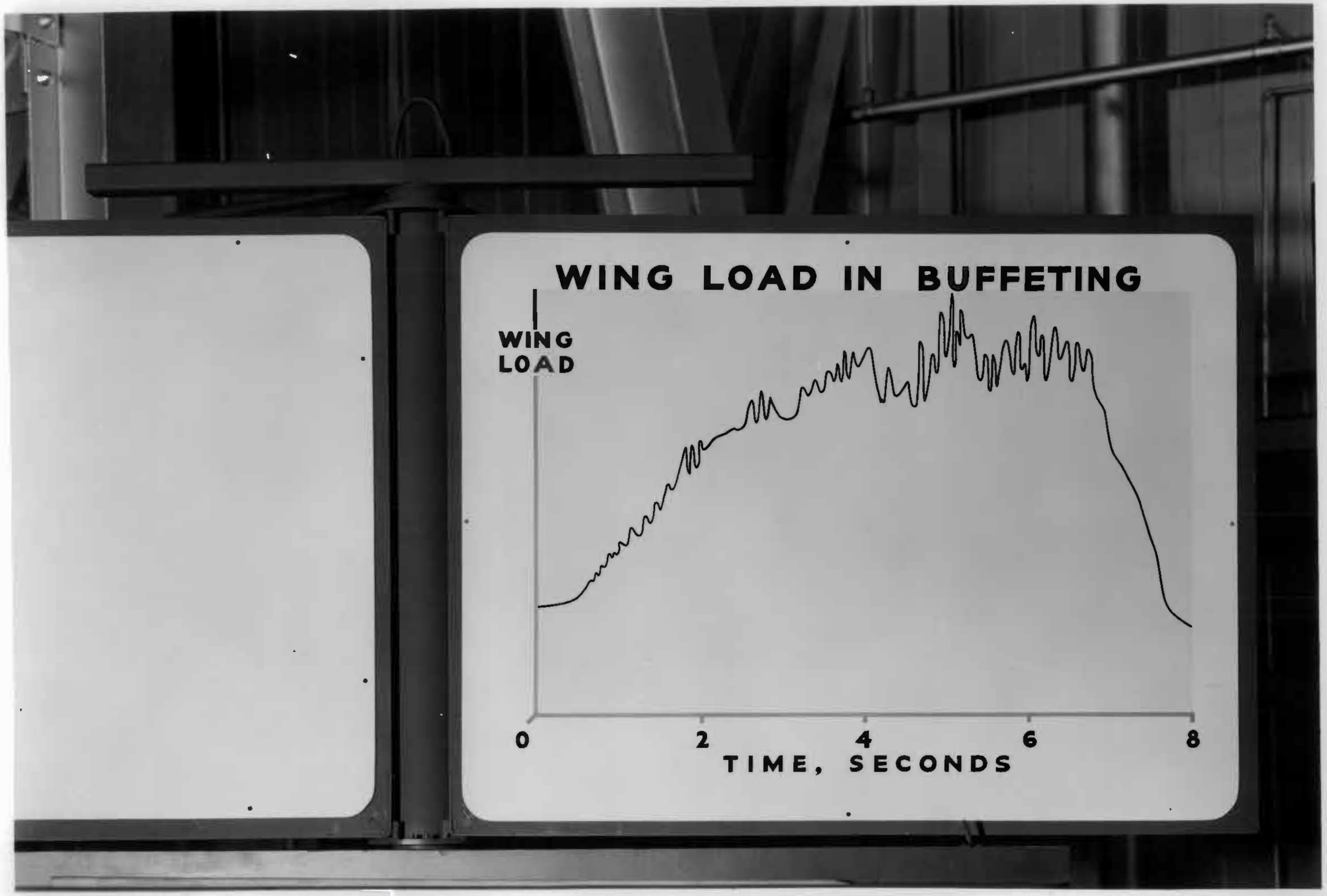

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FRICTION AND CONTROL SYSTEMS

By J. T. Matthews, Jr. and B. P. Brown

1951 BIENNIAL INSPECTION

The NACA has done a lot of work in the past on flying qualities of airplanes with manual controls. This work has enabled the services to set up handling qualities on a quantitative basis. In newer airplanes, as a result of higher operating speeds and the need in many cases of moving the entire horizontal tail, designers have found it necessary to incorporate power operated controls. So, we have had to extend our studies of flying qualities to include these systems. In many of these systems the pilots have reported a certain longitudinal touchiness, that is the pilot has trouble maintaining a constant speed or acceleration. In order to investigate this problem, we are currently using this Vought Corsair airplane which was borrowed from the Navy. This airplane does not normally have a powered control system, but prior to the NACA procurement, the Navy had a booster system installed for experimental purposes. The system is typical of those that have been giving trouble. The investigations to date, have shown up one difficulty with the system which contributes to the reported longitudinal touchiness. This is friction in the servo-valve. The servo valve, which is connected to the stick, controls the flow of fluid and positions the control surface. We'd like to demonstrate with the actual airplane how this friction affects operation. First, with the booster off, the operator will pull on the stick and you'll notice that when the operator stops pulling, the stick will stop moving. Now we'll do the same thing with the booster on but this time you'll notice that when the operator stops pulling, the stick continues to move until he stops it. Notice also that unless he applies just the right force to stop it, it starts back in the opposite direction. What you have just seen is illustrated in the first chart in the form of time histories of stick force and stick angle. As you saw in the demonstration with the boost off, when a force is applied the stick moves and when the force is released, the stick motion ceases. With boost on however, when the force is released the stick continues to move until an opposite force is applied to stop the motion. In this case, friction is causing the servo valve to stick open allowing fluid to move the controls until an opposite force breaks the friction and closes the valve thus stopping the motion of the control.

The significance of this phenomenon in terms of the pilots' ability to maneuver the airplane is shown on the next chart. This chart shows the variations of stick force and normal acceleration with time during two attempted 4g turns, one with boost off and one with boost on. As with the previous charts the dotted line is for boost off and the solid, boost on. For the case of the boost off, the force and acceleration variations are smooth and the acceleration follows the changes in force closely. For the boost on case the oscillations in force and acceleration illustrates the difficulty encountered by the pilot during this maneuver. This friction is not abnormally high for valves controlling the high pressures involved, however it is obviously too high for satisfactory control. The most obvious solution to the problem would be to eliminate the friction; however, this would be very difficult to do and may not be necessary. We are now working to establish design limits for this type of friction. In addition we are studying various methods of alleviating the problem.


PRESSURE DISTRIBUTION MANOMETER
FRICTION CAUSES OVERSHOOT
BOOST OFF
TIME, SEC.
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FT

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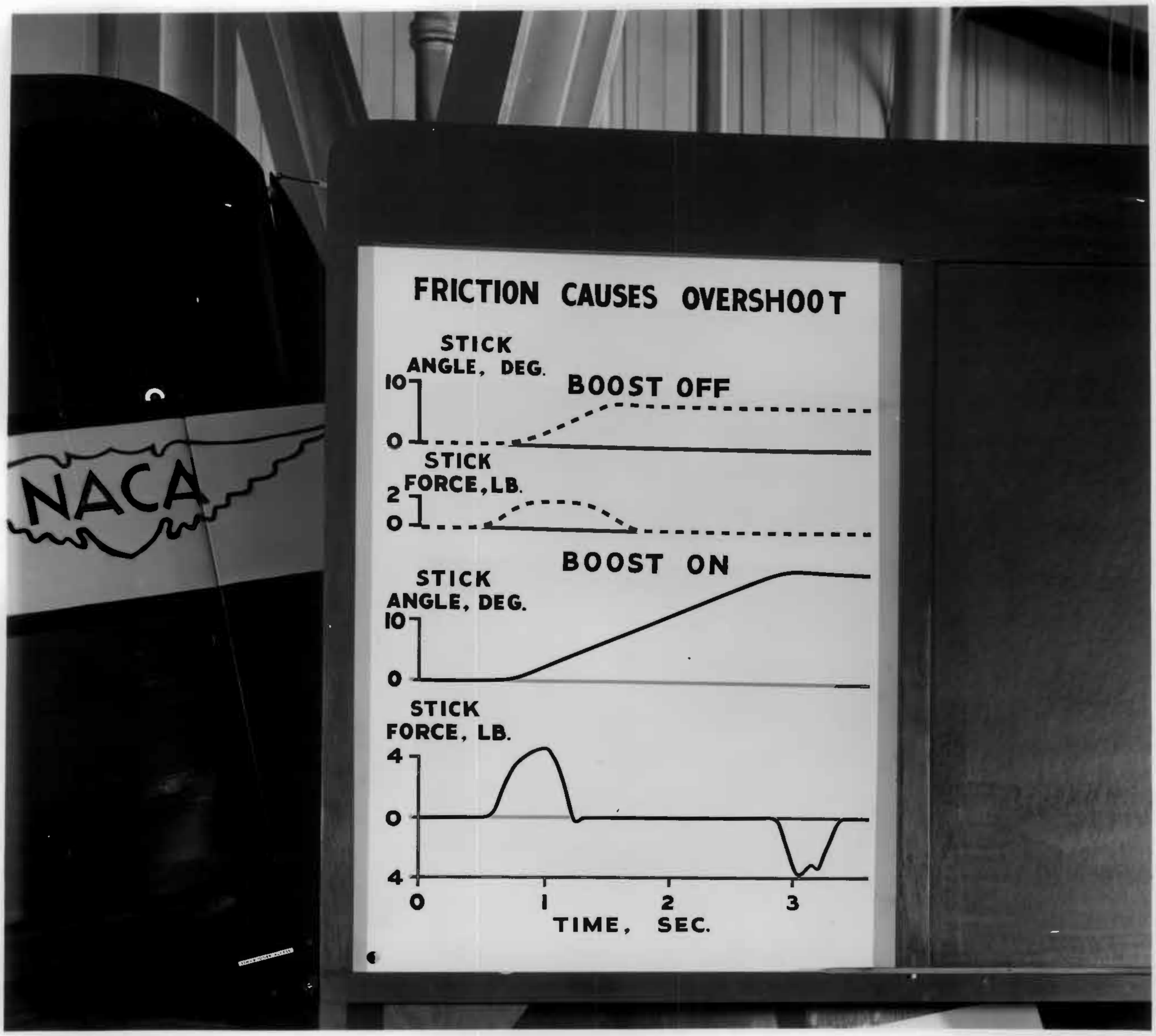

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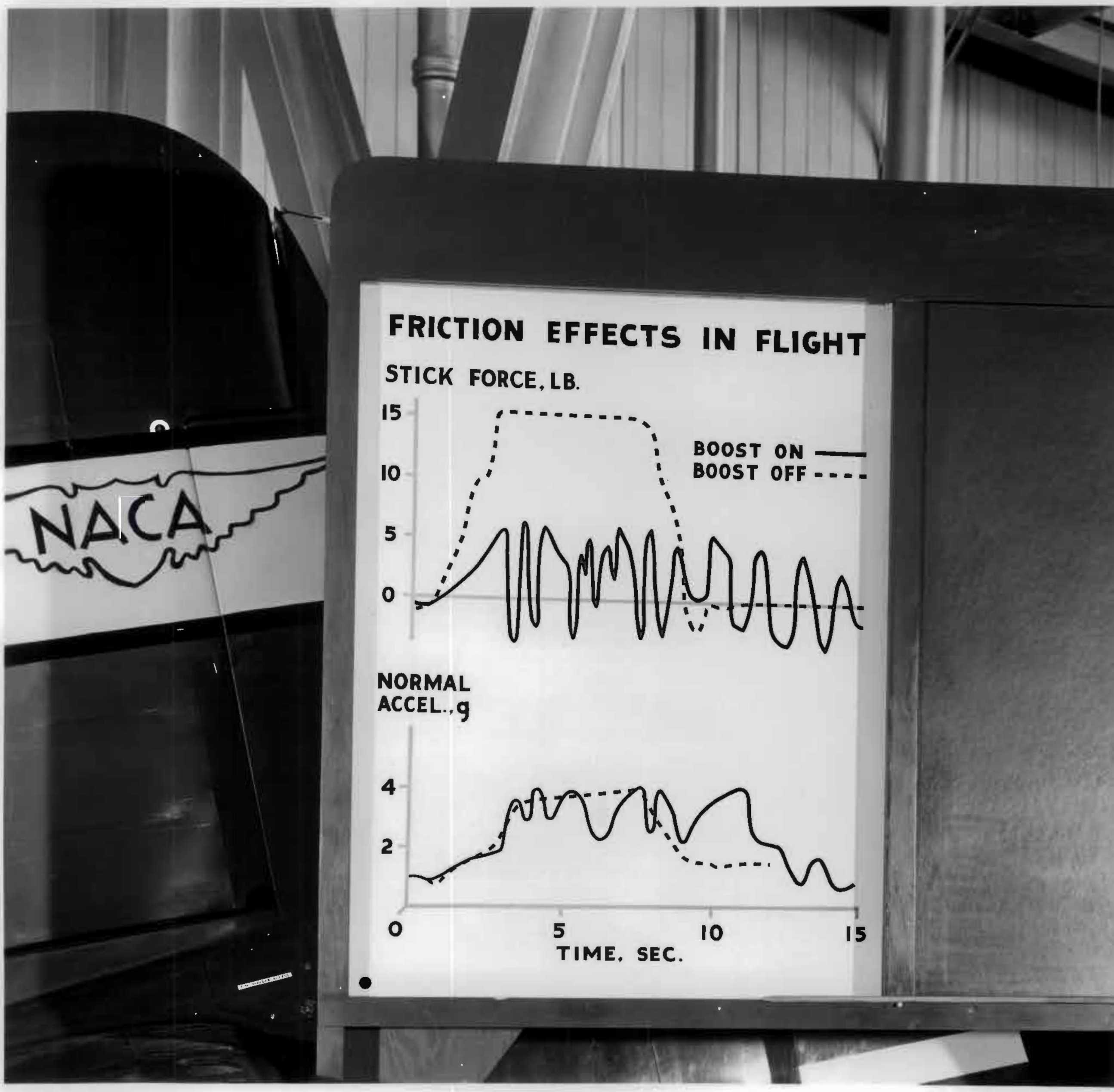

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1951 INSPECTION - HELICOPTER TALKS

by Almer D. Crim - Alternate, Marlin E. Hazen
and Kenneth B. Amer - Alternate, Robert J. Tapscott

For the uses of the helicopter which are currently unfolding, it is essential that all-weather flight be possible. However, very little blind flying has been attempted with helicopters, largely because of poor stability and control characteristics.

We have previously found that certain flying-qualities requirements must be met for satisfactory helicopter flight under conditions of normal visibility. Currently, we are checking the adequacy of those requirements under blind flying conditions.

In this machine we have installed a set of dual controls, a flight instrument panel and a hood, which permit the rear pilot to try blind flying. The instruments are those which are considered adequate for and airplane, and include a turn and bank indicator, artificial horizon and directional gyro. To vary the longitudinal stability for test purposes, we made flights with and without the tail assembly which you see (the paddles with the yellow stripes). To completely meet our flying-qualities criteria, we found it necessary in this case to link these paddles to the longitudinal control, just like the elevator on an airplane.

This chart shows one result of these blind-flying trials. Here we see longitudinal stick motion plotted against time for two cases; tail off, where the stability of the machine is such that our requirements are not met, and tail on, in which they are. It is apparent by comparing the motions on the two curves, that the pilot has much less difficulty in the case where our visual criteria are satisfied.

The significance of this result is that our existing stability and control requirements appear to be adequate, longitudinally, for blind flying.

However, in the case of directional control we seem to have uncovered a new problem, which is illustrated in this next chart. Here we see rudder-pedal motion plotted against time, for both visual and blind-flying conditions. This bottom curve is typical of visual flight, in which our pilots have no trouble maintaining a desired course. During instrument flight, however, they report great difficulty in holding a given heading. This is confirmed by the greatly increased motion shown on the upper record which was taken while the pilot was flying under the hood.

Thus, in this case, a machine which was considered satisfactory for visual flight was found to be difficult to control, directionally, under instrument conditions. This problem is currently being investigated, both to determine what additional stability and control requirements are needed and also to determine whether special flight instruments will be necessary for satisfactory helicopter blind flying.

Sometimes we are able to predict new problems, and solve them, before they are encountered in actual flight. The helicopter stability study about to be described by Mr. Amer is one example.

Early flight investigations indicated that one of the most important factors affecting the ease of flying the helicopter is a characteristic known as rotor damping, which is the rotor contribution to the damping in roll or damping in pitch of the complete helicopter. Thus, if we imagine this model is flying this way, if it rolls to the right like this, the rotor normally produces forces to the left to oppose the motion. A theoretical investigation of rotor damping was then undertaken which indicated that it became smaller with increasing forward speeds or with increasing rates of climb, and could in fact become unstable at very high speeds or rates of climb. By unstable damping, we mean that the rotor would produce air forces in the same direction as the rolling motion of the helicopter. Thus, if the helicopter is rolling to the right, the rotor produces forces tending to cause the helicopter to roll faster and faster to the right.

Because of the serious implications for future high-performance designs, measurements of rotor damping were then made in flight using this helicopter to check the predicted trends as far as possible. The results are shown on this chart on which is plotted rotor damping against increasing forward speed or rate of climb. The measurements confirmed the theoretical prediction that rotor damping decreases with increasing forward speed and rates of climb. However, this test helicopter did not have enough power to reach the region of unstable rotor damping. Model tests in a wind tunnel were therefore used to investigate this region experimentally. This is the model used for the wind-tunnel tests. As you can see, it is mounted on pivots of very low friction.

You will now see movies of this model mounted in a wind tunnel at a high speed, high rate of climb flight condition.

START FILM

The model, like an actual helicopter, is nosed down so the rotor can pull it forward into the wind which is coming from the right. As you can see, the swinging of the model builds up, indicating that for each swing, the rotor is producing forces in the same direction as the model is swinging. Thus, we have experimental confirmation of the theoretical prediction of a region of unstable damping.

Further study indicated that one way to prevent the occurrence of this unstable damping in high-speed flight would be to use a special rotor hub with flapping hinges offset from the rotor shaft instead of a more standard hub with hinges on the shaft. In this next scene, we will see the same model at the same flight condition, but having a special rotor hub with offset flapping hinges. The model gives the impression of having a different number of blades in this scene because of a slightly different stroboscopic effect. The model is being displaced by the operator and then released. As you can see, the swinging damps out very quickly, demonstrating that this hub change produces sufficient additional rotor damping to overcome the unstable damping normally present in this high-speed flight condition. Again the model is displaced by the operator and released, and the swinging damps out quickly.

END OF FILM

To sum up, we have found and demonstrated the problem of unstable rotor damping that designers of high-speed helicopters will have to take into account, and we have demonstrated one possible solution to this problem.

This concludes the demonstration at this step.

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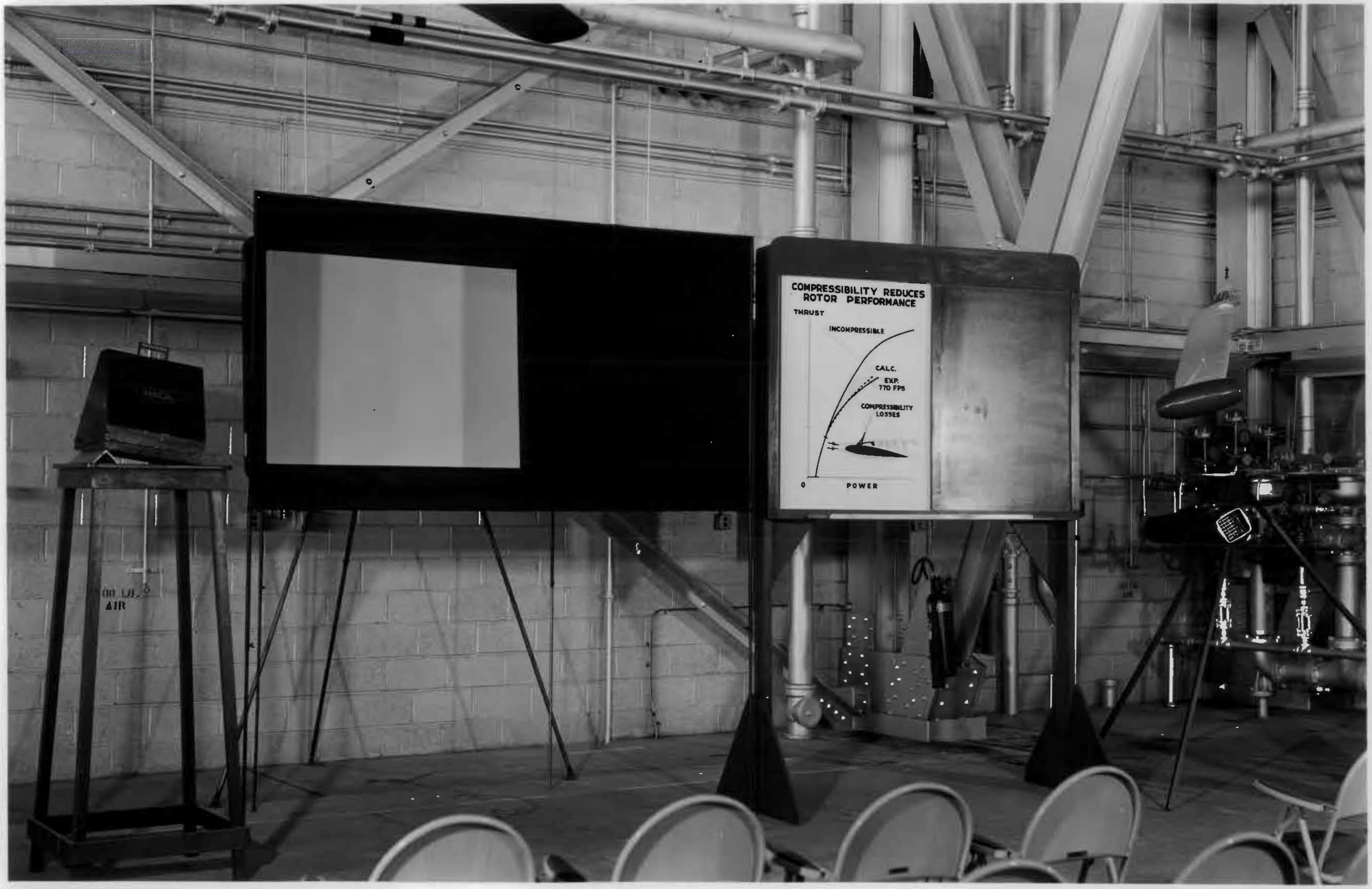

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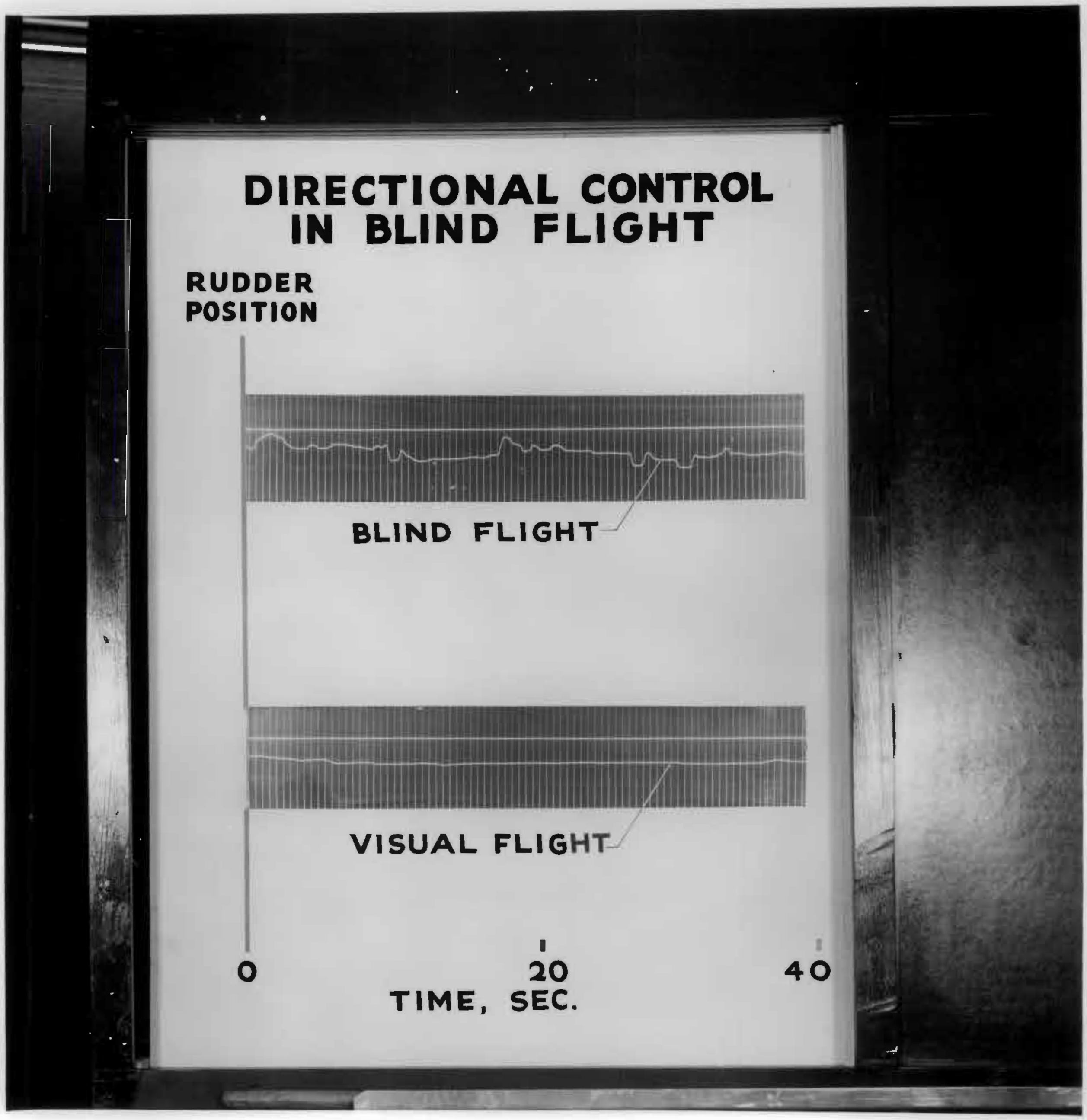

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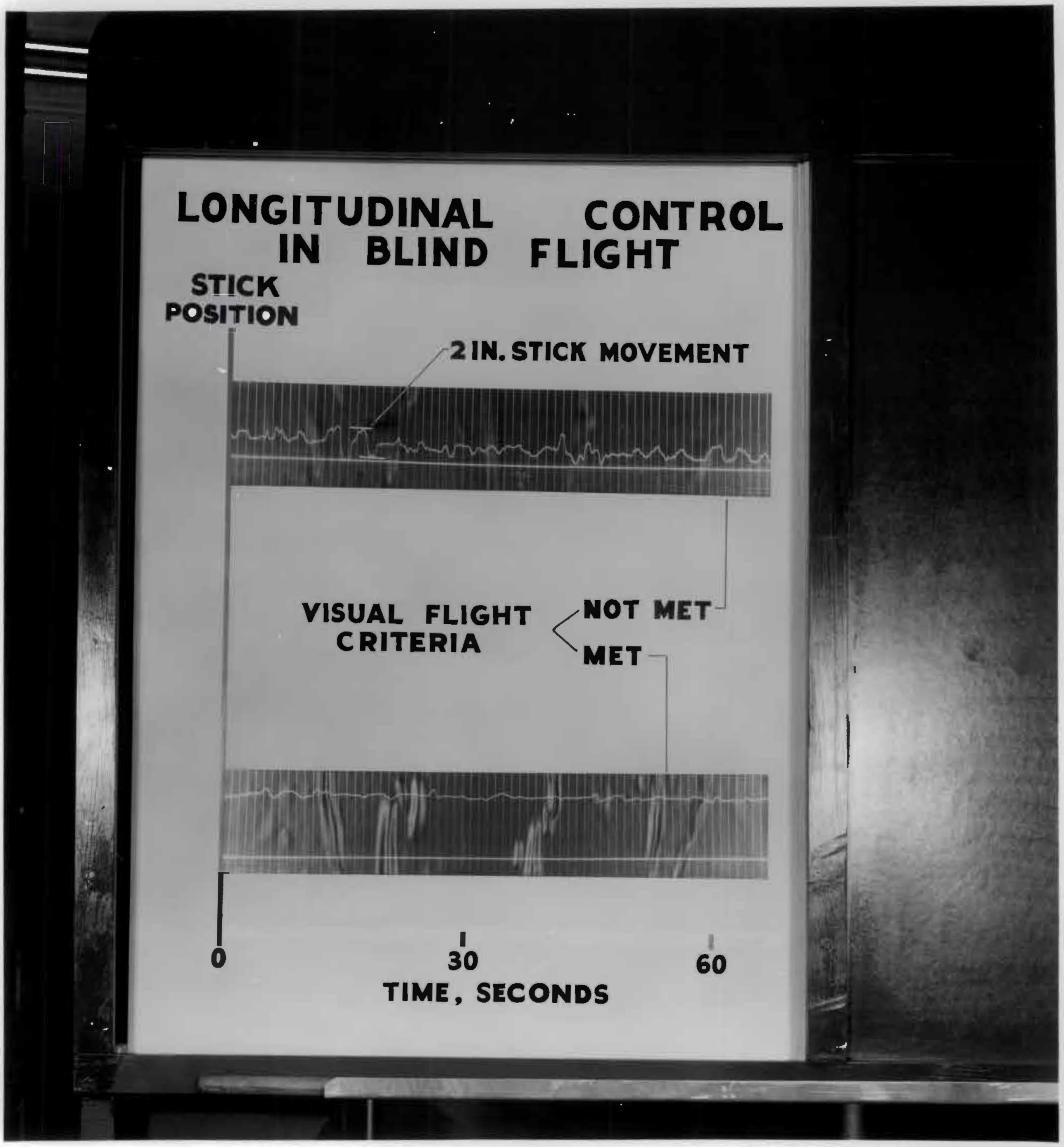

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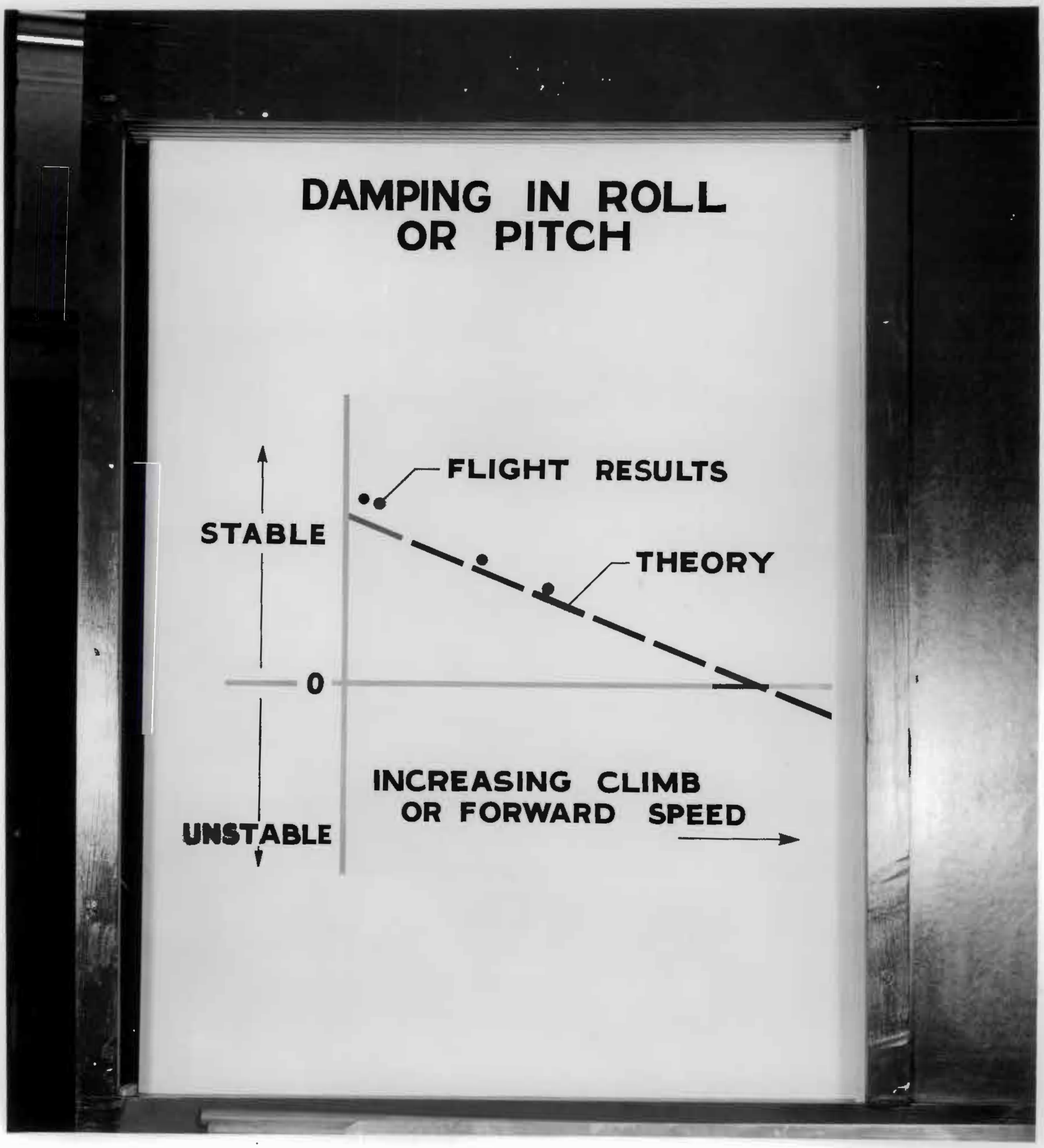

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1951 BI
FLIGHT RES.
Dingeldein

EFFECTS OF COMPRESSIBILITY UPON THE PERFORMANCE OF HELICOPTER ROTOR BLADES AND POWER-OFF DESCENT OF JET POWERED HELICOPTER ROTORS

by Richard C. Dingeldein and Paul J. Carpenter

Presented by - Paul J. Carpenter and Walter C. Kenyon at Flight Research, Biennial Inspection, Langley Aeronautical Laboratory, 1951.

The NACA helicopter effort is directed toward improving both the performance and stability and control characteristics of the helicopter. Investigations are underway in wind tunnels, in flight, on the helicopter test tower, and in the vibration and flutter laboratory.

In order to increase the top speed of the helicopter, it is necessary to increase the rotational speed of the rotors to avoid stalling of the retreating blades. High rotational tip speed is of interest since more lift can be obtained with a given size rotor. High tip speeds are also of interest with certain types of jet power plants which have acceptable propulsive characteristics only when operating at these faster speeds; however, at these speeds rotor blades, like wings, are affected by compressibility which, among other things, causes a rapid rise in the blade drag. As a result, it is important to determine the effects of compressibility and to what extent these effects can be predicted.

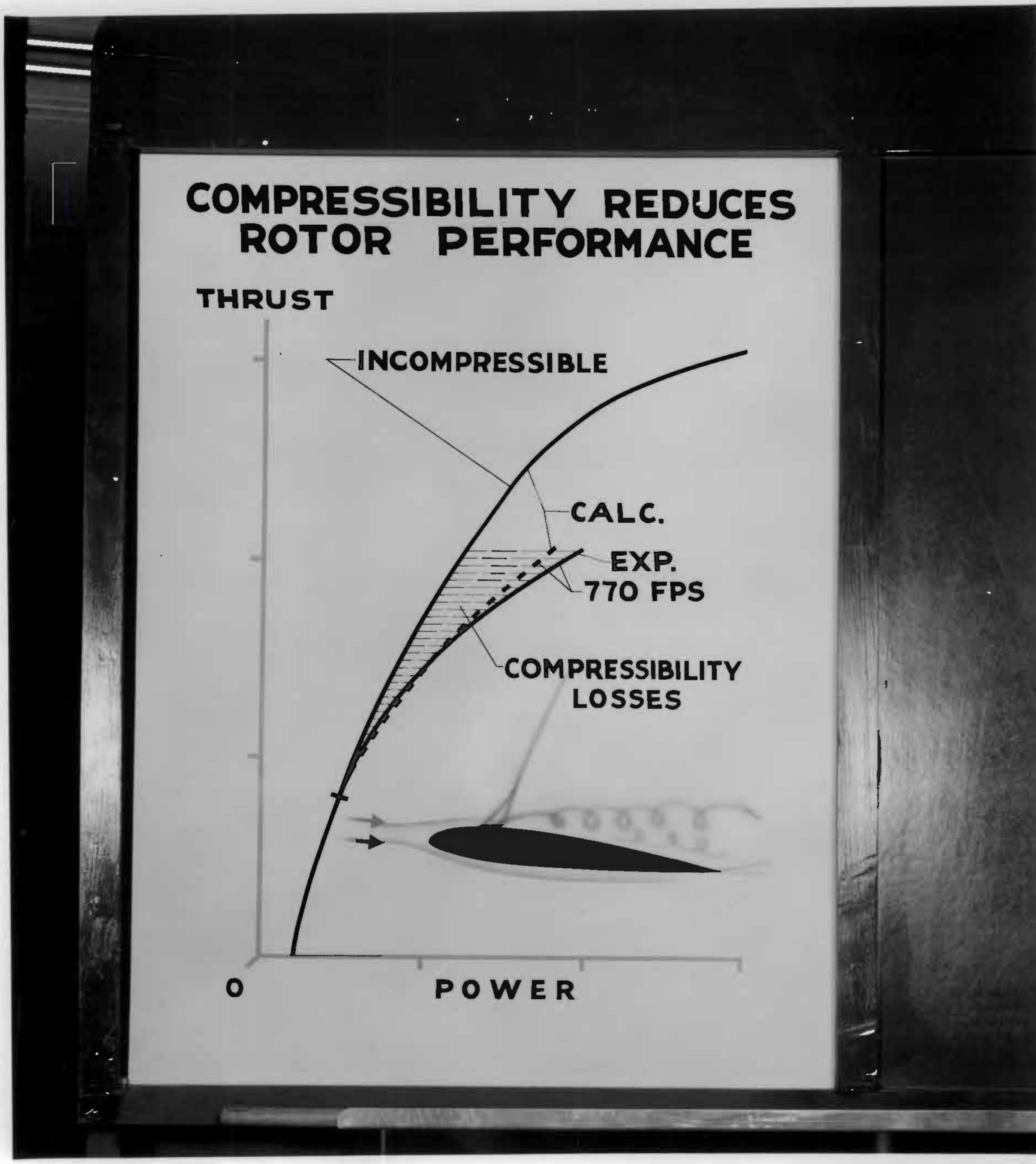
Tests of a hovering rotor operating at high tip speeds have recently been made on the helicopter test tower. Some of the results are given on this chart as a plot of rotor thrust or lift versus rotor input power. The top solid line represents a calculated rotor performance curve without compressibility effects and we have experimental data that show good agreement with this curve when no compressibility losses are present. The experimental results are shown by the second solid line which is for a rotor operating at 770 feet per second tip speed.

Above a certain thrust or blade pitch setting, effects of compressibility on blade drag cause a progressive increase in the power required to drive the rotor. This dashed curve represents the calculated rotor performance at a tip speed of 770 feet per second when compressibility effects are accounted for by using airfoil section data at the proper Mach number and angle of attack. This comparison is significant in that it is shown that wind tunnel tests of a stationery airfoil can be used to correctly predict the performance of a whirling rotor blade. This agreement leads to the belief that airfoil section data can be used in predicting the characteristics of other rotors, particularly the gains which may be expected from blades utilizing thinner airfoils than the 15-percent thick section used in this investigation.

The use of relatively light but powerful jet engines attached to the rotor blade tips for propulsion is currently being studied on the test tower. Both ram-jet and pulse-jet types, similar to these units here, are included. These simple power plants, even with their higher fuel consumption, permit a helicopter to carry larger payloads for short durations than a helicopter equipped with a conventional aircraft engine.

One of the problems with jet-powered rotors is the high rate of power-off descent due to the drag of the jet unit. This tip jet unit moving at a higher velocity than the inboard sections of the blades requires nearly as much power to overcome its drag as to support the helicopter. This is indicated on this chart (chart 2) which shows the descent speed plotted against forward speed for a rotor with and without these ram-jet units. The minimum descent speed is increased about 80 percent by the presence of these jet units. The test tower has been used to investigate various means of reducing this jet drag. As an example, this middle curve shows that completely blocking off the internal flow decreased the drag of the jet unit to such an extent that nearly half of the increase in the minimum rate of descent was gained back. Further studies to reduce the drag and to generally improve the performance of jet powered rotors are underway.

Your next speaker, Mr. ______________ will now tell you about some of the helicopter stability work being conducted by the flight research division.



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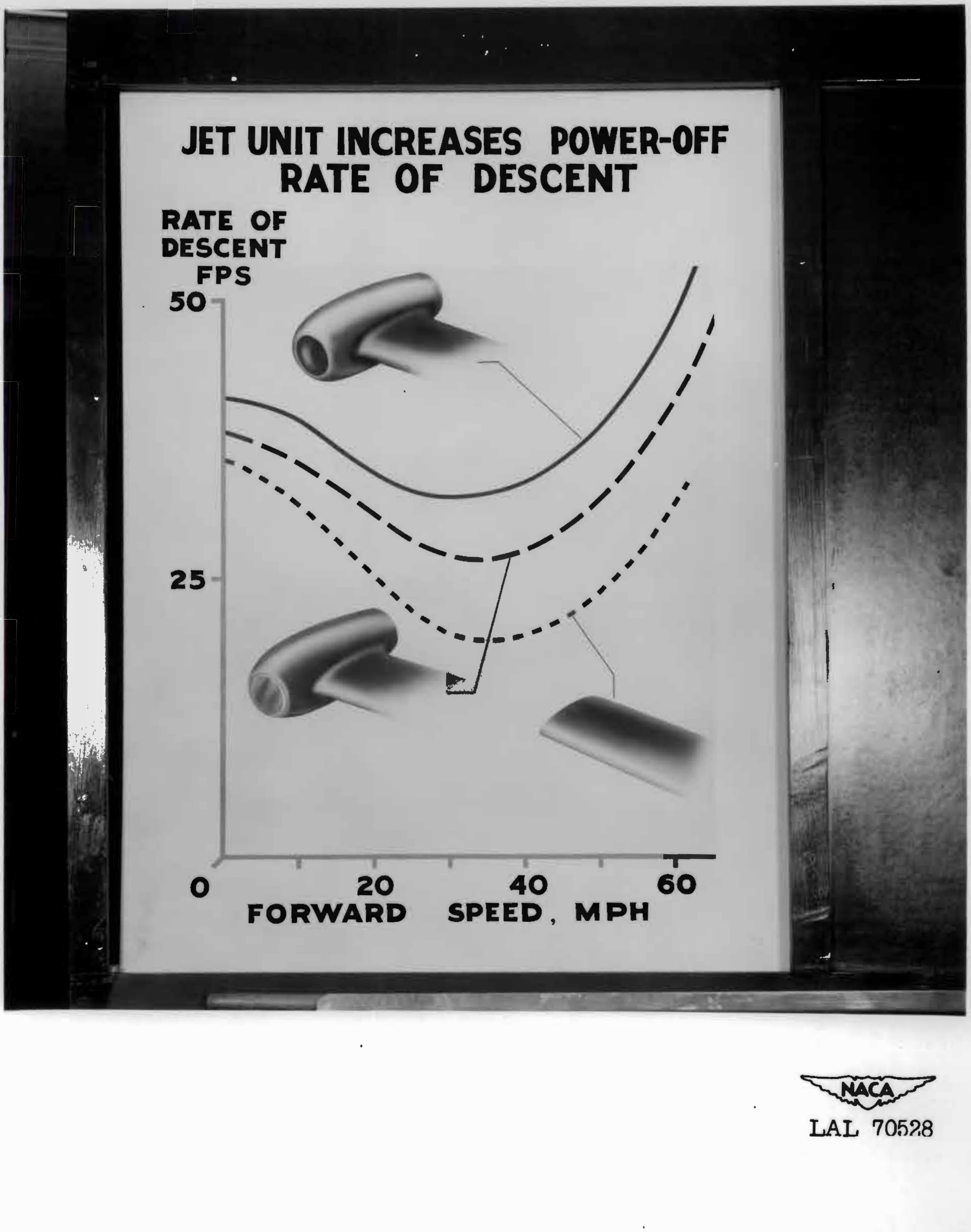

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Speech and Commentary Given with the Films from Muroc
High Speed Flight Research Station

Speaker - Robert A. Champine
Alternate Speaker - William L. Alford

Introductory Remarks

At Muroc, California, the NACA is engaged in a cooperative program of flight research with the Air Force, Navy and airplane manufacturers. In the movie that follows you will see some of the aircraft and operations being conducted by our personnel. These films show the actual operation of the various airplanes. You are reminded that these airplanes are highly instrumented for investigations of stability and control, performance and load distribution in the transonic and supersonic flight range. This picture gives some indication of the large amount of instrumentation that is carried in each of these airplanes.

X-1

Here we see the X-1. Pre-flight attention is being given. The airplane is being backed down into the loading pit to facilitate loading in the B-50 mother plane. The rocket motor is noticeable in the rear of the fuselage. To study airflow conditions, wool tufts have been placed on the fuselage and rudder. Your attention is directed to the instrument door on the fuselage above the wing. The B-50 is positioned over the X-1 and hoisting slings are used to raise it into place. The airplane is equipped with internal recording instrumentation. The airspeed, altitude, control positions and forces, accelerations, angle of pitch and yaw, are but a few of the quantities derived from the records.

The front of the X-1 is being pulled down to clear the nose wheel door. The mother airplane is now in proper position for raising the X-1 into its bomb bay. Hoisting slings are attached to the winches in the bomb bays of the B-50. These slings are then carefully placed under the fuselage fore and aft for necessary balance while lifting the research airplane. It is now in proper position to engage the bomb shackle, and the slings are removed. After the landing gear is raised and inspected, the airplane is ready to be loaded with propellants. Alcohol and liquid oxygen are the main fuels while nitrogen is used to force these propellants into the engine.

These are the storage tanks for the liquid oxygen and nitrogen. The large tank on the left contains the liquid oxygen. The smaller spherical tank on the right is the nitrogen container and it is connected directly to an evaporator which converts the liquid nitrogen to a gas at high pressure. The yellow trailer contains the alcohol which is pumped into the X-1. Next the liquid oxygen and high pressure nitrogen are fed into the airplane. The complete fueling operation takes about 45 minutes. During this same period final checks of the instrumentation are made and the B-50 is then moved to the ramp for starting engines.

A short briefing between the pilots of the X-1, B-50, and chase airplane is held just before take-off. After the pilots and crew have boarded the B-50 the engines are started for take-off. The ground clearance between the X-1 and the runway is approximately 9 inches which is sufficient for take-off and landing. The B-50 has been stripped down and even with the X-1 in its bomb bay, it has good take-off and climb performance. For reasons of personal safety the X-1 pilot is now riding in the B-50. After climbing to approximately 8000 feet he is lowered by elevator to the level of the X-1 cockpit. After entering, the door is closed and the pilot goes over his pre-drop check-off list. In flight the X-1 can easily be seen under the B-50. All the research airplanes are painted white. This gives an excellent color contrast with the dark blue sky, which facilitates visual tracking from the ground. The wing span is 28 feet and fuselage length is 32 feet. The rocket engine delivers approximately 6000 pounds of thrust. The short vapor trail that will soon appear behind the X-1 is the final check of the propellant jettison valves. At full weight the wing loading is 100 pounds per square foot.

The drop is made without rocket power at an indicated airspeed of 260 mph and approximately 25,000 feet. Three or four seconds after drop the rocket motor is started and the airplane is climbed to test altitude.

This is the operations jeep which is in radio contact with the X-1 pilot. Simultaneously with the instruments in the airplane, data is also recorded by the radar and telemeter station.

While the rocket motor is on, the products of combustion produce a vapor trail that is quite visible. The rocket motor will run full power for only about 3 minutes due to its high utilization of fuel.

The remaining is glide flight, which lasts about 15 minutes.

Wing load during landing is 55 pounds per square foot. The landing is made on the lake at approximately 135 mph.

The airplane rolls about a mile and a half before it comes to a stop.

Preparation is now being made to return the X-1 to the hangar.

This complete operation requires about 15 men in the air and 10 on the ground to gather information and lend assistance.

D-558

This airplane is the D-558, Phase II, which is powered with a J-34 jet engine and a 4-cylinder rocket motor. It is being towed in an especially built trailer that contains facilities for pre- and post-flight engine check out. The rocket propellants are alcohol and liquid oxygen which are fed to the motors by a hydrogen peroxide pump.

This shot will show an igniter check. The small dots that will glow in the center of the cylinders are the spark plugs and the igniters that start the rocket motors when fuel is present.

The use of 90% hydrogen peroxide makes it necessary for the loading crews to wear plastic clothes and take special precautions. The ground, in the area of the airplane and the trailer, is kept flooded to dilute any hydrogen peroxide which might be spilled. It is a very dangerous solution in concentrated form. If any of the workmen are exposed to the hydrogen peroxide, they step under this shower that is on the trailer.

The smoke coming from the end of the plane is gaseous oxygen which must be bled off to insure that liquid oxygen is present in the lines at the rocket motor. Instrument technicians are making their pre-flight checks.

This shot shows the rocket engine being started for ground check run. Each of the 4 cylinders are fired, and the intense heat and shock waves are noticeable in the rocket blast.

After loading alcohol and liquid oxygen, the airplane is ready for flight. The wing span is 25 feet, the length 53, and take-off gross weight 12,000 pounds. 35 degrees of sweep back are used on the wing and tail. Speed brakes are extended to slow the airplane down so the landing gear can be lowered.

An orange flare is set off to indicate the wind direction. The drift during landing must be kept to a minimum to reduce tire wear. The landing speed is approximately 160 mph, and 2 or 3 miles of runway is required to stop the airplane.

X-4

The next research airplane we will see is the X-4, a flying wing used to study stability and control problems associated with this type aircraft. The dive brakes are being checked for operation. The plane is powered with two conventional jet engines that are in the wing fuselage junction.

The F-86 in the background is the chase airplane taxiing out with the X-4. Both airplanes will take off from the runway. The wing span of the X-4 is 25 feet and the gross weight is about 6000 pounds.

This scene shows the speed brakes opening in flight. The landing is made on the runway as the landing speed is comparatively slow.

This view shows the speed brakes opened after landing.

The NACA is currently operating these 4 types of aircraft at Muroc -- D-558, Phase II, the X-4, the X-1 and D-558, Phase I.

Concluding Remarks

Our operations at Muroc have now been under way since early 1947. During that time there has been considerable exploration of the transonic and supersonic flight ranges. It has been a very productive source for design information on aircraft loads and general aerodynamic characteristics in the transonic and supersonic speed ranges and has been the major source of information on the dynamics of piloted aircraft at high speed.

COPY FOR LEWIS

64892

116.2-64

Langley Field, Va.
June 28, 1951

From Langley
To NACA
Ames
Lewis

Subject: Transmittal of material presented at 1951 Biennial Inspection at Langley

1. There is transmitted herewith, for your information and file, a copy of the material presented at the 1951 Biennial Inspection held at the Langley Laboratory May 18 - 25, 1951. This material consists of 14 folders containing presentations at the stops indicated on the attached list.

H. J. E. Reid
Director

R.
Enc# 14 folders

FLT

WMH Hunter

ACTION COPY

NACA - Langley

1951 BIENNIAL INSPECTION

May 18 - 25, 1951

14 folders containing material presented at following stops:

BASE THEATRE

FULL-SCALE TUNNEL

FLIGHT RESEARCH LABORATORY

VIBRATION AND FLUTTER LABORATORY

11-INCH HYPERSONIC TUNNEL

PILOTLESS AIRCRAFT RESEARCH DIVISION

INTERNAL AERODYNAMICS LABORATORY

LOADS CALIBRATION LABORATORY

GUST TUNNEL

7- BY 10-FOOT WIND TUNNELS

4- BY 4-FOOT SUPERSONIC PRESSURE TUNNEL

16-FOOT HIGH-SPEED TUNNEL

STRUCTURES RESEARCH LABORATORY

INSTRUMENT RESEARCH (on display in Activities Building at luncheon)

LANGLEY AERONAUTICAL LABORATORY
LANGLEY FIELD, VA.

AMES AERONAUTICAL LABORATORY
MOFFETT FIELD, CALIF.

LEWIS FLIGHT PROPULSION LABORATORY
CLEVELAND AIRPORT, CLEVELAND 11, OHIO

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS
1724 F STREET, NORTHWEST
WASHINGTON 25, D. C.

60692

TELEPHONE: LIBERTY 5-6700

116.2-64

May 8, 1951

DIRECTOR
Exec Off
Eng Plan
P & M
RES
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F & C
C.& T
M & T
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Physics
S-P
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C & CA
Serv Sch
Saf & Sec
Mech Eng
Draft
Elec Eng
Fab
Mech Serv
Mech Oper
Contr Adm
Fac Eng
Plant Oper
Elec Oper

Dr. Edward R. Sharp
Director
Lewis Flight Propulsion Laboratory
National Advisory Committee for
Aeronautics
Cleveland Airport
Cleveland, Ohio

Dear Doctor Sharp:

With regard to your letters of May 3, 1951, requesting that invitations to the 1951 Biennial Inspection of the Langley Laboratory be sent to Messrs. A. J. Hoyt and H. F. Powders of the American Steel and Wire Company and Mr. Allen Oviatt of Gardner Displays, the invitations were mailed on May 7, inviting them for the May 22 Inspection, since that is the day when we can best accommodate them.

Sincerely yours,

EEMiller
for J. F. Victory
Executive Secretary

Files
F

B16767

May 3, 1951. 116.2-64

Dr. J. F. Victory, Executive Secretary,
National Advisory Committee for Aeronautics,
1724 F Street, Northwest,
Washington 25, D. C.

Dear Dr. Victory:

Mr. Howard F. Powders is Aviation Representative with the American Steel & Wire Company here in Cleveland and he is the man who makes all their aviation contacts. He was a Navy officer during World War II and since the end of the war he has been not only very friendly to the NACA but very helpful to the Lewis Laboratory. He succeeded Charlie Meyers who had the job previously and who has attended NACA inspections for many years and he also has been invited this year. I would appreciate it if you would send Mr. Powders a personal invitation right away to attend the Langley inspection.

At the same time, would you send an invitation to Mr. A. J. Hoyt, Manager of Operations, Cleveland District, American Steel & Wire Company. Both Mr. Powders and Mr. Hoyt can be reached at the offices of the American Steel and Wire Company, Rockefeller Building, Cleveland, Ohio.

Sincerely yours,

Edward R. Sharp

Edward R. Sharp,
Director.

B13980

Cleveland, Ohio. 116.r-64

MAR 14 1950

From Lewis
To Langley Attention: Frank Muni.

Subject: Langley Inspection.

1. Walt Bonney and I have been talking about your inspection and agree that we both are determined to make it. Walt thinks there will be a boat trip from Washington to Wallops Island to arrive on the 17th and what I am going to try to do is get hold of Max Cook and get him to drive us down to Washington in his 15 ft. long Buick and take the boat to Wallops and come back via Washington and the Buick. Will let you know how our plans work out.

2. As to the last paragraph of your note, I hate to admit it but there is not a single copy of the 1949 releases inside this building, however, copies of all releases are contained in the big 1949 Inspection Brochure which I sent you a month or so ago. If you can get this back into your possession you can have copies made of any and all released.

S/
Walter C. Orr,
Aviation Information Specialist.

WCO:jmc

cc Files
WCOrr

61061

May 10, 1951

116.2-64

Colonel James W. Freeman
Commanding Officer
Ravenna Arsenal
Ravenna, Ohio

DIRECTOR
Exec Off
Eng Plan
P & M
RES
Edit
Lib
P & C
C & T
M & T
E-H
Physics
S-P
Res Rpt
ADM
Class Off
Pers
Fiscal
Adm. Serv
Proc
SERV
C & CA
Serv Sch
Saf & Sec
Mech Eng
Draft
Elec Eng
Fab
Mech Serv
Mech
Contr
Fac
Plant
Elec

Dear Colonel Freeman:

In sending the enclosed invitation to you and members of your staff to attend the 1951 Biennial Inspection of the Langley Aeronautical Laboratory on Monday, May twenty-first, I wish to add a special note of welcome.

Dr. Sharp has frequently told me of your valuable and sympathetic cooperation as our host and landlord at Ravenna. We are highly gratified at the research results we are obtaining there. Our success is in no small part due to your fine assistance.

I hope you will find it possible to attend the Inspection. It will be a great pleasure to be your host on this occasion.

Sincerely,

J. F. Victory
Executive Secretary

EEM:cn

cc: Dr. Edward R. Sharp

L.A.R.: Mr. Rodert

Files

116.2-64
X124.31
817075

May 9, 1951.

Dr. John F. Victory, Executive Secretary,
National Advisory Committee for Aeronautics,
1724 F Street, Northwest,
Washington 25, D. C.

Dear Dr. Victory:

An oversight of my own has just come to my attention, that is, the matter of inviting Colonel James W. Freeman and members of his immediate staff to attend the Langley inspection. Colonel Freeman, as you may know, is Commanding Officer at Ravenna and is our host and landlord. He has been extremely sympathetic and cooperative.

I would appreciate it if you would get out an invitation to him immediately and also if you could find time to drop him a note to accompany the invitation, telling Colonel Freeman how much we appreciate his invaluable assistance and cooperation. You might also mention that we feel gratified at the results we have obtained thus far at Ravenna in this most promising field of research.

Sincerely yours,

Edward R. Sharp,
Director.

PRESS INVITATIONS FOR INSPECTION

\+ John Adams
U.S. News & World Report
24th and N Streets, N.W.
Washington, D. C.

\+ C. B. Allen
New York Herald Tribune
1255 National Press Building
Washington, D. C.

\+ David Anderton
Engineering
Aviation Week
330 West 42nd Street
New York 18, New York

Edgar Bauman
133 East 36th Street
New York 16, New York

o George Boehm
Science Editor, Newsweek
Broadway & 42nd Street
New York 18, New York

o George Bookman
Time Magazine
Nine Rockefeller Plaza
New York, New York

\+ George Carroll
Aviation Editor
New York Journal American
210 South Street
New York, New York

Richard P. Cooke
Aviation Editor
Wall Street Journal
44 Broad Street
New York 4, New York

\+ Charles Corddry
Aviation Writer
United Press
714 National Press Building
Washington 4, D. C.

\+ Peter Edson
Newspaper Enterprise Association
News Building, Room 300
1013 Thirteenth Street, N.W.
Washington 5, D. C.

\+ Elton C. Fay
Military Writer
Associated Press
Washington Star Building
Washington, D. C.

\+ Fred Graham
Aviation Editor
The New York Times
229 West 43rd Street
New York 18, New York

George E. Haddaway, Editor
Flight
P. O. Box 750
Dallas 1, Texas

\+ James J. Haggerty, Jr.
American Aviation
1025 Vermont Avenue, N.W.
Washington, D. C.

\+ Fred Hamlin
Aircraft Yearbook
Rm. 1107, Warner Building
13th and E Streets, N.W.
Washington, D. C.

\+ Accepted
\# Declined
o Substituted - See page 4

67808

Tom Henry
Washington Evening Star
Evening Star Building
Washington 4, D. C.

° Albert D. Hughes
Aviation Editor
Christian Science Monitor
One Norway Street
Boston 15, Mass.

+ * Ben S. Lee
Aviation Editor
Armed Force Magazine
1833 Jefferson Place, N.W.
Washington, D. C.

+ John F. Loosbrock
Air Force Magazine
1424 K Street, N.W.
Washington 5, D. C.

Jim G. Lucas
Scripps-Howard Newspapers
1013 13th Street
Washington, D. C.

+ Robert McLarren
Technical Editor
Aero Digest
1107 Warner Building
Washington 4, D. C.

+ Alexander McSurely
Aviation Week
National Press Building
Room 1174
Washington, D. C.

+ Dr. Arthur C. Monahan
Science Service
1719 N Street, N.W.
Washington 6, D. C.

Frederick R. Neely
104 West Bellefonte Avenue
Alexandria, Va.

John G. Norris
The Washington Post
1515 L Street, N.W.
Washington 4, D. C.

Wayne W. Parrish
American Aviation Publications
1025 Vermont Avenue, N.W.
Washington 5, D. C.

+ * William Perrault
American Aviation
1025 Vermont Avenue, N.W.
Washington, D. C.

Wesley Price
The Saturday Evening Post
R. D. 3
Doylestown, Pennsylvania

Arthur Riley
Aviation Editor
The Boston Globe
Boston 7, Mass.

Robert B. Sibley
Aviation Editor
The Boston Traveler
80 Mason Street
Boston 12, Mass.

+ Accepted
# Declined
° Substituted - See p. 4
* Sent regular printed invitation and not special press letter.

67808

\# Duke Ramsey
U. S. News & World Report
24th and N Streets, N.W.
Washington, D. C.

\+ Lt. Commander A. L. Schoeni
Naval Aviation News
Room 4D356
Department of Defense
Washington, D. C.

\+ William Shippen
Aviation Editor
Washington Evening Star
Evening Star Building
Washington 4, D. C.

\+ W. A. Shrader
Aeronautical Engineering Review
Two East 64th Street
New York 21 New York

\# James J. Strebig
Aviation Editor
Associated Press
Evening Star Building
Washington 4, D. C.

\# Ansel E. Talbert
New York Herald Tribune
230 West 41st Street
New York 18, New York

\# Bliss K. Thorne
New York Times
229 West 43rd Street
New York 18, New York

\# Kenneth Weiss
International News Service
1317 H Street
Washington, D. C.

\# Gill Robb Wilson
New York Herald Tribune
230 West 41st Street
New York 18, New York

\# Robert Wood
Editor
Aviation Week
330 West 42nd Street
New York, New York

\# * Jules B. Billard
Pathfinder
1323 M Street, N.W.
Washington 5, D. C.

\# * Reginald M. Cleveland
The New York Times
229 West 43rd Street
New York 18, New York

\# * John Cramer
Washington Daily News
1013 13th Street, N.W.
Washington, D. C.

\# * Jerry Klutz
Washington Post
1515 L Street, N.W.
Washington, D. C.

\# * Joseph Young
Washington Evening Star
Evening Star Building
Washington 4, D. C.

\+ Hugh Harvey
Aviation Department
Shell Oil Company, Inc.
50 West 50th Street
New York, New York

* Sent regular printed invitation and not special press letter.
\+ Accepted
\# Declined

Substitutions:

\+ A. T. Hadley for George Boehm
Newsweek
Broadway & 42nd Street
New York 18, New York

67808

\+ Henry Luce III for George Bookman
Time Magazine
Nine Rockefeller Plaza
New York, New York

\+ Harlan Trott for Albert D. Hughes
Christian Science Monitor
One Norway Street
Boston 15, Mass.

Attended Langley Inspection - but not invited by invitation or letter.

Art Clawson
Aero Digest
Room 1107, Warner Building
Washington, D. C.

William Kerwin, INS
1317 H Street, N.W.
Washington, D. C.

Max Karant
Aircraft Owners & Pilots Assn.
Washington Building
15th and New York Ave., N.W.
Washington, D. C.

Elmer Thompson
Air Transport Assn. of America
1107 16th Street, N.W.
Washington, D. C.

John Vandergrift
Bureau of Naval Personnel
All Hands Magazine
Navy Department
Washington, D. C.

Dr. Victory has requested that Mr. Louis R. Ruppel, Editor, Colliers Magazine, be invited to the 1951 Lewis Inspection.

Langley Field, Virginia
~~Langley Air Force Base, Va.~~
Date May 29, 1951

62203

116.x-64

From Langley
To NACA Lewis

Subject: Transmittal of guest lists for 1951 Biennial Inspection

Reference:

Please take the action indicated below:

A Advise status.
x B For your information, proper action, and files.
C For reply by your office.
D Forward (on loan) (for our files).
x E There (is) (are) transmitted herewith the following:
F Hold for further information.
G Copy of this letter enclosed with shipment.
H Advise whether order will be placed soon.
I Billing received. Submit purchase request and/or advise status.
J Information received indicates material shipped ___________. Advise if received and accepted.
K Two (2) copies of subject addendum. Copies forwarded all bidders.

DIRECTOR
Exec Off
Eng Plan
P & M
RES
Edit
Lib
F & C
C & T
M & T
E-R
Physics
S-P
Res Rpt
ADM
Clear Off
Pers
Fiscal
Adm. Serv
Proc
SERV
C & CA
Serv Sch
Saf & Sec
Mech Eng
Draft
Elec Eng

Remarks:

Guest lists for 1951 Biennial Inspection at the Langley Laboratory - May 21, 24, and 25, 1951.

W. Kemble Johnson
W. Kemble Johnson
Administrative Management Officer

JOO.gfd

Enclosure:
1. 3 guest lists 1195

NACA - Langley

PROGRAM

THE 1951 BIENNIAL INSPECTION OF THE NACA LABORATORIES

at

Langley Aeronautical Laboratory
Langley Field, Virginia

May 22, 1951 (Eastern Daylight Time)

8:50 a.m.	OPENING SESSION IN BASE THEATER, LANGLEY FIELD
9:20 a.m.	Leave Base Theater
9:28 a.m.	Full-Scale Tunnel
9:50 a.m.	Inspection of Laboratory in eight groups: red, white, blue, green, gold, brown, tan, gray
10:25 a.m.	(**) denotes 10-minute intermission for all groups
12:20 p.m.	Lunch for all groups at NACA Activities Building. (*) denotes exhibit from which group proceeds to lunch
1:40 p.m.	Resume inspection of Laboratory
2:55 p.m.	(**) denotes 10-minute intermission for all groups

	Red	White	Blue	Green	Gold	Brown	Tan	Gray
Flight Research Laboratory	Start 10:05 **11:00	Start 10:05 **11:00	4:00 4:45	2:35 **3:30	1:45 2:30	1:45 2:30	11:30 12:15*	11:30 12:15*
Vibration and Flutter Laboratory	11:05 11:25	4:25 4:45	Start 10:05 **10:35	3:35 3:55	3:10 3:30	2:35 **3:05	2:10 2:30	1:45 2:05
11-Inch Hypersonic Tunnel	11:30 11:50	11:05 11:25	10:40 11:00	4:00 4:20	3:35 3:55	3:10 3:30	2:35 **3:05	2:10 2:30
Pilotless Aircraft Research Division	11:55 12:15*	11:30 11:50	11:05 11:25	Start 10:05 **10:35	4:00 4:20	3:35 3:55	3:10 3:30	2:35 **3:05
Internal Aerodynamics Laboratory	1:45 2:05	11:55 12:15*	11:30 11:50	10:40 11:00	4:25 4:45	4:00 4:20	3:35 3:55	3:10 3:30
Loads Calibration Laboratory	2:10 2:30	1:45 2:05	11:55 12:15*	11:05 11:25	Start 10:05 **10:35	4:25 4:45	4:00 4:20	3:35 3:55
Gust Tunnel	2:35 **3:05	2:10 2:30	1:45 2:05	11:30 11:50	10:40 11:00	Start 10:05 **10:35	4:25 4:45	4:00 4:20
7- by 10-Foot Wind Tunnels	3:10 3:30	2:35 **3:05	2:10 2:30	11:55 12:15*	11:05 11:25	10:40 11:00	Start 10:05 **10:35	4:25 4:40
4- by 4-Foot Supersonic Pressure Tunnel	3:35 3:55	3:10 3:30	2:35 **3:05	4:25 4:45	11:30 11:50	11:05 11:25	10:40 11:00	Start 10:05 **10:35
16-Foot High-Speed Tunnel	4:00 4:20	3:35 3:55	3:10 3:30	1:45 2:05	11:55 12:15*	11:30 11:50	11:05 11:25	10:40 11:00
Structures Research Laboratory	4:25 4:45	4:00 4:20	3:35 3:55	2:10 2:30	2:35 **3:05	11:55 12:15*	1:45 2:05	11:05 11:25

4:45 p.m. After the last place of visit, busses will return to Activities Building

NACA-Langley - 5-16-51 - 600