Ames Aeronautical Laboratory
National Advisory Committee for Aeronautics
Moffett Field, California

June 27, 1955
For Immediate Release

Knowledge of Jet Fire, Impact Hazards
Advanced by Crash Research

Safety principles for the design of flexible but strong seats that will protect airplane pilots and passengers from the hazards of crash have been advanced by scientists of the NACA Lewis Flight Propulsion Laboratory. The research group also has modeled a means to prevent fires in crashing jet planes.

Preventing a crash fire is worthwhile only if the occupants of the airplane can survive the crash impact. For that reason, the crash fire research program was extended to include study of the hazards of impact. The Lewis group staged a series of crashes with worn-out Navy and Air Force planes, which carried dummy passengers and sensitive instruments to determine the forces experienced by human passengers in similar accidents.

An experimental seat, built of strong elastic materials, has been proved capable in crash tests of reducing impact loads upon the occupant. The seat flexes in any direction and recoils at a decreased rate. In this way the peak "g" loads are lowered and spread over a longer period of time. In effect, the worst of the crash blow is sustained by the seat rather than the rider.

NACA tests show that its "forgiving" seat may take as much as three-fourths of the power of a blow from the occupant's body. At the same time, the structure is strong enough to resist breaking and is free of sharp or pointed parts which could injure vital parts of the body.

The seat base contains two cylindrical members held together under 1000 lbs. of force by an elastic band, one part being fastened to the floor, the other to the seat pan. This design affords flexibility in any direction force is applied. A rubber sheet sandwiched between the cylinders damps out forces of recoil. Upper members of the seat are composed of inflated rubber.

The continuing survival study indicates that though there is little chance for survival when cockpits or passenger compartments are crushed, real safety gains are possible in less serious accidents by improved seat construction, location and position. Pilots and passengers must be protected against flying missiles thrown off in a crash. Proper safety belts and shoulder harness also are desirable -- especially for pilots in crowded cockpits -- to prevent plane occupants from being thrown against dangerous obstacles.

Rigid seats and their floor attachments built strong enough to withstand crash may be too heavy for aircraft use. They can transmit death-dealing "g" forces to the occupant. Flexible and rigid seats were tested together in a transport plane crash at 110 miles an hour. In this crash the dummies in flexible seats recorded less than one-third the peak deceleration experienced by dummies in rigid seats.

The shock absorption principle solves only one of the problems of impact survival. Future work in the continuing safety research program includes studies of seat floor attachments and the effect of airplane design on crash loads relayed to the passengers.

The experimental turbojet engine inerting system evolved by the program incorporated knowledge gained earlier in research with piston engines. For both engine types, the system provides cooling, and mechanisms to shut off the normal supply of fuel and electricity at the moment of crash.

The aircraft engine is the worst fire hazard in a crash since it operates at high temperatures and is located close to the plane's fuel tanks. In many accidents the tanks are burst or ripped open, spilling the contents close to the hot engines. The jet engine, moreover, having no propeller to strike the earth and bring the engine to rest, will continue to draw large amounts of air through its heated interior.

Fire breaks out instantly when the flammable mixtures are sucked through the inlet, while burning of magnesium parts adds to the conflagration. Detail studies on laboratory test stands showed that some engine parts may remain hot enough to start fire many minutes after the combustor flame is extinguished. Full-scale crashes revealed that the gas turbine can "feed" upon spilled fuels and force large flames out of its inlet and tailpipe onto pools of combustibles.

The NACA inerting system contains a rig of plumbing to spray water upon critical points inside the engine and upon a steel screen surrounding the tailpipe cone. The water cools the heated metals and readily converts to steam, thereby shutting out the oxygen supply necessary to support combustion. A typical jet engine can be inerted fully with as little as nine gallons of water.

The experimental inerting apparatus worked successfully in six crashes involving heavy airplane damage, while like trials without the inerter produced large fires. Though the model is heavy, it is believed possible to reduce weight to practical limits by further development.

In extended research of the jet crash fire problems, the Lewis group plans to explore the effects of changes in engine design, including high compression ratios and varying cleanliness and mechanical condition.

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
AMES AERONAUTICAL LABORATORY
MOFFETT FIELD, CALIF.

AMES UNITARY PLAN WIND TUNNEL - FACT SHEET

The Ames Unitary Plan Wind Tunnel is built on an 11-acre area of the NACA's Ames Aeronautical Laboratory. Construction on the site began in December 1951, and the tunnel is expected to be completed during 1955. Total cost of the tunnel including buildings, auxiliary equipment and basic instrumentation will be $27,000,000.

This new facility is a continuous flow tunnel in which three separate test sections cover a Mach number range between .7 and 3.5 (seven tenths of the speed of sound to three and one half times the speed of sound). The 11- by 11-foot transonic test section operates between a Mach number of .7 and 1.5. The 9- by 7-foot low supersonic test section covers the range between Mach number 1.4 and 2.6 and the 8- by 7-foot high supersonic test section operates between Mach 2.4 and 3.5. Test pressures can be varied from a partial vacuum to over twice atmospheric pressure.

Tunnel Structure:

1. All welded steel pressure vessel.
2. Plate thickness 1 inch to 2-1/2 inches with some reinforcements up to 4-1/2 inches thick.
3. 5,000 tons of steel plate in structure.
4. 2,500 tons of plate and rolled sections in nozzles.

5. 100 tons of welding rod used to assemble structure and nozzles.
6. Structure erected by Chicago Bridge and Iron Company.

Foundations:

1. Tunnel rests on 1700 Raymond concrete piles driven to an average depth of 48 feet. Each pile carries a load of 45 tons.
2. Concrete foundations contain a total of 10,400 cubic yards or 21,000 tons. The largest single pour consisted of 3250 cubic yards placed during 69 hours of continuous pouring.
3. Foundations installed by the Carl N. Swenson Co., San Jose, Calif.

Flow Diversion Valves:

1. The two largest three-way plug type valves ever constructed are used in the tunnel.
2. The 20-foot valve weighs 251 tons; the 24-foot valve weighs 392 tons.
3. Each valve can complete a half turn rotation in 3-1/2 minutes.
4. Valves were built by the Newport News Shipbuilding and Drydock Company, Newport News, Virginia, and installed on the site by the Eichleay Corporation.

Three-Stage Axial Flow Compressor:

1. Driving mechanism for the transonic circuit of the tunnel. The rotor consists of three forged steel wheels each 17 feet in diameter. Rotor with blades weighs 160 tons and turns at a maximum of 685 rpm. Rotor is fitted with 156 aluminum alloy blades.

2. Stator casing is fabricated from 3-inch steel plate. Internal diameter 24 feet. Stator has 240 cast steel blades arranged in five rows.

3. Compressor will handle 6,250,000 cubic feet or 400 tons of air per minute. Air temperature rises 70° as it passes through the compressor.

4. Compressor was built by the Newport News Shipbuilding and Drydock Company, Newport News, Virginia, and installed on the site by the Eichleay Corporation.

<u>11-Stage Axial Flow Compressor</u>:

1. Driving mechanism for the two supersonic circuits of the tunnel. Compressor output is directed by flow diversion valves through the circuit being used.

2. Rotor weighs 445 tons including blades and drive shaft. It consists of 11 forged steel wheels each 18 feet in diameter. Each rotor wheel weighs 24 tons. Rotor is fitted with 1122 stainless steel blades. Tip diameter is 22 feet.

3. Rotor turns on two journal bearings 31 feet 9 inches apart. The bearings are 36 inches in diameter and 55 inches long. A 60-inch diameter Kingsbury horizontal thrust bearing is provided to withstand a thrust load of 1,000,000 pounds.

4. Stator casing is fabricated from 2-inch to 3-1/2-inch steel plate. It contains 1223 cast steel blades.

5. Compressor will handle 3,200,000 cubic feet or 90 tons of air per minute, increasing its pressure 3-1/2 times. Air leaves the compressor at 450° F.

6. Compressor was built by the Newport News Shipbuilding and Drydock Company, Newport News, Virginia, and installed on the site by the Eichleay Corporation.

Drive System:

1. Four wound-rotor-type electric motors connected in tandem. They are rated to deliver 180,000 hp continuously and have a 1 hour overload rating of 216,000 hp. They operate at 6900 volts. Each motor weighs 154 tons.
2. Motors are provided with slip regulator type control (liquid rheostat) providing 100 percent speed variation. They drive only one of the two compressors at one time.
3. Total shaft length of motors plus both compressors is 266 feet. Length of shaft motors and 11-stage compressor is 194 feet.
4. Including rotors and shafts, there is a rotating mass of 1300 tons in the drive system.
5. Motors built by General Electric Company.

Auxiliaries System:

1. Make-up air is furnished by a Clark compressor delivering 50,000 cubic feet per minute. After passing through silica gel dryers it is stored in four spherical tanks each 38 feet 6 inches in diameter at a pressure of 140 pounds per square inch. Tanks can be completely filled in 18 minutes.
2. Two coolers are provided to maintain the tunnel air at 120° F. A 70-foot diameter unit lowers the temperature of air from the 3-stage compressor from 210° to 120° F. A 45-foot diameter cooler receives air from the 11-stage compressor at 450° F and lowers its temperature to 120°. Each cooler circulates 54,000 gallons of water per minute as the coolant.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
AMES AERONAUTICAL LABORATORY
MOFFETT FIELD, CALIF.

June 27, 1955
For Immediate Release

NACA Research Seeks Ways to
Save "Airport Concrete"

Vertical takeoff and landing, boundary layer control, high speed seaplanes, flying platforms, helicopters - these are some of the ideas under investigation by NACA to find solutions for the nation's costly airport construction problem.

All airplanes must take off and land, and as their top speed in a decade has jumped to more than twice the speed of sound, there has been a corresponding boost in their minimum speeds for takeoff and landing. Such fast ground operations - some research planes top 250 miles an hour - are hazardous, and they demand more skill in pilots; larger, more expensive airports and naval aircraft carriers.

Research scientists of the NACA Langley and Ames Laboratories have attacked this problem with the objective of learning how to reduce speeds, to permit flight operations from unprepared surfaces, and ultimately to attain vertical takeoff and landing in high speed airplanes.

Control of the air flow about a wing, commonly known as boundary layer control, has been under considerable research effort for many years in NACA. The problem is a matter of maintaining smooth air flows at low speeds over a wing, to retain effective lift.

One solution is to remove the disturbed air flows through porous wing surfaces. An equally effective solution is to blow air through the surface to speed up the disturbed air. Both methods are used principally to improve lift effectiveness of simple flaps.

The arrival of the jet engine has intensified interest in boundary layer control. The turbojet, in contrast to the piston engine, offers a convenient pump for control air. Furthermore, the application of boundary layer control to the modern thin wing eases the aggravated design problems of flaps as means toward lower speeds in landing, approach and takeoff.

Research on boundary layer control has included tests with scale models in the laboratory and with high speed military fighter planes in flight. Results of these studies show that boundary layer control can reduce landing and takeoff speeds by a significant amount.

Vertical flight appears to be another solution to the airport length problem for high speed aircraft. In the extreme, vertical flight means takeoff, hovering and landing in a conventional airplane.

The direct lift of VTO may be achieved by several means, among them turning the wings and propellers to the vertical, or redirecting the slipstream through sets of extra wings and flaps (arranged like the venetian blind), or setting the entire airplane on its tail.

The Langley research group has conducted investigations to develop a simple wing-flap system which can turn the air stream with reasonable efficiency. At the same time, such a system must retract readily to form a clean wing for normal flight. Applied to a scale model of a transport plane, this system permitted hovering, takeoff and landing, while the fuselage was nosed upward a maximum of 15 degrees from the horizontal.

Stability and control problems of VTO have been studied by NACA more than 10 years. These tests started with simplified research models. The program later was extended to include tests of models of the tail-sitting types of turboprop fighters being developed by Lockheed and Convair for the U. S. Navy. Turbojet VTO now is being investigated in the NACA program.

Probably the simplest type of vertical flight - the simplest of aircraft, in fact - is the thrust vector of so-called "flying platform" made public earlier this year. This concept of flight utilizes lift forces attached to a man's feet. It was first investigated with attached jets of air supplied from a tank on the ground. The principle was developed further in a platform incorporating a rotor system for lift.

In flight outdoors in gusty winds as high as 16 knots, the experimental platform proved stable and controllable - to hover the flyer stands stationary, to cause movement he merely leans in the direction he wishes to move. It was found that the average person could use his normal sense of balance to fly the platform without much instruction or practice.

The helicopter, capable of efficient vertical flight performance, is a prime example of VTO and the NACA Langley Laboratory is continuing studies of rotary wing flight. However, the top speeds of rotary wing systems appear too limited for application to high speed aircraft.

NACA research has attacked another solution to the runway length problem by seeking ways to improve the performance of seaplanes. One of the major developments in this area since the war is the hydroski, a planing device projected below the hull or fuselage. The hydroski planes on the water surface to support the aircraft load during all but the lowest-speed part of a takeoff or landing. As the plane becomes airborne, the 'skis are retracted like landing wheels into the fuselage. The water ski can be used on rough seas, sand, snow, ice and sod.

Hydroskis have been studied with a variety of models, including operational jet fighters and high speed research aircraft such as the Douglas D-558-II. The Navy's F2Y Sea Dart, a fast fighter type being developed by Convair, is a water-based airplane equipped with hydroskis.

Recent laboratory work with hulls of flying boats also has produced interesting results. Whereas the flying boat of the past was slow and cumbersome because of its wide hull, the new narrow hulls and sharp "vee" bottoms are making possible big gains in speed and performance.

Not only do the new hull shapes have less aerodynamic drag; their impact loads upon landing are likewise decreased. It is possible, in fact, to cut landing loads by as much as three-fourths. The advantages of these new shapes can be realized without significant loss in hydrodynamic characteristics.

The design ideas produced by research with water-based aircraft suggest that this type of airplane will offer a worthwhile solution to the problems of huge airports required for the extreme high speeds of the future.

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PRESS RELEASES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
AMES AERONAUTICAL LABORATORY
MOFFETT FIELD, CALIF.

What Ames Laboratory Is

Ames Aeronautical Laboratory is one of three major research establishments operated by the National Advisory Committee for Aeronautics. Founded in 1915, the NACA is an independent, civilian agency of the Federal Government, whose 17 members are appointed by the President of the United States and who serve without pay.

Most of NACA's research is of a fundamental nature: all of it is directed toward practical solution of the problems of flight, and much of it is focused upon scientific problems. In this manner, the frontiers of aeronautical knowledge are being broadened constantly. NACA does not design or build airplanes. However, the scientific information obtained by its engineers and technicians is gathered for the purpose of assisting the designers and builders of airplanes.

To obtain this knowledge, the Committee operates the Ames Laboratory, which was established at Moffett Field, near San Francisco, in 1940; the Langley Aeronautical Laboratory near Hampton, Virginia; and the Lewis Flight Propulsion Laboratory at Cleveland, Ohio. The NACA also has field stations at Wallops Island, Virginia, where rocket-propelled models are studied, and at Edwards Air Force Base, Edwards, California, where transonic and supersonic flight research is conducted with such special airplanes as the Bell X-1 and X-5, the Douglas Skystreak and Skyrocket, and the Northrop X-4.

What Ames Laboratory Does

The scientists and technicians of Ames Laboratory are engaged primarily in the firld of supersonic aerodynamics - in other words, in a continuous search for the wings, bodies, controls, air inlets, and other components which will prove the safest and most efficient for airplanes flying at and beyond the speed of sound. (Research on the jet and rocket engines to power these airplanes of the future is carried on at the Lewis Flight Propulsion Laboratory. Work at the Langley Laboratory covers aerodynamics, hydrodynamics, structures, stresses, and allied fields.)

Many of the experiments under way at Ames Laboratory (and at the other NACA laboratories) are concerned with the varied problems encountered in the transonic speed range - in which the airplane may be said to be passing through the speed of sound (which varies from 760 miles per hour at standard sea-level temperatures to around 650 miles per hour at high altitudes where temperatures drop to 60° below zero).

It is in the transonic range that aircraft encounter many difficulties, including drastic increases in drag, buffeting of wing and tail surfaces, dangerous changes in control forces. In seeking solutions to these problems, Ames scientists are experimenting with many and varied types of wings and fuselages. Some of the wings, for example, are thin and swept back sharply from the fuselage - as are tail surfaces. Others are triangular in form.

While continuing to explore the transonic range, the NACA has also intensified scientific study of air-flow phenomena at high supersonic (or hypersonic) speeds. This speed range, in excess of five times the speed of sound, is of growing importance because of the need for more knowledge concerning conditions encountered by guided missiles.

Much of the work now under way at Ames Laboratory may be described as a long range search for further knowledge of the laws governing transonic and supersonic flight - knowledge which will be applied to the airplanes of the future. The knowledge gained through this research is promptly made available to the military services and the aircraft industry in the form of technical reports.

The People of Ames Laboratory

Currently, there are more than 1100 persons - all Civil Service employees - working at Ames Laboratory. At their head is Director Smith J. DeFrance, who directs the activities of six major units; the Full-Scale and Flight Research, High-Speed Research, Theoretical and Applied Research, Research Instrumentation and Engineering Services, Technical Service, and Administrative divisions.

Many and varied professions and skills are required for aeronautical research. The Laboratory's staff includes research scientists, aeronautical engineers, physicists, test pilots, electrical and electronics engineers, machinists, photographers, wood workers, airplane mechanics, draftsmen, instrument makers, sheet metal workers, tool makers, artists, electricians, and clerical workers.

Tools of Research

Experiments at Ames Laboratory are carried on both in wind tunnels and in actual flight.

The 15 Ames wind tunnels are among the largest and fastest in the world. They include:

40- by 80-foot wind tunnel: (Note: Wind tunnels are measured by the size of the section in which the model is tested.) This is the world's largest, with a test section big enough to accommodate a full-scale airplane with a 70-foot wing span. The circuit of this tunnel is approximately half a mile in extent. Electric motors totaling 36,000 horsepower drive six 40-foot propellers. Maximum speed of the air stream is about 250 miles per hour.

6- by 6-foot supersonic wind tunnel: One of the largest, most modern supersonic wind tunnels in existence. The maximum speed is twice the speed of sound (equivalent to 1500 mph). The giant compressor which achieves these airspeeds is driven by two electric motors of 25,000 horsepower each.

16-foot wind tunnel: A large, high-speed wind tunnel particularly useful in studying flight problems with large models. Motors with a total of 27,000 horsepower permit airspeeds up to 680 miles per hour.

12-foot pressure wind tunnel: In a tunnel of this type, the scientist has at his command a special device to study the effects of model scale, or size, on air-flow behavior, as separate from the effects of speed. By varying the air density, while holding constant speeds, or the reverse, these effects can be isolated and defined. In the Ames 12-foot tunnel, full-scale flight conditions can be more nearly simulated than in any other wind tunnel in existence. Two 18-ton fans provide speeds up to about 700 miles per hour. Horsepower totals 11,000. Pressures from one-sixth to six times atmospheric can be achieved.

1- by 3-foot supersonic wind tunnels: Ames Laboratory has two of these tunnels. One, with compressors driven by 10,000-horsepower motors, achieves speeds 2.2 times the speed of sound. The other, operated intermittently with air released from the adjoining 12-foot low-turbulence pressure tunnel, registers as high as 3.4 times the speed of sound (equivalent to 2600 mph). In these and other supersonic tunnels, it is possible to observe and photograph shock waves forming around models through the use of an optical device known as the schileren apparatus.

Supersonic free-flight wind tunnel: One of the latest research tools to be placed in operation at the Laboratory, this wind tunnel employs the technique of firing models from guns into air stream rushing in the opposite direction to the model's flight. Speeds eight times the speed of sound have already been achieved.

10- by 14-inch supersonic wind tunnel: Another valuable piece of equipment for exploring air-flow problems in the hypersonic range. This wind tunnel is capable of supplying aerodynamic data over the wide range of 2.75 to 7 times the speed of sound, equivalent to about 2,000 to 5,000 miles per hour at sea-level temperatures.

Currently under construction at the Laboratory is a new 8-foot supersonic wind tunnel which will be powered by electric drive motors totaling 216,000 horsepower.

Wind tunnels provide a controllable air stream and the means to measure reactions of a model airplane, wing, or other component to that air stream; but research in actual flight is equally important. The test pilots of Ames Laboratory fly a number of different types of airplanes, including jet fighters. These are usually used as flying laboratories for basic research, the results of which will be applicable to many types of high-speed aircraft.

Much of this research is concerned with stability and response to controls in flight. As the performance of aircraft increases, these problems become more and more serious, and the NACA program, which seeks methods for their alleviation, becomes more intensified.

Ames Aeronautical Laboratory was named in honor of Dr. Joseph Sweetman Ames (1864-1943) who for more than 20 years served as chairman of the National Advisory Committee for Aeronautics or NACA's Executive Committee. Doctor Ames was an eminent physicist and was president of the Johns Hopkins University from 1929-1935.

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
AMES AERONAUTICAL LABORATORY
MOFFETT FIELD, CALIF.

FOR IMMEDIATE RELEASE
June 27, 1955

NACA DISCLOSES TRANSONIC WIND TUNNEL ACCOMPLISHMENTS

Moffett Field, California, June 27, 1955 -- First public showing by the National Advisory Committee for Aeronautics of the test section of a transonic wind tunnel developed by NACA scientists took place here today for guests attending the Triennial Inspection of the NACA's Ames Aeronautical Laboratory.

The transonic wind tunnel is the most important new tool of aeronautical research devised in the past quarter century. It was developed by NACA engineers to fill the critical gap that formerly existed in the zone between subsonic and supersonic flight speeds where conventional wind tunnels are unusable.

Important performance improvements reflected in every tactical transonic and supersonic military airplane now flying in the United States have been made possible through research in the new type tunnels now operating at the NACA's Ames and Langley Aeronautical Laboratories.

The value of the transonic wind tunnel was publicly recognized when John Stack and his associates of the NACA's Langley Laboratory received the Collier Trophy Award for 1951 for their work in devising this newest addition to the research scientist's arsenal. Details of this new type of tunnel were at that time a closely guarded secret and remained on the classified list until 1954.

Outstanding advantage of the transonic wind tunnel is its ability to reproduce under controlled laboratory conditions the same type of air flow found in free flight as an aircraft accelerates from subsonic speeds through the speed of sound to supersonic velocities.

Conventional subsonic and supersonic tunnels do not give accurate test results near the speed of sound because of a phenomenon called choking which occurs when shock waves forming near the speed of sound block the air passage between the model and the wind-tunnel walls. Additional power only intensifies the blockage without increasing tunnel speed and a choked tunnel does not represent flight conditions because the shock waves around an aircraft extend unhindered by any confining walls.

As developed by the NACA, transonic tunnels closely approximate free-air conditions by providing perforated or slotted walls which permit flow disturbances to pass through the open parts while retaining sufficient solid area to guide the air stream uniformly past the model. They make it possible to use the most advanced techniques of wind-tunnel research, such as accurate and detailed force and pressure measurements, in the critical transonic speed range.

The transonic range of speeds - lying between 600 and 800 miles per hour - is an area in which an airplane is subjected to mixed aerodynamic reactions. As its speed increases, regions of supersonic flow develop over parts of the structure while subsonic conditions exist simultaneously at other places. An aircraft designer must have complete and accurate knowledge of these varying conditions if he is to design an airplane to perform efficiently at transonic speeds. It is this type of research knowledge that the NACA, using its transonic tunnels, is now able to provide in greatly increased measure.

Many ingenious techniques were used to get transonic knowledge before the tunnels were available. Useful information was obtained from gravity-propelled models dropped from airplanes at 40,000 foot altitudes. Instruments within the model recorded aerodynamic reactions as the free-falling model passed through the speed of sound as it plunged to earth.

Small models mounted on the upper curved surface of a fighter plane wing added their share to the store of transonic knowledge. In a high-speed dive, the fighter could develop a region of transonic and low supersonic airflow over the part of the wing where the model was placed while instruments inside the wing measured responses. In high-speed wind tunnels, a similar method was used by adding a curved bump to the tunnel wall. Air speeding up to get around the bump reached transonic speeds around a properly located model.

At the NACA's Pilotless Aircraft Research Station on Wallops Island, Virginia, rocket-driven models could be accelerated to transonic and supersonic speeds while internally carried telemetering equipment reported data to a ground station. Finally, the research airplanes which gather scientific data in actual flight have been a most valuable source of transonic information.

Knowledge obtained by these methods indicated so clearly the pressing need for a more thorough understanding of transonic phenomena that efforts to obtain a truly transonic wind tunnel were redoubled.

The NACA had begun, prior to 1942, to work on the design of a wind tunnel suitable for transonic research. By 1946 the project had progressed to the point where the design of an actual "transonic throat" was commenced. By late 1950, the Langley Laboratory placed its first transonic tunnel in operation and a second large transonic tunnel followed a few months later.

At the Ames Laboratory, two transonic tunnels are already operating and a third, part of the Ames Unitary Plan Wind Tunnel, will soon be in service. Earliest of the Ames tunnels is the 2- by 2-foot transonic tunnel which has served as a pilot model for developing newer and larger facilities.

The Ames 14-foot transonic wind tunnel is a modernization of an existing high-speed subsonic tunnel and is one of the newest and largest of its type to begin operations. In it a flexible wall nozzle and perforated test section combine to make possible smooth and precise speed variations from subsonic through transonic to low supersonic values. Power is supplied by three electric motors totaling 110,000 horsepower driving a three-stage axial-flow fan. Total weight of rotating machinery in the tunnel drive system is 328 tons.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
AMES AERONAUTICAL LABORATORY
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FOR IMMEDIATE RELEASE
June 27, 1955

NACA SCIENTISTS FORESEE 15,000 MPH MISSILE SPEEDS

Moffett Field, California, June 27, 1955 -- Intercontinental missiles speeding to their destinations at 10,000 to 15,000 miles per hour are possible provided an unrelenting scientific attack is maintained on the formidable problems still to be solved, scientists of the National Advisory Committee for Aeronautics said today at the Triennial Inspection of the Ames Aeronautical Laboratory, Federal research establishment at Moffett Field.

The heat problem is perhaps the most difficult technical hurdle to surmount before a successful long-range missile can be flown, but the scientists report progress in the concerted attack being made by all of the NACA Laboratories.

Research on the many problems has been intensified because of the potential advantages of hypersonic flight -- that is, flight at many times the speed of sound.

The most significant advantage of a 15,000 mph missile is that it is relatively invulnerable to presently known methods of defense. Even with a defense missile equally fast, the job of shooting down anything moving 20 times the speed of sound would be enormously difficult. Only seconds would elapse between the time such a missile could be detected in flight and the moment of its impact at destination.

Two major types of hypersonic missiles are of interest -- the ballistic missile and the glide missile.

The true ballistic missile will be accelerated to hypersonic speeds in the first 15 or 20 miles of its flight. The initial push will carry it outside the earth's thin atmosphere to heights between 500 and 600 miles where it will travel in space during the main part of its flight. Its name comes from the fact that under the influence of gravity it will follow a curved path like the trajectory of an artillery shell. When it returns to the atmosphere, resistance of the air will slow it to about 5,000 mph at the end of its flight. Tail fins, useless in space, might be required in the final phases to provide control.

A flat trajectory inside the atmosphere marks the glide-type missile which will also be propelled at 10,000 to 15,000 mph speeds. It will have wings to obtain aerodynamic lift. Like the ballistic missile, this second type would get its major push in the first few minutes of flight and would then glide to destination. The lifting wings present the interesting possibility of landing a vehicle of this type under control and it may thus have commercial as well as military applications.

Temperatures high enough to melt or vaporize most metals in general use today quickly develop in the air next to the skin of a missile flying at hypersonic speeds. Even at only half the speeds envisioned, or about 7,000 mph, sustained flight could produce temperatures up to 8,000° F. At such high temperatures, heat soaks rapidly into the skin and structure of the missile, and ways of dealing with this heat must be found.

One promising technique for keeping an aircraft cool at hypersonic speeds is transpiration cooling. It requires porous skin through which liquid is evaporated. The human body is cooled very efficiently in this method and the same liquid - water - may be used in missile applications.

Further studies on the heat problem will be made in the new 10- by 12-Inch Heat Transfer Wind Tunnel at Ames Laboratory. Heaters in the tunnel circuit will raise the air temperature to 1,200°F if required although this will drop considerably as the air is accelerated through the tunnel nozzle to six times the speed of sound. In the tunnel test section where models will be placed, conditions very close to those of actual flight at extreme speeds will be accurately simulated.

Another new research tool giving answers of value in missile design is the Ames 8-Inch Low-Density Tunnel. In this highly specialized facility a series of ejectors lowers air pressures and densities to those encountered by an aircraft operating at altitudes over 100,000 feet. At 200,000 feet and above, the air is so thin that it is a series of individual molecules rather than the familiar gas we know at the earth's surface. A test stream up to six times the speed of sound can be generated in the Low-Density Tunnel.

Electrical analog computers have been devised at the Ames Laboratory to work out the complex problems of what happens to heat after it enters the structure of a missile. This information is essential so that a designer will know how much heat he must deal with and where the structure will be hottest. Thin skins heat up much faster than the heavy spars supporting them. Heat may occur irregularly, with some portions of a missile growing very hot quickly while others remain several hundred degrees cooler. Such uneven heating may lead to warping and buckling and eventually to structural failure.

The Ames Laboratory analog computer gives the scientists a device to find out where heat builds up most rapidly and how it soaks into various parts of a structure. Their findings are of great value in designing airplanes and missiles intended to fly at extremely high speeds.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
AMES AERONAUTICAL LABORATORY
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FOR IMMEDIATE RELEASE
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FIRST OF UNITARY WIND TUNNELS PUT INTO OPERATION BY NACA

Three new Unitary wind tunnel facilities are going into full operation this year at the main laboratory centers of the National Advisory Committee for Aeronautics to advance scientific research and development of high speed aircraft.

The new test facilities, designed for studies in a speed range from under 500 miles an hour up to five times the speed of sound, will be used primarily for development testing of aircraft, missiles and propulsion systems. They also will release scientists and research tools to work on fundamental problems affecting design of aircraft of the future.

NACA's newest tunnels are located at the Langley Aeronautical Laboratory, Langley Field, Va., Ames Aeronautical Laboratory, Moffett Field, Cal., and Lewis Flight Propulsion Laboratory, Cleveland, Ohio. Costs of construction of the three totaled $75,000,000 under the Unitary Plan Wind Tunnel Act passed by Congress in 1949.

The Langley tunnel, which is currently undergoing calibration tests, has been designed with an operating speed range of Mach Number 1.2 to 5.0. Its two 4- by 4-foot test sections will be devoted to aerodynamic studies of airplanes and guided missiles.

Unique in design, the Ames facility has three air circuits driven from a single source of power, a bank of electric motors delivering 180,000 horsepower. One of the tunnel components, a slotted 11- by 11-foot transonic test section, will permit aerodynamic studies on models between Mach No. 0.7 and 1.5. In this tunnel branch a three-stage axial flow fan circulates the air.

The other two circuits of the Ames unit, designed for supersonic studies, are driven by an 11-stage axial flow compressor placed in a common air passage. Huge flow diversion valves direct the air stream through either a 9- by 7-foot test section at Mach No. 1.4 to 2.6, or an 8- by 7-foot test section with a Mach number range of 2.4-3.5. While one test section is in use, the two others are closed down for maintenance or model instrumentation.

The two supersonic circuits are driven by a compressor with a rotor 22 feet in diameter and weighing 450 tons, which is the largest of its type in the world operating today. The compressor's 11 stages discharge air into the tunnel circuit at the rate of 90 tons a minute.

The new Lewis 10- by 10-foot supersonic tunnel, with a 250,000-horsepower electric drive, is one of the world's most powerful. Designed for work with propulsion systems and engine components, the Lewis tunnel will operate in the Mach No. 2.0-3.5 speed range, and in pressures simulating altitudes up to 100,000 feet. This facility is in the final phases of operating tests.

In each of the new Unitary plants, designers will be able to obtain full measurements on both scale models of aircraft and engines and full-scale components, at high Mach numbers. They will serve industry and military designers to advance the performance and reliability of aircraft now being developed and planned well into the future.

All of the tunnels are equipped with advanced electronic computing machines able to reduce the complex test results quickly, and plot them on charts while the run is in progress. Compared to older means of processing data, the computers can save many weeks in the solution of problems.

The Unitary tunnel legislation derived its name and stemmed from a unified long-range plan developed by American scientific leaders, including those of NACA, industry, the Congress, military and other government agencies, to meet the growing needs of research for supersonic flight.

Throughout its 40-year history, NACA has attempted to concentrate on fundamental research for aeronautical knowledge, but this effort lagged seriously in World War II. The military needs of the period were urgent and the problems of development of existing warcraft pressing. The ability to do both tasks at once was plainly beyond the capacity of the size of NACA's staff and its facilities.

At war's end it was evident that the backlog of basic knowledge was seriously depleted, and that powerful new wind tunnels for development testing of new high speed aircraft must be built or NACA effort could not return to the normal business of basic research. The extreme high cost of the required new tunnels--first estimated at over $1,000,000,000 --made a unified plan imperative.

The Congress authorized construction under the Unitary Plan of a series of large tunnels by the NACA, Air Force and Navy. These tunnels will be used by industry on two general classes of development work: government-sponsored projects, and those for the benefit of industry alone. Users will be charged for services of the latter type.

Representatives of the Air Force, Navy, Army and NACA have been drawn into a group to set up allocations and priorities for scheduling of Unitary tunnel services.

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