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National Advisory Committee for Aeronautics
Lewis Flight Propulsion Laboratory
Cleveland 11, Ohio

FACT SHEET (10-57)

WHAT LEWIS LABORATORY IS

The Lewis Flight Propulsion Laboratory is one of three major research establishments operated by the National Advisory Committee for Aeronautics. Created by Congress in 1915, NACA is the top aeronautical research organization of the Federal Government. Dr. James H. Doolittle is Chairman on NACA's "board of directors" whose 17 members are appointed by the President of the United States and serve without pay.

The business of NACA is scientific research in aeronautics directed toward practical solution of the problems of flight. Scientific knowledge gained by NACA is used by the military services and the aircraft industry in the design and development of improved aircraft and propulsion systems.

To obtain this knowledge, NACA operates Lewis which was established on a 200-acre site adjacent to the Cleveland Hopkins Airport in 1941; the Langley Aeronautical Laboratory started in 1917 near Hampton, Virginia; and the Ames Aeronautical Laboratory, on which construction was begun in 1939, near San Francisco, California. NACA also has smaller facilities at Wallops Island, Virginia, and at Edwards, California. Now under construction near Sandusky, Ohio is a research reactor facility where Lewis scientists will study some of the problems of aircraft nuclear propulsion.

WHAT LEWIS LABORATORY DOES

Lewis is primarily engaged in investigation of aircraft powerplant problems, including the special aerodynamics of high-speed flight propulsion. More than $100-million worth of research facilities are in use at the Laboratory. Turbojet, ramjet, rocket, and nuclear aircraft propulsion systems are studied here.

Some areas under study are combustion, fuels, propulsion system installation, engine component design, controls, cooling, high-temperature materials, and lubrication. A few recent Lewis contributions to aeronautical science include supersonic inlets, transonic compressors, high energy fuels, turbine cooling, turbojet afterburners, and a crash-fire inerting system.

Work at the Langley Laboratory covers aerodynamics, hydrodynamics, structures, stresses and other allied fields. Research on wings, bodies, controls, and other components which will provide the safest and most efficient airplanes at very high speeds is conducted at the Ames Laboratory.

THE PEOPLE OF LEWIS LABORATORY

Under NACA's Director, Dr. Hugh L. Dryden, with Headquarters in Washington, D. C., activity of the 2700-man professional and technical staff of Lewis is directed by Dr. Edward R. Sharp. Varied professions and skills are required for aeronautical research. Lewis's staff includes research scientists, engineers, technicians, and other skilled supporting personnel.

RESEARCH FACILITIES AT LEWIS LABORATORY

The unique tools of research at Lewis are used to study the problems of propulsion through the full range from chemistry of fuels to the operation of full-size engines under simulated conditions of high-speed, high altitude flight. Major research facilities at Lewis include:

The 10X10 Foot Supersonic Wind Tunnel, so called because of the size of its test section, was completed in 1956. Air is moved through its test section by two large compressors turned by seven electric motors producing up to 250,000 hp. The air enters the tunnel through a dryer building which removes moisture from the air by heat and chemicals at a rate equal to the capacity of about 12,000 home clothes dryers. Walls of the test section are stainless steel plate, 10 feet wide, 78 feet long, and 1-3/8 inches thick. Hydraulic jacks can squeeze portions of these walls as much as $2\frac{1}{2}$ feet each to form a variable nozzle for different airspeeds. A two-story structure houses a muffler which silences the air as it is exhausted to the atmosphere. Air can also be recirculated for reuse within the tunnel. A closed-circuit television system permits scientists to view the object undergoing test during operations.

The 8X6 Foot Supersonic Wind Tunnel was completed in 1949 and modernized in 1957. Though slightly smaller than the 10X10, it is similar in appearance. Modernization included modification of the throat and test section for transonic as well as supersonic operation, and erection of duct to permit reuse of the air within the tunnel.

NACA aeronautical research scientists utilizing the capabilities of both these wind tunnels can study full-scale airplane and missile powerplants operating at speeds from 400 to 2500 mph at simulated altitudes to 30 miles. The 8X6 produces the 400-1500 mph speed range, and the 10X10 from 1500-2500 mph. Both tunnels are used in investigations of aircraft powerplant air inlet and outlet configurations, nacelle configurations and shapes, and location of engines on an aircraft's structure.

The Altitude Wind Tunnel is used to test full-scale aircraft engines under conditions which simulate pressures and temperatures of altitudes up to 50,000 feet. This tunnel has a 20-foot diameter test section. Air is driven through it at speeds up to 500 mph by an 18,000 hp electric motor. Refrigeration equipment requiring 22,000 hp cools the air in the tunnel to -48° F.

The Propulsion Systems Laboratory contains two altitude chambers for testing high-speed turbojet and ramjet engines under conditions simulating very high altitudes and low temperatures. Engine thrust, fuel consumption, operating temperatures, and other characteristics are measured. The chambers are 14 feet in diameter and 100 feet long. Air is supplied at various pressures, heated, dried, or refrigerated, as required. A total of 150,000 hp is required to drive the air and exhaust machinery. Two small altitude chambers are also located here.

The Engine Research Building occupies 5-1/2 acres and contains about 100 test stands for investigation of components of engine propulsion systems. Studies are conducted here on turbojet engine air compressors, combustors, and gas turbines. Many environmental conditions can be duplicated in the test stands by supplying them with compressed air in wet, dry, or refrigerated form. Air can also be exhausted from the test set-ups, or be furnished at atmospheric or altitude pressures.

The Rocket Laboratory conducts studies of thrust producing devices which carry their own fuel and oxidant and, therefore, require no external air supply. Various engine configurations, fuel injectors, nozzles, fuel ignition and combustion, with a variety of fuels and oxidants, are studied and their effects on the thrust developed by the engine is determined.

The Rocket Engine Research Facility, completed in 1957, supplements other facilities of the Rocket Laboratory. Here practical-sized rocket engines may be used to determine means to effectively use high-energy rocket propellants. Research and design ideas can be carried through initial investigations with low-cost fuels before using those which are more expensive and scarce. Included here are a thrust stand, propellant supply and storage systems, silencing equipment and exhaust disposal system, and an operations building. As in the two large supersonic wind tunnels, a closed-circuit television system enables tests to be monitored from the control room.

The High Energy Fuels Laboratory employs high pressure air supply systems, burners, and evacuated exhaust systems to investigate special fuels under various conditions of air mixing and burning.

The Materials and Stresses Laboratory is the location of studies of materials suitable for use in future aircraft engines.

The Icing Research Wind Tunnel operates over a temperature range from atmospheric to -40° F. Water vapors and sprays of various droplet size are mixed with the tunnel air stream, which can reach 300 mph, to test the effects of icing on engines and components.

The Central Automatic Data Processing System transmits raw data on a 24-hour basis from major facilities at Lewis. Essential elements of the laboratory-wide integrated data processing system are automatic digital potentiometers (ADP) and digital automatic multiple pressure recorders (DAMPR) at the major facilities. This equipment sends data signals to the central automatic digital data encoder (CADDE) where it may be stored or be returned on typewriters or facsimile receivers as raw data to the control room of the originating facility. Data may also be fed into the ERA 1103 (UNIVAC), "electronic brain", for final calculations of end results in a matter of minutes rather than in days, as is required in manual computations.

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For use: Monday, October 7, 1957

NEW ROCKET RESEARCH FACILITY SHOWN BY NACA

A $2.5-million addition to research equipment available to NACA aeronautical scientists, the Lewis Rocket Engine Research Facility, was shown publicly for the first time today. Completed in August, the facility was viewed by representatives of the aircraft industry, military services, Government, and scientific organizations during the Triennial Inspection of the Lewis Flight Propulsion Laboratory.

The new facility permits scientists to use practical-sized rocket engines in their search for means to utilize new high-energy rocket propellants. This versatile research tool also allows realization of economies gained through use of low-cost fuels during initial studies of design ideas before investigations are made with scarce, more-expensive fuels.

A propellant supply and storage system, a thrust stand, silencing equipment, exhaust gas disposal system, and an operations building, which includes an instrument and control room, are the facility's components.

Fuels and oxidants for operating test rockets are stored in tanks away from the test area. In preparing for operation, the propellants are transferred to tanks in concrete pits adjacent to the test area, then are pressurized by an inert gas. The high pressure gas forces the propellant to a rocket engine mounted vertically on the test stand.

The tubular-steel frame of the test stand can hold a 20,000 pound thrust rocket while it is fired. Elaborate instrumentation provides means for recording data during tests.

The rocket jet is directed downward into a treatment duct to which the engine is sealed. Within the duct, harmful exhaust products are removed and the roar of the engine is silenced. Both functions are accomplished by a scrubber-silencer in which water is sprayed at a rate of 50,000 gallons per minute through many spray nozzles. The cleaned gases leave through a vertical stack.

Water for scrubbing is stored in a 450,000 gallon reservoir and is gravity-fed to the scrubber. This arrangement takes advantage of natural terrain, eliminating the need for costly, high capacity pumps. The contaminated waste water is collected in a detention tank for chemical treatment before disposal.

The facility is operated from a station about a half-mile away from the test area. Operators control the rocket firing from a large console, and monitor the firing by means of closed-circuit television. All engine data are recorded in an instrument section, also located in the control room.

- END -

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HIGH-ENERGY FUELS TESTED IN NACA PROGRAM

The possibility of high-energy fuels capable of increasing the range of supersonic aircraft and missiles by as much as 40 percent was disclosed today at the Triennial Inspection of the NACA Lewis Flight Propulsion Laboratory. Research on the new fuels already has been carried to the point where they have been tested in flight on an experimental full-scale ramjet engine.

Many problems in connection with the high-energy fuels remain to be solved. Lewis scientists have been studying all phases of the program in order to predict theoretical performance limits, to compound new fuels and determine their properties, and to learn how to use them in engines. The work includes investigation of liquid fuels containing various powdered light metal solids. Liquid fuels containing boron have been favored because of their high energy content, which provides the increased aircraft range. NACA engineers calculate that the range of a boron fueled ramjet missile flying at an altitude of 60,000 feet and 2100 mph could be extended 40 percent over the same missile using jet fuel.

There is more energy in boron-hydrogen compounds than in boron itself. The boron hydrides, or boranes, can be prepared in liquid form, more convenient for handling in aircraft fuel systems. Research has been aimed to evaluate the boranes under a wide range of conditions, including flight tests in ramjet and turbojet engines. Boron compounds are toxic and produce deposits inside the engine which reduce performance. The fuels are expensive and have not been manufactured in sizeable quantities. Plants now under construction will make additional quantities available. NACA is planning expanded full-scale turbojet and ramjet engine research with these fuels.

- END -

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For use: Monday, October 7, 1957

RESEARCH INDICATES TURBOJET HAS MACH 4 SPEED CAPABILITIES

High-flying turbojet-propelled aircraft traveling at speeds up to four times the velocity of sound--about 2600mph at altitude -- are envisioned by NACA scientists of the Lewis Flight Propulsion Laboratory. At the NACA Triennial Inspection today, Lewis scientists discussed research which indicates that the turbojet has Mach 4 speed capabilities.

Formidable obstacles stand in the way of the actual design and development of a turbojet capable of nearing the hypersonic speed region, but Lewis scientists who have conducted extensive research on aircraft propulsion systems and their components are confident that a Mach 4 turbojet can be built.

During the 15 years since the turbojet engine was first flown in the United States, significant progress has been made in its development. The United States has a number of turbojet-powered aircraft capable of sustained flight above twice the speed of sound. Even faster airplanes powered by turbojets are in the experimental stage.

A large portion of the Lewis research effort has been expended on the study of turbojet engine problems. In comparison with gas turbines in existence at the end of the war, today's engines have more than three times the power; at least twice the efficiency, and far more dependability. Weight has been held down, if not actually reduced, through research and development work by the Government and industry. In the intervening years, engine diameter has been reduced--a vital factor in the continuing quest for higher speeds.

The confidence of Lewis scientists that turbojet engines can be applied to flight speeds up to Mach 4 is based on research on the major engine components and from NACA analyses of engine characteristics. The facilities used to study turbojet engine problems at Lewis include wind tunnels and test cells for evaluating individual components, and high altitude test chambers in which complete propulsion systems are studied. Research indicates that the Mach 4 airplane must combine the advantages from the most advanced concepts in aerodynamics, airplane structures, and powerplants--all of which mutually influence each other.

In aircraft engines, thrust should exceed drag by about 35 percent throughout the speed range; if not, the airplane will accelerate so slowly that excessive fuel will be consumed during the acceleration to design speed--thus reducing the overall range.

An important factor in the success of any Mach 4 turbojet engine will be the design of inlet and exhaust systems. Although the basic turbojet may be capable of producing more than enough thrust to satisfy flight requirements under ideal conditions, thrust can be dissipated by installation details. Thrust is reduced primarily by pressure losses in air intake systems, drag due to inlet flow conditions, and shock or over-expansion losses in the exhaust nozzle. Furthermore, variable inlets and exhaust nozzles will be necessary on an engine of this speed capability, even though these devices add weight and complexity. A Mach 4 engine with fixed inlet and exhaust nozzle may be unable to fly faster than Mach 1.4. Takeoff itself would be marginal.

Considerable Mach 4 inlet and exhaust nozzle research is in progress at Lewis, including a special program to determine the best principles for designing inlets having high pressure recovery and low drag over a range of flight speeds up to Mach 4. Several research models devoted to the study of the complex inlet problem were shown during the Inspection.

Studies indicate that a Mach 4 turbojet need not have as great a pressure rise across the whole compressor as do current engines. Thus, by combining relaxed pressure rise requirements with improved transonic performance, NACA is able to conceive of an engine having only a three-stage compressor as compared to the 12 to 15 in today's engines.

Other NACA studies indicate satisfactory combustion can be obtained with much smaller combustor sections than are needed in present engines. The very short primary and afterburner combustion chambers of a Mach 4 engine would contribute to compactness.

Although it appears that aerodynamic and combustion principles of a Mach 4 engine are being worked out, practical construction will be difficult because of the high temperature environment in which engine components must operate. The compressor temperature of a Mach 4 turbojet is so high that its construction will require use of the alloys currently being used for turbine blades.

The necessity for a high stress level to match aerodynamic capabilities of the compressor will place heavy demands on turbine structural materials. Engine bearings and seals will represent another special problem--requiring measures to protect components from heating by ram air, as well as from temperatures generated inside the engine.

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For use: Monday, October 7, 1957

TWO LEWIS SUPERSONIC ENGINE TUNNELS PERMIT RESEARCH IN 600 to 2500 MPH RANGE

Two large wind tunnels, shown today during the Triennial Inspection of the Lewis Flight Propulsion Laboratory, enable NACA scientists to conduct ground research on aircraft engines and their components operating at speeds ranging from 600 to 2500 mph and at simulated altitudes to 30 miles. The tunnels are the recently completed 10 x 10 Foot Supersonic Wind Tunnel and the 8 x 6 Foot Supersonic Wind Tunnel which was modernized this year for transonic capacity.

Research conducted at both the Lewis wind tunnels includes investigation of full-scale aircraft powerplants, engine inlets and outlets, nacelle configurations and shapes, and aerodynamic interference between powerplants and the remainder of the aircraft structure. Work in these tunnels includes investigation of problem areas which must be studied further if a turbojet powerplant capable of speeds up to 4 times sonic velocity is to be developed. NACA scientists envision a Mach 4 turbojet as a practical research goal.

The 10 x 10 duplicates engine operating conditions in a speed range betwee 2 and more than 3.5 times sonic velocity and at altitudes more than 150,000 feet above the earth. This tunnel was completed in 1956 for use by NACA in cooperation with industry and the armed forces for development testing of engines and components for high-performance aircraft.

The 10 x 10 operates on two different cycles: When engines are under investigation, air from the atmosphere passes through the tunnel and is discharged back to the atmosphere through an acoustic muffler; for aerodynamic runs, air moves continuously around the tunnel circuit. The cycle path is controlled by the setting of a 24-foot diameter, 34-ton valve.

Supersonic speed in the stainless steel 10 x 10 foot test section is obtained by expanding air through an adjustable nozzle. Two axial flow compressors supply the necessary pressure differential during tunnel operation. Four electric motors totalling 150,000 hp turn the primary compressor, and three other motors supply 100,000 hp to the secondary. The altitude simulated in the test section is regulated by exhausters near the nozzle.

Temperature of the tunnel cycle is increased by heat of compression, as well as from combustion in the test engine. This heat is removed continuously by water in coolers located ahead of each compressor.

Although the temperature of the air before it enters the nozzle may be 300°F, the expansion process which achieves supersonic velocity may reduce the temperature to as low as minus-230°F in the test section. Since any moisture in the airstream would condense in the nozzle and cause nonuniform flow, moisture is removed in a huge air dryer before the air enters the tunnel.

The entire tunnel operation is conducted from the control room containing instruments for automatically recording temperatures, forces, and other data which are analyzed and incorporated in NACA technical documents by Lewis scientists. The control room is some distance from the test section, and several television screens in the room permit operators to monitor action in the test section.

Complementing the 10 x 10 is the eight-year-old 8 x 6 tunnel which has a new speed range from about 0.9 to 2.1 times the speed of sound. Formerly, it was limited to the supersonic end of this range. The 8 x 6 modernization included modification of the tunnel throat and test section for transonic (at or near the speed of sound), as well as supersonic operation, and erection of a duct which permits reuse of air within the tunnel to reduce limitations on operations set by air dryer capacity.

The 8 x 6 tunnel, which also operates on two cycles, was modified to allow greater flexing of the stainless steel tunnel walls to the position needed for transonic operation. In addition, 4700 holes were bored in the four walls of the test section, permitting air to "bleed" through the walls. A dome-shaped shell surrounding the test section is connected by a six -foot-diameter pipe to large vacuum pumps for removal of the "bleed" air.

Greater knowledge of the transonic flight speed range is required to increase performance of both airplanes and missiles. Operating requirements for aircraft powerplants differ greatly between supersonic and slower speeds, and some during flight all aircraft must operate in the transonic area.

Modification of the 8 x 6 tunnel cost $2-million, a fraction of the cost of a new facility.

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HIGH ENERGY PROPELLANTS BOOST ROCKET PERFORMANCE

The spectacular rocket developments of the past few years may be surpassed by even greater gains resulting from fuel researches described at today's Triennial Inspection of the NACA's Lewis Flight Propulsion Laboratory. Rocket propellants with higher energy hold this promise: NACA's rocket research effort is almost wholly directed toward the investigation of high energy fuels and oxidizers.

The fuel-oxidant combination most commonly used in rocketry today is modified jet fuel and liquid oxygen. Red fuming nitric acid and dimethylhydrazine are also being used extensively. Propellants that offer substantially higher specific impulse are fluorine-ammonia, fluroine-hydrazine, oxygen-hydrogen, fluorine-hydrogen, and ozone-hydrogen.

Many problems must be solved before the high-energy combinations can be put into operational use. Hydrogen has a high heat content but its density is so low that it requires very large tank space. Further, hydrogen is very difficult to maintain in liquid state.

Most of the problems, however, arise from the need to use oxidizers that will be highly effective. Ozone, theoretically one of the best oxidizers, is extremely unstable. If it is jarred or heated, or contacts the wrong material, a violent detonation is likely to occur.

In many ways, fluorine is the most desirable of all the oxidizers. At the same time it is among the most difficult to handle, and it is so reactive that it is difficult to contain in storage and flow systems. Fluorine's reactivity with fuels is so strong and the resulting combustion temperatures are so high that extraordinary difficulties must be overcome to accomplish successful injection of the fluorine and fuel into the burner chamber. Fluorine-supported flames may be 2000° to 3000°F hotter than oxygen - jet-fuel flames, which reach 5000°F. Better ways must be learned to cool rocket chambers when fluorine-fuel combinations are burned.

Design of gas generators, turbines, pumps, exhaust nozzles, and controls capable of efficient operation in the presence of violently reactive oxidizers, will also be necessary before rocket-engine systems can satisfactorily use the new oxidant-propellant combinations.

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NACA SEEKS METHODS TO PRODUCE BETTER HEAT-RESISTANT MATERIALS FOR NEW AIRCRAFT ENGINES

New engine materials with high strength at the extreme temperatures generated in hypersonic flight were discussed at the Triennial Inspection of the NACA Lewis Flight Propulsion Laboratory today. The laboratory seeks gas turbine materials with strength at 2000°F, ramjet materials for operation at 3000°F, and nuclear rocket materials that are strong at 5000°F. These metallurgical goals are keys to future outstanding gains in the propulsion sciences.

With extreme heating the atomic structure of a metal changes, causing it to creep or deform. By locking the atomic structure of the materials in place with refractory particles that do not melt, deformation can be prevented. Some of the conventional metal alloys dissolve these particles and thus lose strength under intense heating, but there are others that possess greater heat resistance and chemical inertness. Mixtures of small amounts of finely divided aluminum oxide in nickel are being studied as one means of improving heat strength. In the Lewis research program, it was found that this type of alloy retains strength at significantly higher temperatures, and no undue brittleness occurs.

Columbium, tungsten, and other high-melting point base metals offer another approach to the heat-resistant problem, although these have serious oxidation properties. With a melting point in excess of 6000°F, Tungsten retains considerable strength at 3500 degrees F. Study is being directed toward improving the oxidation resistance of tungsten and like materials. Some progress has been made with columbium, in reducing the rate of oxidation and altering the type of oxide formed.

Refractory ceramics suggest still another means of combatting the temperature problem. These have worthwhile resistance to heating and oxidation, but they are too brittle. Therefore, they would fail under thermal and mechanical shocks likely to be encountered in missile re-entry, and in propulsion system operations.

Brittleness of ceramics is not completely understood but some studies indicate that certain ones may be inherently ductile except for surface imperfections. Some of the investigations of this subject in the laboratory have shown, in a limited way, that elimination of surface imperfections can help maintain ductility. By surface treatment of single crystals of magnesium oxide and sodium chloride ductile ceramics have been created in the Lewis Laboratory.

Much research on the overall problem of heat resistance in materials remains to be accomplished, the Lewis spokesmen said in their demonstration. Although results have been encourageing, considerable more work needs to be done before the highly advanced materials for use in engines or structural aircraft and missile parts will be available.

--END--

NACA

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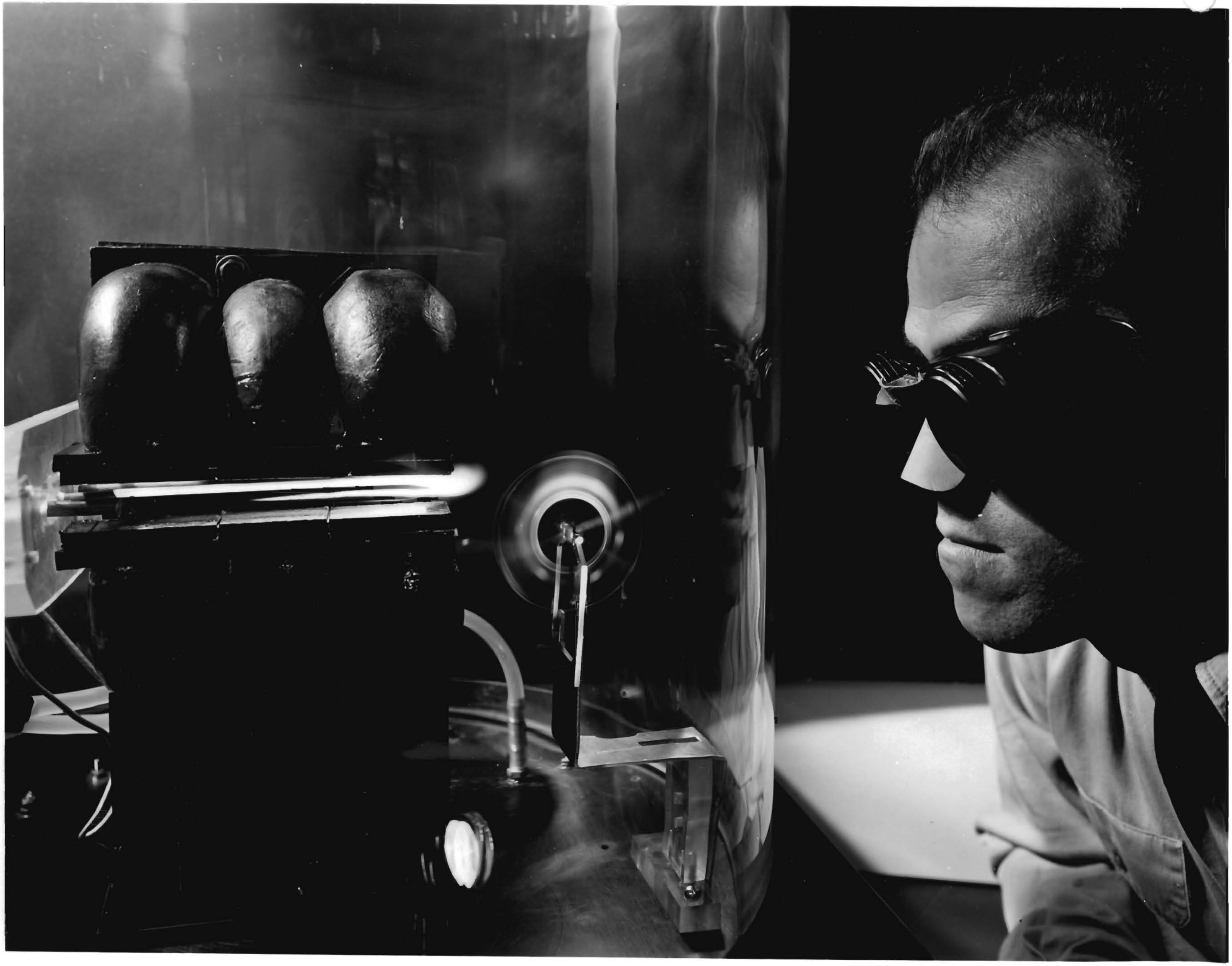
Lewis Flight Propulsion Laboratory
Cleveland, Ohio

C-45903

A two-stage hypersonic rocket is prepared for flight test by launching from a B-57A bomber in the propulsion research program of the Lewis Laboratory. NACA pilots fly these research models to altitudes as high as 50,000 feet. This 15-foot, 440-pound rocket is carried by the airplane above 45,000 feet, then launched with its nose headed slightly downward. Top velocity at the end of burnout of the second stage is Mach No. 10.5 (about 7000 miles an hour) at 40,000 feet.

NACA
46015



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Cleveland, Ohio

C-46015

A miniature laboratory ion-propulsion model, operating at near vacuum conditions, produces thrust which is detected by the small wheel behind the jet. An ion jet is produced when charged particles are formed in an electric discharge between two electrodes, and are accelerated by a magnetic field. An ion-propulsion unit serving as a low thrust engine may be useful in flight at extreme altitudes. However, many problems must be solved before it will be practical.

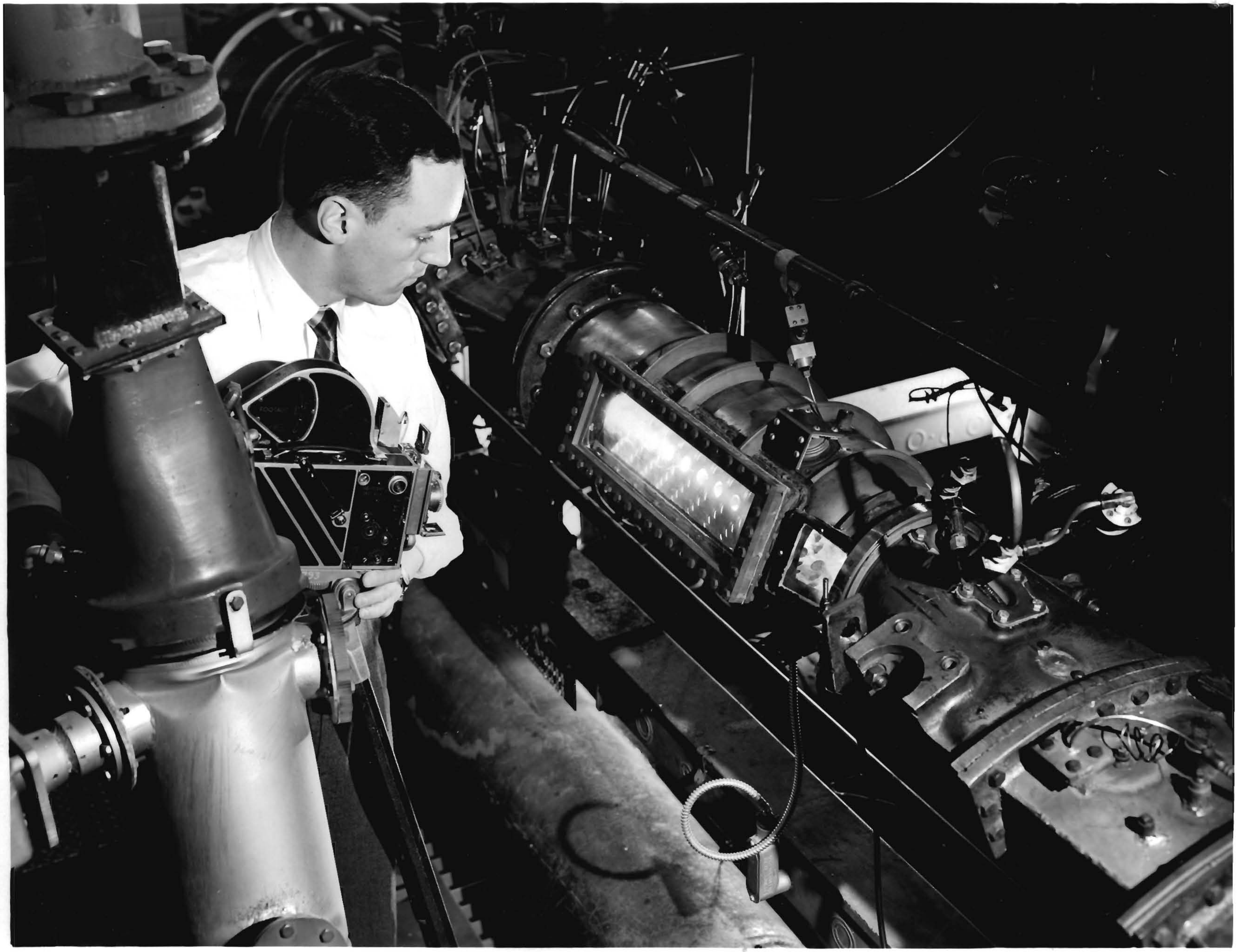
NACA
C-45671

National Advisory Committee for Aeronautics
Lewis Flight Propulsion Laboratory, Cleveland, Ohio

C-45671

An experimental supersonic aircraft model is prepared by an NACA research scientist and a technician for operation in the test section of the 10 x 10 Foot Supersonic Wind Tunnel at the NACA Lewis Laboratory. This facility permits testing of advanced design aircraft engines and their components at speeds of 1500 to 2500 mph at simulated altitudes up to 30 miles. (8.570)

NACA
37671



National Advisory Committee for Aeronautics
Lewis Flight Propulsion Laboratory
Cleveland, Ohio

C-37671

Research to find new fuels that would have higher energy content has been a major effort of the Lewis Laboratory for more than 10 years. Here, a Lewis engineer operates a combustion test apparatus on a high-energy chemical fuel study. The fuels program has included predictions of theoretical fuel performance, study of new compounds and determination of their properties, and investigation of new chemicals in engine operations. By increasing the energy content of fuels, scientists seek to improve the range and performance of propulsion systems in aircraft and missiles.

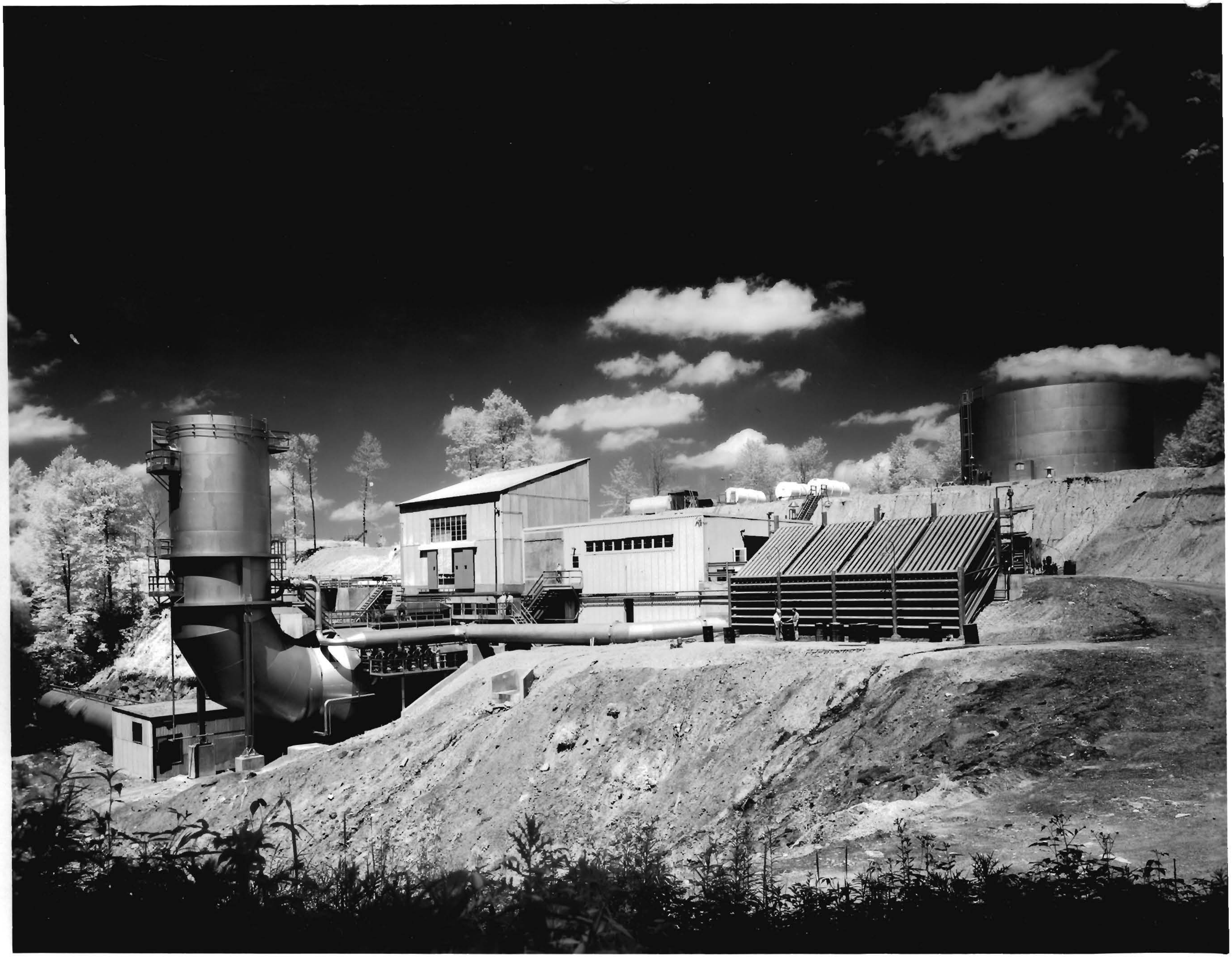
C- 45925

National Advisory Committee for Aeronautics
Lewis Flight Propulsion Laboratory
Cleveland, Ohio

C-45925

A cloud chamber is used by Lewis scientists to obtain information aimed at minimizing undesirable effects of radiation on nuclear-powered aircraft components. Here, alpha particles from a polonium source emit in a flower-like pattern at the cloud chamber's center. The particles are made visible by means of alcohol vapor diffusing from an area at room temperature to an area at minus-78° Centigrade.

NACA
15652



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Lewis Flight Propulsion Laboratory, Cleveland, Ohio

C-45652

The Lewis Rocket Engine Research Facility, completed during August 1957, is a $2.5-million addition to the aeronautical research equipment available to NACA scientists. Activity here is undertaking to determine, with practical-sized rocket engines, means to effectively utilize new high-energy fuels. The facility is versatile enough to permit research and design ideas to be carried through initial investigations with low-cost fuels before using scarce, more expensive fuels. The installation consists of a thrust stand, propellant supply and storage systems, silencing equipment and exhaust gas disposal system, and an operations building which includes an instrument and control room. (10.570)

NACA
C-42303

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Cleveland, Ohio

C-42303

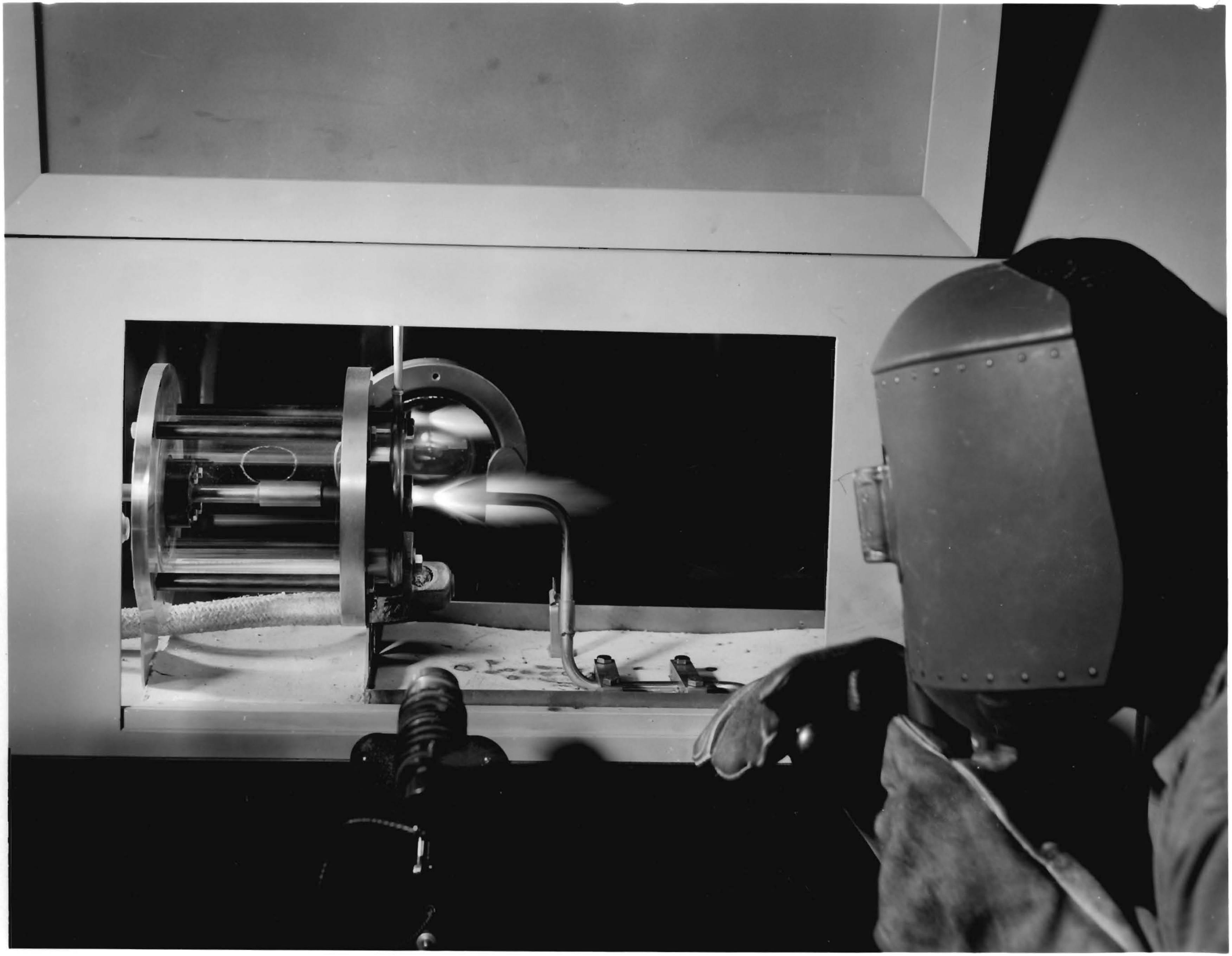
The Lewis 10x10-Foot Supersonic Wind Tunnel is operated by NACA in cooperation with industry and the armed forces for development testing of full-scale engines and components for high-performance aircraft.

Research is conducted on aircraft powerplant inlets and outlets, nacelle configurations and shapes, and aerodynamic interference between powerplants and the remainder of the aircraft structure. The year-old tunnel simulates conditions at speeds in a range from 1500 to 2500 mph and altitudes up to 30 miles.

The steel air duct at right leads to the tunnel test section, housed in the long, narrow structure in the center. The building at left and the one at the opposite end of the intervening steel duct house axial flow compressors, which supply the air flow. Seven electric motors totaling 250,000 hp drive the compressors. Flanking the center ducting are an air dryer (top center) and an acoustic muffler (center). Offices and shops are housed in the building area in the lower part of the photograph.

NACA

C-46018



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C-46018

A plasma jet of ionized air, hotter than the surface of the sun, disintegrates a small aircraft model. This laboratory device is useful in the study of aerodynamic heating problems. The jet is produced in an arc chamber by arcing a high electric current between a tungsten cathode rod and a graphite anode nozzle. By injecting a working fluid and passing it through the nozzle, the high temperature jet is formed.

NACA
C-45726

National Advisory Committee for Aeronautics
Lewis Flight Propulsion Laboratory, Cleveland, Ohio

C-45726 An NACA aeronautical research scientist compares materials under a barrage of atoms to determine which are most resistant to atomic attack and more useful in missile and rocket manufacture. Atoms are produced by passing a gas at low pressures through a high voltage discharge. Fast vacuum pumps make the atoms hit a material test sample. Conditions in this laboratory experiment are similar to those experienced by a missile flying through the upper atmosphere encountering large numbers of chemically active free atoms formed by dissociation of the atmosphere's gas molecules. (8.570)

NACA

C [illegible]907

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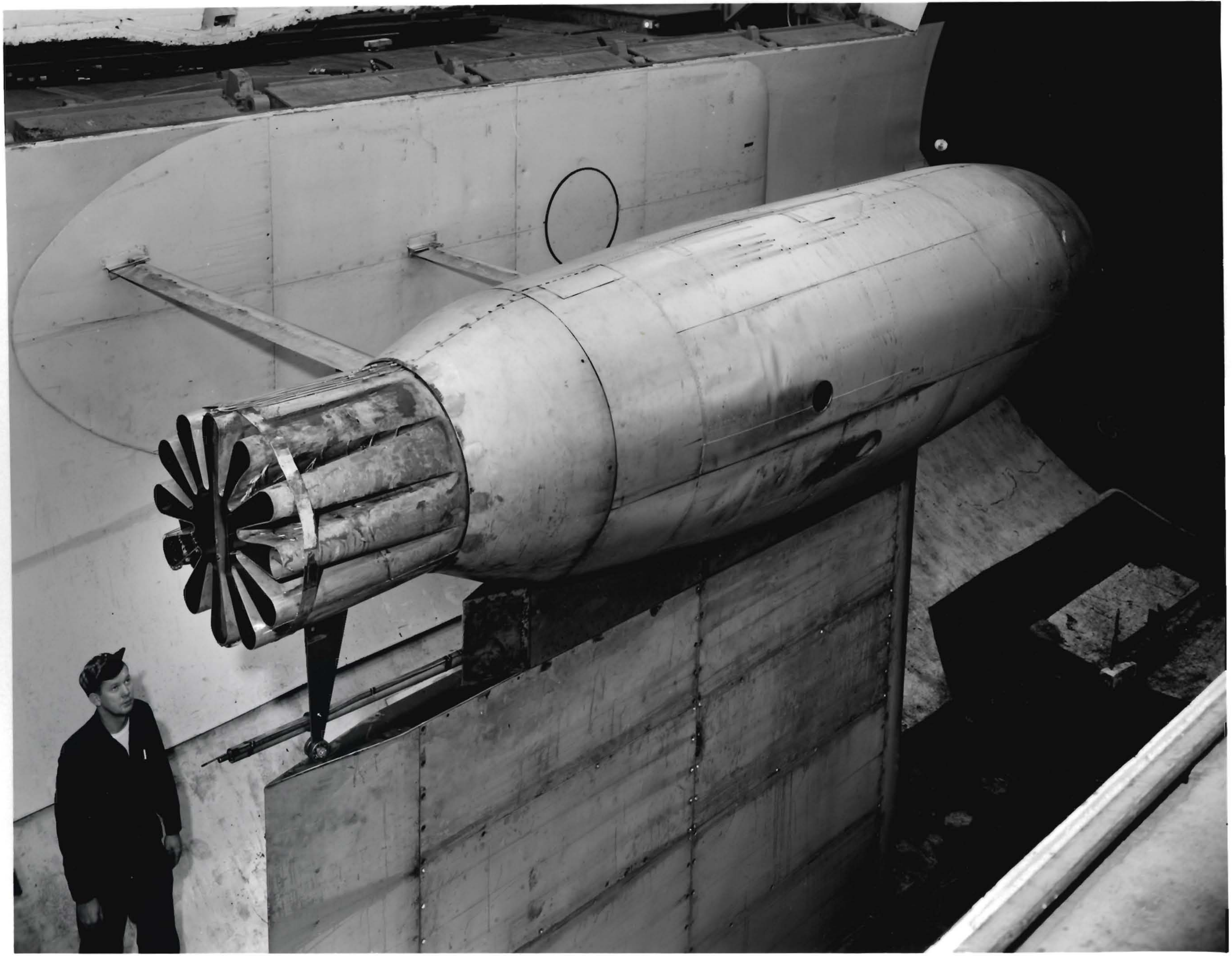
C-43907

An NACA aeronautical research scientist, displays a model of a theoretical Mach 4 turbojet engine based on a composite of advanced ideas from component research and cycle analysis. The compressor-turbine section is dwarfed by the large air inlet and the highly expanded exhaust nozzle. The basic engine is much shorter than present engines, since it utilizes only three instead of 12 to 15 compressor blade rows. The primary burner and afterburner can be very short if the fullest advantage is taken of highly reactive, easily combustible, high-energy, non-hydrocarbon fuels.

NACA

C 14227



National Advisory Committee for Aeronautics
Lewis Flight Propulsion Laboratory
Cleveland, Ohio

C-44227

An experimental turbojet noise suppressor nozzle is mounted on an engine in the Lewis Altitude Wind Tunnel during investigations of means for reducing jet aircraft noise. Jet exhaust and the air do not mix smoothly; hot gas and air roll up into irregular swirls and eddies producing fluctuating pressures which are radiated as sound waves. Research has been conducted on various nozzle shapes, some of which will lessen the noise substantially by reducing the peak sound levels at certain frequencies. Difficulties are encountered in the design of such nozzles, to keep drag, weight, and engine performance penalties at a minimum while at the same time accomplishing the desired noise reduction.