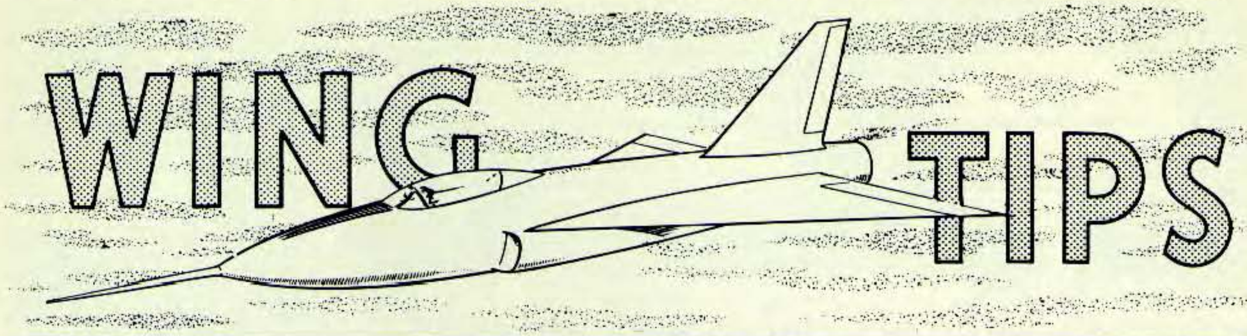
NACA LEWIS FLIGHT PROPULSION LABORATORY



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EXCERPTS FROM CONGRESSIONAL RECORD - HOUSE, APRIL 11, 1957

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS CONSTRUCTION PROGRAM

Mr. DURHAM, Mr. Speaker, I move that the House resolve itself into the Committee of the Whole House on the State of the Union for the consideration of the bill (H.R. 3377) to promote the national defense by authorizing the construction of aeronautical research facilities and the acquisition of land by the National Advisory Committee for Aeronautics necessary to the effective prosecution of aeronautical research.

The motion was agreed to. . . . .

(Mr. Durham continues). The Committee on Armed Services has, after hearings and due consideration, unanimously reported H. R. 3377, the bill before us. It is an important bill in that it calls for the authorization of $44,700,000 for the construction of new research facilities, and the modernization of existing equipment at laboratories of the National Advisory Committee for Aeronautics.

But aeronautical research is never finished. Every major discovery or break-through by NACA merely opens a new frontier that must be explored and breeds a new family of problems that must be solved if we are to be second to none in aeronautics. I need not, I am sure, belabor the importance of our superiority in the air and today it is more important than ever that NACA should be authorized the tools necessary to simulate the fantastic environment encountered and the forces generated by ever greater high-speed flight. This sound investment in security will enable the American people to continue to look toward NACA with confidence on its continuing aggressive and skillful attack on the aeronautical problems of the future. . . . . . .

To advance the frontiers of speed, altitude, and range, special research facilities are required. H. R. 3377 reflects NACA's need for additional facilities for research in the hypersonic speed range and the continuing need for modernizing existing facilities for the solution of new problems in all speed ranges.

The sum of $44,700,000 will be primarily used for additional research facilities in the hypersonic speed range and for the modernization of existing facilities, as follows:

New facilities for hypersonic research $20,965,000
Expansion for facilities for nuclear research $5,655,000
Expansion and modernization of research facilities 10,936,400
Expansion and modernization of supporting facilities 6,485,200
General plant and utility improvements 657,900

In the report of the committee there is a full breakdown of all these items, but I should like to summarize the new facilities for hypersonic research included in this program for a fuller understanding of this bill and why I consider it so vital in these days when our national security depends on airplanes and missiles of superior performance to those of any potential adversary.

Research at hypersonic speeds, that is, in excess of five times the speed of sound, is relatively new. The reproduction of the conditions of high speed and temperature experienced in hypersonic flight is necessary for the development of ballistic missiles and satellite vehicles. . . . .

(Continued on page 3)

EXCERPTS FROM CONGRESSIONAL RECORD

(Continued from page 1)

So that the control on the consumption of fuel and getting the whole thing burned in the exact amount of time is a tremendously difficult technical problem. If we are going after really high accuracy in ballistic missiles, we have to solve problems of a difficulty that has not been experienced so far.

Pumps for rocket propellants must operate under severe conditions, such as with surging inlet pressure due to boiling of the fluids being handled. Turbines and their gas generators for driving the pumps must be adapted to use the same propellants as the main rocket combustion chamber to avoid the need for separate tanks and flow systems. The proposed facility will then be equipped to handle inert fluids such as water and liquid nitrogen for research on flow fundamentals, as well as liquid rocket propellants.

The design of the bearings and seals used in the liquefied gas pumps require studies in a new field involving unfamiliar phenomena that have not been significant in usual bearing applications. Among these phenomena are extreme dangers from leaks in bearings and seals, handling fluids hostile to lubricants and lubrication, and lubrication at temperatures as low as that of boiling hydrogen, -424° F.

This will be accomplished by the Rocket Systems Research Facility project at the Lewis Flight Propulsion Laboratory which proposes the construction of two new buildings and the alteration of an existing building at a cost of $5,700,000.

In the sum of appropriations, we have invested in NACA some $325 million. Reproduction cost is probably closer to $500 million. As many of you know, it is a very complex plant. It includes motors that produce up to 250,000 horsepower in a single tunnel, air-drying equipment, heating equipment, and all of the mechanical devices necessary to do research in this complex technological field. It takes a certain sum to keep things current with the advances in the art.

It is proposed to expand the existing propulsion systems facility at the Lewis Laboratory by the installation of facilities to investigate the performances of engines up to 4-1/2 times the speed of sound. These facilities will also permit the more extensive use of high-energy fuels in large full-scale engine tests.

Through the years we have given NACA the funds to continually keep the capacity of the propulsion systems laboratory in step with developments in the size and speed of engines. This project will keep the propulsion system laboratory capable of meeting the problems of the engines that are now being designed. . . . .

The research results of NACA are the foundation for the military, civil, and industrial development of superior aircraft and missiles. The rate at which NACA is able to attack and solve fundamental scientific problems limits the rate of progress in the development of aircraft and missiles in the United States. A strong NACA is essential to our national security.

The CHAIRMAN. Under the rule the Committee rises.

Accordingly the Committee rose; and the Speaker having resumed the chair, Mr. HERLONG, Chairman of the Committee of the Whole House on the State of the Union, reported that the Committee having had under consideration the bill H. R. 3377, to promote the national defense by authorizing the construction of aeronautical research facilities and the acquisition of land by the National Advisory Committee for Aeronautics necessary to the effective prosecution of aeronautical research, pursuant to House Resolution 224, he reported the same back to the House with sundry amendments adopted by the Committee of the Whole.

The SPEAKER. Under the rule the previous question is ordered.

The question is on the engrossment and third reading of the bill.

The bill was ordered to be engrossed and read a third time, and was read the third time.

The SPEAKER. The question is on the passage of the bill.

The bill was passed.

85TH CONGRESS } HOUSE OF REPRESENTATIVES { REPORT
1st Session } { No. 209

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS CONSTRUCTION PROGRAM

MARCH 19, 1957.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

Mr. DURHAM, from the Committee on Armed Services, submitted the following

REPORT

[To accompany H. R. 3377]

The Committee on Armed Services, to whom was referred the bill (H. R. 3377) to promote the national defense by authorizing the construction of aeronautical research facilities and the acquisition of land by the National Advisory Committee for Aeronautics necessary to the effective prosecution of aeronautical research, having considered the same, report favorably thereon without amendment and recommend that the bill do pass.

PURPOSE OF THE BILL

The purpose of this bill is to authorize construction, installation of equipment, and the acquisition of land at installations of the National Advisory Committee for Aeronautics.

BACKGROUND OF NACA

In view of the importance of the National Advisory Committee for Aeronautics in the basic research which leads to the ultimate development of our military airpower, the committee feels that it would be helpful and informative to describe briefly what the NACA is and the manner in which it functions. There is set out below, therefore, an excerpt from the 42d Annual Report of the NACA.

> During the 41 years since the Congress founded it as an independent Federal agency, the National Advisory Committee for Aeronautics has sought to assess the current stage of development of aircraft, both civil and military; to anticipate the research needs of aeronautics; to build the

scientific staff and unique research facilities required for these research needs; and to acquire the needed new knowledge as rapidly as the national interest requires.

By discharging its primary responsibility—scientific laboratory research in aeeronautics—the NACA serves the needs of all departments of the Government. The President appoints the 17 unpaid members of the Committee, who report directly to him. They establish policy and plan the research to be carried out by the 7,900 scientists, engineers, and other persons who make up the staff of the agency.

The NACA research programs have both the all-inclusive, long-range objective of acquiring new scientific knowledge essential to assure United States leadership in aeronautics and the immediate goal of solving, as quickly as possible, the most pressing problems. In this way, they effectively support the Nation's current aircraft and missile construction program.

Most of the problems to be studied are assigned to the NACA's research centers. The Langley Aeronautical Laboratory in Virginia works on structural, general aerodynamic, and hydrodynamic problems. The Ames Aeronautical Laboratory in California concentrates on high-speed aerodynamics. The Lewis Flight Propulsion Laboratory in Ohio is a center for powerplant studies. At the high-speed flight station in California special fully instrumented research aircraft probe transonic and supersonic problems in flight. The pilotless aircraft research station at Wallops Island, Va., is a branch of the Langley Laboratory where rocket-powered free-flight models are used to attack aerodynamic problems in the transonic and supersonic speed ranges.

A major task of the NACA since its beginning in 1915 has been coordinating aeronautical research in the United States Through the members of the Committee and its 28 technical subcommittees, the NACA links the military and civil government agencies concerned with flight. The aviation industry, allied industries, and scientific institutions, are also represented.

Assisting the committee in determining and coordinating research programs are 4 major and 24 subordinate technical committees with a total membership of nearly 500. Members are chosen because of technical ability, experience, and recognized leadership in a special field. They also serve without pay, in a personal and professional capacity. They furnish valuable assistance in considering problems related to their technological fields, review research in progress at NACA laboratories and in other establishments, recommend new research to be undertaken, and assist in coordinating research programs.

* * * * *

Research coordination is also accomplished through frequent discussions by NACA scientists with the staffs of research organizations of the aircraft industry, educational and scientific institutions, and other aeronautical agencies. Through a west coast office the NACA maintains close

liaison with aeronautical research and engineering staffs in that important aviation area.

The NACA sponsors and finances a coordinated research program at 33 nonprofit scientific and educational institutions, including the National Bureau of Standards. In this way scientists and engineers whose skills and talents might otherwise not be available contribute importantly to Federal aeronautical research.

During the fiscal year 1956, the following institutions participated in NACA contract research:

National Bureau of Standards
University of Alabama
Battelle Memorial Institute
Polytechnic Institute of Brooklyn
Brown University
California Institute of Technology
University of California
Carnegie Institute of Technology
Case Institute of Technology
University of Cincinnati
Columbia University
Cornell University
Franklin Institute
Forest Products Laboratory
Georgia Institute of Technology
Johns Hopkins University
University of Kentucky
Lightning & Transients Research Institute
Massachusetts Institute of Technology
University of Michigan
University of Minnesota
New York University
University of North Carolina
University of Oklahoma
Purdue University
Syracuse University
University of Washington
University of Wisconsin
Southwest Research Institute
Stanford Research Institute
Stanford University
Stevens Institute of Technology
Yale University

Proposals from such institutions are carefully weighed to assure best use of the limited funds available to the NACA for sponsoring research outside its own facilities. Published research reports of the useful results of this part of the NACA program are distributed as widely as other NACA publications.

During the fiscal year, most of the NACA technical subcommittees reviewed research proposals from outside organizations or gave attention to research reports of completed contracts. There were 43 sponsored-research reports released during fiscal 1956.

Most of NACA's research information is distributed by means of its publications. Technical notes and reports are not classified for military security reasons and are available to the public in general. Translations of important foreign research reports appear as technical memorandums. The NACA also prepares research reports containing classified information. For reasons of national security, these receive carefully controlled circulation. When such information can be declassified, the research reports may be given wider distribution. Current NACA publications are announced in the NACA Research Abstracts.

Every year the NACA holds a number of technical conferences with representatives of the aviation industry, the universities, and the military services present. Attendance at these conferences is restricted because classified material is presented and the subject matter discussed at each conference is focused on a specific field of interest.

Summary, construction and equipment program

Project	Location	Estimated cost
3.5-foot hypersonic tunnel	Ames	$11,731,000
High-speed leg for the unitary plan tunnel	Langley	760,000
Hypersonic physics test area	do	1,987,900
Modifications to the component research facility for nuclear propulsion	Lewis	5,655,000
Data reduction center	Langley	3,067,200
Expansion of the propulsion systems laboratory	Lewis	5,800,000
Modernization of instrumentation	Wallops	2,560,000
Improved air supply for the internal flow laboratory	Langley	858,000
Bypass air system for the unitary plan tunnel	Ames	100,000
Boundary-layer removal for the 14-foot transonic tunnel	do	4,435,000
Flow improvement in the unitary plan tunnel	do	255,000
Land acquisition	Lewis	300,000
Modification of the 26-inch transonic tunnel	Langley	346,400
Central heating system for the east area	do	209,100
Hypersonic helium blowdown tunnel	do	796,600
Rocket systems research facility	Lewis	5,700,000
West area approach road	Langley	148,800
Total, fiscal year 1958 program		44,700,000

There is set out above a summary of the construction and equipment program which permits a quick analysis of what H. R. 3377 contemplates. It is the committee's view, however, that there should be set out a functional summary of this program in order that it may be immediately evident what items fall under the headings of new facilities, expansion of existing facilities, modernization of facilities, and general plant and utility improvements. Such a functional summary is set out immediately below:

Functional summary, construction and equipment program

New facilities for hypersonic research:		
3.5-foot hypersonic tunnel (Ames)	$11, 731, 000	
High-speed leg for the unitary plan tunnel (Langley)	750, 000	
Hypersonic physics test area (Langley)	1, 987, 900	
Hypersonic helium blowdown tunnel (Langley)	796, 600	
Rocket systems research facility (Lewis)	5, 700, 000	
		$20, 965, 500
Expansion of facilities for nuclear research:		
Modifications to the component research facility for nuclear propulsion (Lewis)		5, 655, 000
Modernization of research facilities:		
Expansion of the propulsion systems laboratory (Lewis)	5, 800, 000	
Bypass air system for the unitary plan tunnel (Ames)	100, 000	
Boundary-layer removal for the 14-foot transonic tunnel (Ames)	4, 435, 000	
Flow improvement in the unitary plan tunnel (Ames)	255, 000	
Modification of the 26-inch transonic tunnel (Langley)	346, 400	
		10, 936, 400
Modernization of supporting technical facilities:		
Data reduction center (Langley)	3, 067, 200	
Modernization of instrumentation (Wallops)	2, 560, 000	
Improved air supply for the internal flow laboratory (Langley)	858, 000	
		6, 485, 200
General plant and utility improvements:		
Land acquisition (Lewis)	300, 000	
Central heating system for the east area (Langley)	209, 100	
West area approach road (Langley)	148, 800	
		657, 900
Total, fiscal year 1958 program		44, 700, 000

CHANGED CONCEPTS OF MILITARY POWER

The airplane, the missile, and the atomic fission and fusion bombs have changed concepts of military power and the course of history. The Soviet Union is making a tremendous effort to surpass us; her technology, her scientific manpower, and her stockpile of modern weapons have made great strides. Informed sources believe that the quality of our weapons taken as a whole is ahead, but the gap is rapidly closing.

OUR DEPENDENCE ON AIRPLANES AND MISSILES

Our national security depends on an adequate number of airplanes and missiles of superior performance. Numbers alone are insufficient unless their performance is at least equal to those our skilled airmen may be called upon to oppose. It is the task of the aeronautical laboratories not only to provide the new ideas necessary to insure superior performance, but at the same time to prove in advance the soundness of the design as a whole. The NACA's work, therefore, falls into two principal categories: (1) research to furnish new ideas; and (2) the application of new ideas to current military designs in cooperation with industry.

THE NEED FOR RESEARCH FACILITIES

To advance the frontiers of speed, altitude, and range, special research facilities are required. Until recently the NACA has had insufficient knowledge to reproduce the conditions of high speed and temperature experienced in hypersonic flight. It has had to be content with small scale exploration of many ideas and it knows now how to proceed with pilot facilities and in some cases with larger facilities which give results immediately applicable in design.

H. R. 3377 reflects NACA's urgent need for additional facilities for research in the hypersonic speed range, and the continuing need for modernizing existing facilities for the solution of new problems in the subsonic, transonic, and supersonic speed ranges.

DEFINITION OF TECHNICAL TERMS

The activities of the NACA are in great part carried on in a field somewhat foreign to the layman. Many of the terms which are used in the description of their operations and in the text of this report are not such as are used in the everyday parlance. For a full understanding of the projects contemplated by H. R. 3377, the committee feels that it would be helpful if some of the more technical terms were defined. It, therefore, has inserted in the report a glossary of terms which it hopes will make for greater understanding of the important work performed by the NACA. The glossary will be found immediately following the construction justification.

JUSTIFICATION FOR CONSTRUCTION PROJECTS

3.5-foot hypersonic tunnel

The construction of a 3.5-foot hypersonic tunnel at the Ames Aeronautical Laboratory is proposed to investigate the aerodynamics of aircraft capable of steady level flight at hypersonic speeds. The proposed facility will be capable of duplicating flight Reynolds numbers at Mach numbers from 5 to 10, and flight temperatures at flight Reynolds numbers at a Mach number of 5. The tunnel will accommodate models large enough to permit the scaled duplication of aircraft structural components so that detailed studies can be made of aerodynamic heating on the aerodynamic characteristics of hypersonic aircraft as they occur in flight.

Aerodynamic heating

Aerodynamic heating is one of the foremost problems encountered in flight at hypersonic speeds. The success or failure of a hypersonic aircraft may well depend on how it reacts to the temperatures and heating rates encountered in flight. At present, the design of such vehicles would have to proceed without detailed knowledge of their aerodynamic characteristics since much of the needed design information is not available. This proposed tunnel is designed to provide detailed and integrated studies of all required aerodynamic characteristics under conditions comparable to those that would be encountered in flight. The tunnel will duplicate flight Reynolds numbers and flight air temperatures so that the details of convective heat-transfer to a vehicle may be studied under conditions corresponding to those that would be encountered in flight. Since the nozzle walls of this facility remain cool, the heat radiation from the model surface will approximate that experienced by an aircraft at hypersonic speeds and the counterbalancing effects of convective and radiative heat transfer can be observed as they would occur in flight.

The proposed tunnel will also be used to study the overall aspects of convective heating for a complete configuration. In this connection, an analysis has been made which demonstrates that a wind tunnel can simulate the heating histories of vehicles in level flight in essentially the same manner that the atmospheric-entry simulator reproduces the heating histories of ballistic-type vehicles. The simulation requires that flight Mach numbers, stream temperatures, and Reynolds numbers be duplicated, and that the essential components of a vehicle be reproduced in scale. The committee wishes to point out the strikingly dramatic function of this tunnel by stating that testimony received by the committee indicated that a one-tenth scale model tested in the wind tunnel for 1 minute would simulate the heating experienced by a full-scale vehicle in a flight at a Mach number of 5 over a distance of about 6,000 miles.

Summary

In summary, the designer of hypersonic aircraft is confronted with difficult problems in the fields of aerodynamic heating, stability, control, and performance which can be solved only with the aid of detailed and accurate data from tests which duplicate actual flight conditions. Much of the required data could be obtained in the proposed tunnel. The facility will provide test Mach numbers of 5, 7, and 10, and at each of these Mach numbers typical flight Reynolds numbers will be duplicated. The duplication will be adequate for the study of many hypersonic design problems, particularly those of performance and control. The facility will also be capable of operation at stagnation temperatures up to 2,000° F. at all Mach numbers.

HYPERSONIC BLOWDOWN TUNNEL

The second facility proposed for basic hypersonic research is a helium blowdown tunnel. Experimental rocket-propelled vehicles are attaining speeds in excess of those which can be studied in existing experimental facilities.

Earth satellite

The current earth satellite program and military plans for long-range missiles point up the actual need for greater information on phenomena which occur at speeds attainable in outer space. There is no wind tunnel available for testing at Mach numbers much above 10 and the likelihood of an air tunnel achieving Mach numbers much in excess of this appears remote because of the extreme pressures and temperatures required for air.

Helium as test medium

An analysis of the potentialities of helium as a test medium has shown it to be highly suitable for hypersonic research at speeds far above the capabilities of air tunnels. The practicality of a helium tunnel has also been experimentally demonstrated. While helium does not permit exact simulation of flow conditions for air, for purposes of basic fluid mechanics research, the difference is of little consequence.

The proposed hypersonic blowdown tunnel will use helium as a test medium and will be capable of operating at Mach numbers from 10 to 25.

HIGH-SPEED LEG FOR UNITARY PLAN TUNNEL

The project entitled "High-Speed Leg for the Unitary Plan Tunnel" covers construction of two fixed nozzles. The project as now contemplated will cover the Mach number range between 10 and 12.

ROCKET SYSTEMS RESEARCH FACILITY

The rocket systems research facility project at the Lewis Flight Propulsion Laboratory proposes the construction of two new buildings and the alteration of an existing building to provide research stands, cells, and laboratories.

The increasing application of rocket powerplants and the use of new propellants has brought new and pressing problems in controls, pumping, and the interferences caused by close coupling of multiple-engine systems. In long-range ballistic missiles, these problems are greatly accentuated.

Directing the missile

Making sure that the missile is directionally on its proper course is only part of the problem; in addition you have to make sure that the missile is traveling at precisely the right speed when the rocket motor burns out. Otherwise, of course, the target will be overshot or undershot. Single rocket engines, each with thrusts much greater than that of present turbojet engines, must be operated together.

V–2 and ICBM

The rocket motor of the V–2 burned for about 70 seconds. Purely for illustration, let's say the burning time of one concept of an ICBM might be about 3 times that, some 200 seconds. During that time—3⅓ minutes—the fuel and oxidant might be pumped into the combustion chamber at the rate of about a ton a second.

Calculations indicate that if the missile is going to destroy a priority target the rocket motor must operate with a degree of precision which has not been used before in devices of this size or complexity. In 5 minutes a missile must reach an altitude of 500,000 to 1 million feet, traveling at a velocity of 18,000 miles per hour. If the velocity is 18,005 miles per hour, it misses the target by 5 miles. Likewise if 1 percent of the propellant isn't used, the miss may be measured in hundreds of miles.

Pumps for rocket propellants must operate under severe conditions, such as with surging inlet pressure due to boiling of the fluids being handled. Turbines and their gas generators for driving the pumps must be adapted to use the same propellants as the main rocket combustion chamber to avoid the need for separate tanks and flow systems. The proposed facility will be equipped to handle inert fluids such as water and liquid nitrogen for research on flow fundamentals, as well as liquid rocket propellants.

The design of the bearings and seals used in the liquefied gas pumps require studies in a new field involving unfamiliar phenomena that have not been significant in usual bearing applications. Among these phenomena are: Extreme dangers from leaks in bearings and seals; handling fluids hostile to lubricants and lubrication; and lubrication at temperatures of boiling hydrogen (−424° F.).

This proposed new facility will make possible research on these and many other rocket problems. Turbopump research will be directed at providing pumps and turbines that are operable with boiling and corrosive fluids, that deliver large flow rates and high pressures, that have suitable suction characteristics, and that have maximum efficiencies and minimum size and weight. Controls research will have the objectives of accurately controlling the rocket thrust-time relationship, accurately monitoring propellant consumption, obtaining desired fluid flow-pressure-time sequence in the turbopump, and providing a reliable system that operates smoothly, without pulsation, vibration damage, or malfunctioning. Bearing and seal research will be directed at developing bearings and seals which will operate satisfactorily and reliably in corrosive and low viscosity fluids, and at very high as well as at very low temperatures.

HYPERSONIC PHYSICS TEST AREA

Research on materials, structures, and aerodynamics at elevated temperatures requires the investigation of problems at all points along the Mach number and temperature scales up to Mach numbers of 20 or more. Experimental equipment and facilities suitable for such investigations, as well as the problems themselves, differ greatly in nature as the speeds and temperatures increase. The development of large-scale devices capable of producing extremely high temperature and at the same time capable of representing correctly other environmental conditions such as speed, gas chemistry, and time durations has not yet been accomplished satisfactorily. For this reason, NACA seeks on a small scale to try ideas for accomplishing such developments while at the same time utilizing for limited research the equipment produced for such trials.

The proposed hypersonic physics test area is designed to facilitate progress in the general area of equipment and technique development in the higher temperature ranges while at the same time providing safe and integrated means for conducting exploratory research at these temperatures. The facilities proposed for the test area include chemical jets providing temperatures up to nearly 11,000°F., and hypervelocity guns to conduct research relating to problems of missile countermeasures and meteor impact problems.

The five projects outlined are NACA's proposed new facilities for hypersonic research.

MODIFICATION OF NUCLEAR RESEARCH FACILITY

A modification and extension of the component research facility for nuclear propulsion presently under construction near Sandusky, Ohio is proposed. This research facility is for research on components for use in nuclear-powered aircraft under realistic conditions of radiation, temperature, and pressure. The design studies of the reactor, the committee was informed, show that it will provide an excellent source for high-level radiations.

Experience to date in the aircraft nuclear propulsion program has brought to light the need for extensive auxiliary equipment and laboratory facilities. The results of tests must be analyzed adequately and rapidly, making necessary the addition of more extensive facilities for handling and studying highly radioactive materials than first contemplated. A secondary reflector of beryllium is required to provide a higher and improved flux distribution in the large test holes. A large air supply and emergency power supply is needed to carry on certain types of experiments. A radiation analysis laboratory is required for the study of the effects of radiation on aircraft structures and equipment.

Recent experiments by AEC

Recent reactor runaway experiments by the Atomic Energy Commission have resulted in a requirement for improved containment of the NACA reactor to insure safety to the surrounding area in event of an accident. The facility under construction has been designed to achieve the larger and more complex containment vessel required. Other modifications are needed to meet the requirements of the Atomic Energy Commission's Safeguard Committee including (1) additional retention basins; (2) additional cooling tower capacity for use as a secondary coolant for some experiments; (3) additional equipment in the primary and secondary water supply systems to provide for safer operation and better continuity of operation; and (4) an additional independent power line to provide for continuity of operation and increased safety to the facility.

MODERNIZATION OF RESEARCH AND TECHNICAL FACILITIES

The other items in the proposed construction program are for modernizing existing research and technical facilities and for general plant and utility improvements.

Propulsion systems laboratory

It is proposed to expand the existing propulsion systems laboratory at the Lewis Laboratory by the installation of facilities to investigate the performance of engines up to Mach numbers in excess of 4.5 using the free-jet technique. The facilities recommended will also permit the more extensive use of high-energy fuels in large full-scale engine tests.

Bypass system

A bypass system for the Ames Laboratory unitary plan tunnel will substantially improve the usefulness and value of the 9- by 7-foot supersonic circuit of this tunnel by eliminating surging of the flow through the compressor which drives air through the 2 supersonic circuits of the tunnel which is encountered under some conditions, and by reducing power losses in the diffuser, resulting in some increase in maximum Mach and Reynolds numbers.

Auxiliary suction

It is proposed that auxiliary suction be applied to the slotted test section of the Ames Laboratory 14-foot transonic wind tunnel for boundary layer removal. Since the design of the 14-foot transonic tunnel was completed, important advances have been made in transonic wind-tunnel design. The application of auxiliary suction to the plenum chamber surrounding the test section has proven to be the most beneficial of recent improvements to transonic tunnels. This improvement, the committee was cautioned, should be applied to the 14-foot transonic tunnel without further delay.

Boundary-layer removal system

The addition of the boundary-layer removal system will permit the tunnel's effective model size to be doubled, will increase the Mach number limit from 1.2 to 1.4, and will reduce the need for overload operation of the main drive motors over most of the tunnel's speed range.

Improvement in airflow

It is proposed to improve the airflow in the 11-foot transonic tunnel circuit of the Ames unitary plan tunnel. The acquisition of new knowledge on the characteristics of transonic test sections indicates that significant improvements in the quality of the airflow can be achieved by altering the method of venting the test section and by redesigning the bypassed air reentry region at the downstream end of the test section. The proposed modernization offers the possibility of a decrease in the Mach number variations in the test section and an improvement in the airflow at the diffuser entrance of sufficient magnitude to result in a decrease in the required tunnel drive power.

Flutter investigations

It is proposed to modify the Langley Laboratory 26-inch transonic blowdown tunnel by installing an alternate 20-inch square test section to extend the maximum attainable Mach number of the facility from about 1.4 to about 4.0. This tunnel is used primarily for flutter investigations. The nature of the flutter problem at the higher Mach numbers is relatively unexplored and is urgently in need of investigation.

In addition to modernizing the research facilities just discussed, it is also necessary to modernize three of our supporting technical facilities.

The capabilities of the research vehicles used in the conduct of aeronautical research at the pilotless aircraft station at Wallops Island have exceeded the ability of the ground instrumentation to provide full coverage of a research flight. It is essential that modern instrumentation be provided to obtain urgently needed data in the hypersonic speed range. The project covers two tracking radars, telemeter receiving equipment, an increased range Doppler system, and auxiliary equipment.

A data reduction center is required for the expansion and improvement of the automatic data-processing facilities at the Langley Aeronautical Laboratory. The complex problems involved in research at increased flight speeds and altitudes and on new aircraft configurations required for supersonic flight have greatly increased the amount of required data reduction and analysis. The new building will centralize existing data-processing facilities, improve operating efficiency, and provide on-line data-processing service for three major wind tunnels.

The increasing need for structures research at high temperature has made marginal an existing central compressor system at the Langley Aeronautical Laboratory which supplies air to several research facilities. An improved air supply for the internal flow laboratory will permit the installation of the necessary additional compressor capacity.

PLANT AND UTILITY IMPROVEMENTS

With regard to general plant and utility improvements, it is proposed (1) to acquire approximately 115 acres of land adjacent to the Lewis Laboratory to permit the future expansion of research facilities, (2) to install two boilers in the heating plant near the Langley Laboratory full-scale tunnel in place of the 8 low-pressure boilers which are nearing the end of their useful lives after more than 15 years of operation, and (3) to construct a new west area approach road at the Langley Laboratory which is necessitated by the Air Force installation of a runway extension.

Construction and equipment program, by laboratory

Langley Aeronautical Laboratory:		
High-speed leg for unitary plan tunnel	$750,000	
Hypersonic physics test area	1,987,900	
Data reduction center	3,067,200	
Improved air supply for the internal flow laboratory	858,000	
Modification of the 26-inch transonic tunnel	346,400	
Central heating system for the east area	209,100	
Hypersonic helium blowdown tunnel	796,600	
West area approach road	148,800	
Total, Langley		$8,164,000
Ames Aeronautical Laboratory:		
3.5-foot hypersonic tunnel	11,731,000	
Bypass air system for the unitary plan tunnel	100,000	
Boundary-layer removal for the 14-foot transonic tunnel	4,435,000	
Flow improvement in the unitary plan tunnel	255,000	
Total, Ames		16,521,000
Lewis Flight Propulsion Laboratory:		
Modifications to the component research facility for nuclear propulsion	5,655,000	
Expansion of the propulsion systems laboratory	5,800,000	
Land acquisition	300,000	
Rocket systems research facility	5,700,000	
Total, Lewis		17,455,000
Pilotless aircraft station:		
Modernization of instrumentation	2,560,000	
Total, Wallops		2,560,000
NACA total		44,700,000

GLOSSARY OF TERMS

Beryllium

A hard, light metal resembling magnesium in appearance and chemical properties. When used in the presence of nuclear radiation, has the peculiar property of reflecting as well as increasing the supply of neutrons when used as a reflector in a nuclear reactor. This increases the intensity of radiation in the reactor.

Blowdown tunnel

A wind tunnel where the flow is produced by the discharge of a reservoir of compressed gas. The tunnel may connect a high-pressure reservoir to an evacuated reservoir permitting a gas such as helium to be saved for reuse. When air is used, the tunnel may discharge directly to the atmosphere. A relatively small amount of power may be used to pump up the reservoir over a period of hours, while the discharge of the reservoir may take place in a matter of minutes or seconds to produce hypersonic and supersonic test conditions.

Boundary layer

The thin layer of air next to the outside surface of a body moving air which tends to stick to the body and move along with it. This thin layer flows off the aft end of the body as a wake.

Convective heat transfer

Convective heat transfer is the transfer of heat from a hot gas moving by the outside of a body, to the body. It is similar to being heated by hot wind, even though you may be in the shade.

Diffuser

The term applied to a portion of a duct or pipe containing a flowing gas in which the cross section area is changed at a carefully controlled rate in order to slow down the air with a minimum disturbance to the flow. When the gas is flowing at subsonic speeds, enlarging the cross section area decreases the rate of flow, while at supersonic speeds decreasing the cross section area also decreases the rate of flow.

Doppler system

A type of radar for measuring the speed of a body moving away from or toward the radar. Due to the speed of the body, the frequency of the electronic radiation of the radar is changed by an amount proportional to the speed. This effect is similar to the frequently heard phenomena of the change in tone of a locomotive whistle at a grade crossing. The pitch of the whistle increases as the locomotive approaches and decreases as it goes away.

Hypersonic speed

Generally used to describe speeds greater than five times the speed of sound. The type of airflow that occurs at supersonic flight speed is different from the type of airflow that occurs at subsonic flight speed. The type of airflow that occurs at hypersonic flight speed, in turn, is also different from that which occurs at supersonic flight speed.

ICBM

Abbreviation for intercontinental ballistic missile.

Mach number

Airspeed divided by the speed of sound in air; hence, the multiple of the speed of sound for airplane or missile flight speed or of the flow through a wind tunnel.

For example, Mach No. 1 at sea level equals 763 miles per hour (the speed of sound); Mach No. 1 at 25,000 feet equals 690 miles per hour; Mach No. 1 at 50,000 feet equals 660 miles per hour.

Oxidant

A rocket must carry its own oxygen with which to burn fuel for propulsion. Oxidant is the term for the chemical which supplies the oxygen. It may be liquid oxygen, acid, or other chemical containing oxygen.

Plenum chamber

An enlarged chamber in an airflow system where the air moves at relatively low speed, similar to a settling basin in a waterflow system.

Radiative heat transfer

Transfer of heat from a warmer body to a colder body or gas by means of radiation, identical with the manner in which the sun's heat reaches the earth.

Reynolds number

A measure of the scale or size of airplane or missile model and test flow conditions at which aerodynamic tests are conducted. It is directly proportional to the density of the air, the size of the model, and the airspeed, and inversely proportional to the viscosity of the air. If wind tunnel experiments are conducted in air which is compressed to 10 times the density of atmospheric air, the results would be applicable to an airplane 10 times as large as the model tested. Wherever possible, the Reynolds number of wind tunnel tests should be the same as the flight conditions of the actual missile or airplane.

Slotted test section

A term used to describe the test section of a transonic wind tunnel. The test section contains numerous open slots in the wall running parallel with the airflow in order to minimize and absorb the effects of the shock waves occurring on the model in the transonic speed region.

Stagnation temperature

The temperature measured in a moving airstream when the air is brought to rest. In the process of bringing the air to rest, such as on the nose of a missile, the air is compressed and is hotter than the surrounding air, a serious problem at supersonic and hypersonic speeds.

Supersonic speed

Flight speed greater than the speed of sound. Usually referred to as the speed range from Mach No. 1 to Mach No. 5. At these speeds shock waves spread like the waves from a moving ship.

Telemeter device

A device for the remote reading of experimental measurements. As used in this report, refers to the conversion of instrument readings on rocket-propelled, free-flight models to radio signals, and the deciphering of these radio signals on the ground by suitable recording devices to provide scientific research information.

Transonic speed

Term used for the speed range from approximately 0.8 to 1.2 times the speed of sound. In this speed range the local velocities of flow around an airplane or missile may be partially subsonic and partially supersonic, and many complex flow phenomena occur which are difficult to predict. Supersonic shock waves start to form in this speed range.

WIND TUNNEL

Since so much of NACA's work relates to the use of wind tunnels and in view of the fact that these facilities represent very large expenditures of Federal funds, the committee feels that a description of a wind tunnel would prove helpful to the Members of the House in the same fashion as the glossary of terms set out above.

A wind tunnel is a device whereby the flight of an airplane or a missile or any object affected by the movement of air may be simulated under laboratory-controlled conditions. After mounting a body on balances to measure the forces acting on it, a carefully controlled airstream is blown over the body to provide conditions corresponding to flight.

Since the early use of wind tunnels by the Wright brothers, such devices have become highly specialized tools. There are subsonic wind tunnels, transonic wind tunnels, supersonic wind tunnels, and hypersonic wind tunnels. In two of the NACA subsonic wind tunnels it is possible to mount a complete operating airplane.

Wind tunnels are used, first to acquire research information that will be used by designers to predict the performance of an airplane or missile, the strength of its wings, and how well it will fly and maneuver. As the design progresses, models representing the designers' best efforts are tested in wind tunnels to see if the predictions were accurate. After the airplane or missile has flown, wind tunnel tests are again conducted to show how to correct difficulties that could not be foreseen in the earlier tests.

Wherever possible, it is much less expensive to run wind tunnel test than flight tests, provided the flight conditions can be adequately reproduced in the wind tunnel.

FISCAL DATA

Enactment into law of this measure will involve the expenditure of $44,700,000 in Federal funds.

DEPARTMENTAL DATA

H. R. 3377 represents the construction program of the National Advisory Committee for Aeronautics and has the approval of the Bureau of the Budget as is evidenced by letter dated January 18, 1957, from Mr. J. F. Victory, executive secretary, National Advisory Committee for Aeronautics, which is set out below and made a part of this report.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS,
Washington, D. C., January 16, 1957.

The HONORABLE SAM RAYBURN,
Speaker of the House of Representatives,
House of Representatives,
Washington, D. C.

SIR: The National Advisory Committee for Aeronautics respectfully submits for your consideration a draft of proposed bill to promote the national defense by authorizing the construction of aeronautical research facilities and the acquisition of land by the National Advisory Committee for Aeronautics necessary to the effective prosecution of aeronautical research.

The purpose of the proposed legislation is to provide legislative authorization for the Committee's 1958 construction program as approved by the Bureau of the Budget and is in accord with the President's program.

The NACA has been authorized by the Bureau of the Budget to submit this proposed legislation to the Congress. It is respectfully requested that it be introduced in the 85th Congress.

Sincerely yours,

J. F. VICTORY,
Executive Secretary.

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