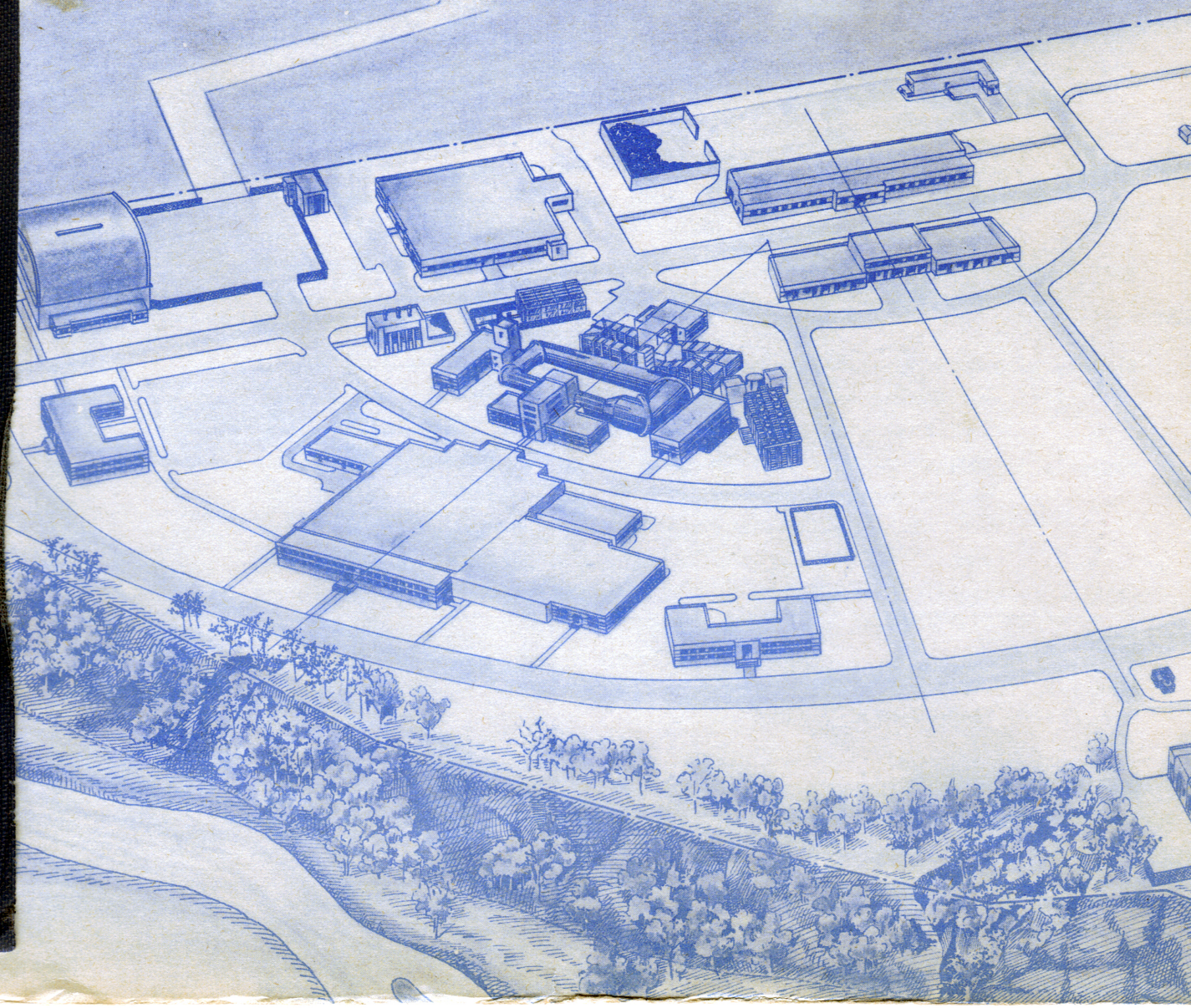
Aviation Writers Association Inspection June 11th 1945 of the

AIRCRAFT ENGINE RESEARCH LABORATORY

National Advisory Committee for Aeronautics



AIRCRAFT ENGINE RESEARCH LABORATORY
CLEVELAND, OHIO

Edward R. Sharp,
Manager

Robert C. Sessions,
Assistant Manager

Eugene C. Braig, Jr.,
Administrative Officer

Charles A. Herrmann,
Service Branch Engineer

James R. Braig,
Property Officer

Carl H. Dawson,
Chief, Auditing Division

Beverly G. Gulick,
Chief, Design Division

Franklin J. Hobson,
Chief, Buildings and Grounds Division

John D. Tousignant,
Personnel Officer

Robert E. Tozier,
Chief, Instrument Division

Dan White,
Chief, Fabrication Division

Carlton Kemper,
Executive Engineer

Addison M. Rothrock,
Acting Executive Engineer

John H. Collins, Jr.,
Chief, Engine Research Division

Willson H. Hunter,
Chief, Icing Research Division

Charles S. Moore
Chief, Engine Components Research Division

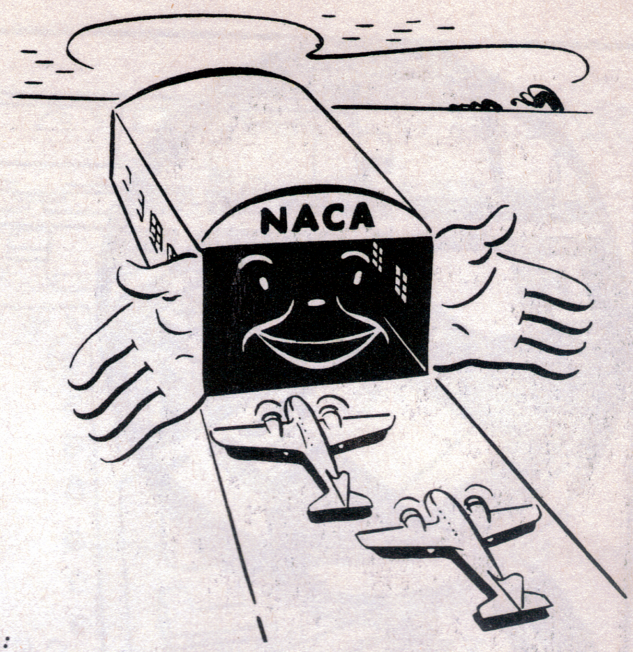
Benjamin Pinkel,
Chief, Thermodynamics Division

Addison M. Rothrock,
Chief, Fuels and Lubricants Division

Oscar W. Schey,
Chief, Supercharger and Airflow Research Division

Abe Silverstein,
Chief, Engine Installation Research Division

Joseph R. Vensel,
Chief, Flight Research Division



Cleveland, Ohio
June 11, 1945

To Members of the Aviation Writers Association:

Sometime before the Japs made the mistake of starting a war with us we, of NACA, threw wraps over our wind tunnels and research laboratories. We quietly started working like never before to do whatever the Army and Navy called on us to do to assist the aviation industry fashion the equipment which licked the Germans and which are taking the Nips in stride.

It has been a long time since any of you have visited us. We have expanded from the section we are now pleased to call the 'East Area' of Langley Field (the 'West Area' is new to you) to this great Aircraft Engine Research Laboratory at Cleveland and to another aerodynamics laboratory at Moffett Field, California.

We know, and are very proud of it, that your confidence in us has never wavered even though we were obliged to keep our work secret from you. As a sort of V-E Day celebration we are going to show you today, in most candid fashion, what we have been and are up to. Much work lies ahead of us - primarily to help beat the Japs - and forever to contribute all that we are capable of to keep America first in the air. We have looked forward to the time when we could re-extend our welcome to you and this day marks that occasion.

Many thanks for coming to Cleveland and we hope that you will find the opportunity to visit us more often in the future.

NACA
Aircraft Engine Research Laboratory

pressure at the compressor outlet. To obtain the high rotative speeds with the lightest weight impeller requires a study of the strength of impellers of the various desired shapes made from different materials being considered. Impellers are spun at speeds sufficient to make them fly apart from the centrifugal forees developed to determine the margin of safety of the breaking speed over the desired operating speed.

AXIAL-FLOW COMPRESSOR

The axial-flow blower has the desirable characteristics of small diameter and high efficiency for use as the compressor for gas turbine aircraft power plants as used for jet propulsion. It, however, has a narrow range of airflow capacity when compared with centrifugal compressors. The axial-flow blower is being investigated for application to jet propulsion type power plants to utilize its high efficiency for increased power and reduced fuel consumption and its smaller diameter for less drag.

COMBUSTION INVESTIGATION (NACA HIGH-SPEED CAMERA)

The existence of knocking combustion in engines was known long before its nature was understood. By means of high speed photography the knocking phenomena can be studied. By knowing the nature of knock and its causes investigations can be made to suppress it or eliminate the ill effects of knock on the engines.

JET PROPULSION COMBUSTION RESEARCH

The burning of fuels in jet propulsion engines requires the burning of extremely large quantities of fuel in small combustion chambers. More efficient burning of the fuel reduces losses from incomplete combustion with consequent improvement in fuel economy. A number of new fuels that appear promising for use in jet propulsion engines will require special consideration in burner design if efficient combustion is to be obtained to take advantage of their higher energy content.

FUEL SYNTHESIS

The synthesizing of pure hydrocarbon fuels with better characteristics than existing fuels make possible the evaluation of potential increases in power and economy of existing aircraft power plants by fuel improvement. Engine tests with improved fuels indicate where changes should be made in the engines to take full advantage of possible gains by using new fuels.

ALTITUDE WIND TUNNEL

When new aircraft power plants are being developed such as the recent jet propulsion engine development, it is necessary to know the operational characteristics of the new engines in as short a time as possible. Because of the variation in weather conditions, hazards in the use of new and untried power plants, and limitations on weight and space for instruments, flight research may be too expensive in time and equipment to carry out comprehensive and certain specific investigations satisfactorily. In the altitude wind tunnel temperatures and pressures can be attained at will equal to a summer, winter or mean day for a range of altitudes up to and exceeding that of the airplane ceiling.

ICING RESEARCH TUNNEL

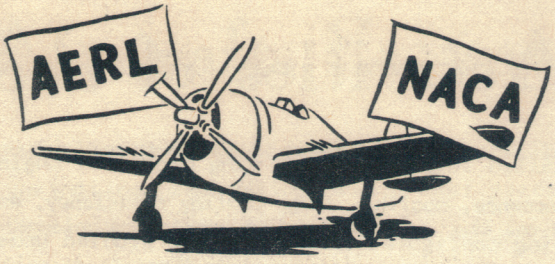
Research on the prevention and removal of ice formations in and on the various parts of the airplane as wings, engine, air induction system, fuselage parts and attachments, is primarily safety research. Elimination of the icing hazard on operational military airplanes would allow our military commanders to ignore the fairly prevalent weather conditions conducive to ice formation in planning operations without risking the loss of valuable airplanes and far more valuable men.

INTERMITTENT RAM JET PROPULSION

The intermittent ram jet which was utilized by the Germans as the propulsion means for the V-1 buzz bomb is not new in principle, but is outstanding in simplicity among aircraft power plants and may also be classed as outstanding from the standpoint of high fuel consumption. The results of the research and development of the enemy in aircraft propulsion systems must be evaluated to utilize and improve on all available developments for possible use.

JET PROPULSION ENGINE RESEARCH

Jet propulsion engines are investigated in the laboratory to determine the best lines of attack to increase the thrust developed by these engines, and to reduce the fuel consumed.



The Aircraft Engine Research Laboratory — the NACA

The Aircraft Engine Research Laboratory of the National Advisory Committee for Aeronautics is representative of a revolution in aeronautics. The revolution occurs in the field of aircraft propulsion. Much of this laboratory is devoted to the full exploration of that field. The research regions are vast and many, such as, high-temperature alloys for gas turbines and jet-propulsion engines, more efficient compressor and combustion chambers, gas turbines and rocket power plants, and fuels for supplying power. The new propulsion systems open up extraordinary high speed posibilities which pose many aerodynamic problems for the other NACA laboratories.

A very considerable amount of research work remains to be done in connection with reciprocating-type power plants and a considerable proportion of the Aircraft Engine Research Laboratory's facilities are devoted to this end.

Ground was broken for construction of the Laboratory at Cleveland Airport in January 1941 and the first research project was started in May 1942. By the spring of 1945 the $24,000,000 installation comprised some fifteen large buildings and numerous smaller testing laboratories.

THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

The National Advisory Committee for Aeronautics was established by the Congress in 1915, to deal broadly with scientific aeronautical research. Its principal function is to explore the infinite field of aeronautics and to provide a solid foundation for aeronautics as an exact science. In carrying out this function, it has amassed countless, priceless data from its wind tunnels, test cells, chemical retorts, and flight research equipment for use by the Nation's aeronautical engineers. There is no airplane in existence today whose design is not profoundly influenced by NACA research.

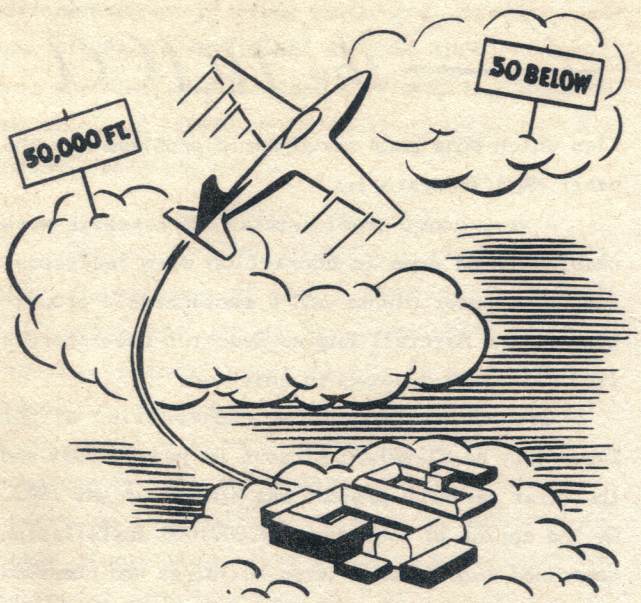
The fifteen Committee members represent the Army and Navy, other Government departments contributing to aviation, and top-ranking scientists from private life. Under the chairmanship of Dr. Jerome C. Hunsaker the Committee employs a most impressive staff of engineers, scientists, and technicians whose efforts are directed by Dr. George W. Lewis. The gathering of the Nation's talents is completed with the serving of the aviation industry's key engineers, on the numerous subcommittees which guide work on specific aeronautical problems. Probably in no other single scientific field of endeavor have the people of the United States provided for such an inclusive organization of brains and laboratory equipment.

The carefully calculated growth of NACA's research facilities marks American progress in aeronautics during the past thirty years. The original Langley Field research station at Hampton, Virginia has grown steadily with the years and is the largest and best equipped laboratory of its kind in the world.

To meet the extraordinary demand for technological superiority in the war emergency, and to insure the maintenance of our Nation's superior position in both military and civil aviation in the years to come, the Government later expanded its NACA research facilities to include another aerodynamics laboratory at Moffett Field, California and the Aircraft Engine Research Laboratory at Cleveland, Ohio.

From these three laboratories have come the basic scientific data which have been so brilliantly applied by the Army and Navy in evaluating and specifying its aviation equipment and by the private aviation industry's engineers in designing and producing America's unmatched aircraft.

The Equipment and Activities of the



More than 130,000 horsepower are installed to drive the research equipment at the Aircraft Engine Research Laboratory.

Under maximum operating conditions, approximately 50,000 horsepower are required to operate the ALTITUDE WIND TUNNEL -- the only wind tunnel of its kind anywhere. It is capable of testing complete aircraft propulsion installations under precise altitude conditions up to 30,000 feet, while pressure conditions can be simulated up to 50,000 feet. Humidity, temperature, and pressure conditions at altitude can be duplicated in the tunnel test section. The tunnel is designed to give wind velocities up to 500 miles per hour. The world's largest refrigerating plant with a capacity equivalent to 20,000,000 pounds of ice daily can lower the air temperature to -48° F. This unparalleled design achievement is the most effective research apparatus in existence for the jet-propulsion and gas-turbine work.

The Engine Installation Research Division, one of AERL's eight research divisions, is in charge of the Altitude Wind Tunnel. With its equipment, the division under Mr. Abe Silverstein can make full-scale studies of complete power plants as they are installed in fuselages or wing nacelles. Engine performance, cooling, drag, cowling efficiency, and fairing configurations can all be studied under almost perfectly simulated flight conditions.

Another unique research tunnel is the ICING RESEARCH TUNNEL used to investigate flight characteristics of propeller power plants and aircraft components under icing conditions. In this tunnel spray water is introduced into the wind stream by spray nozzles located around the tunnel perimeter immediately before the converging section. Icing is achieved by lowering the tunnel air temperature to as low as -60° F. Any atmospheric flight condition can be reproduced through the accurate control of air temperature, spray water drop-size, water concentration and air velocities up to 400 miles per hour. The tunnel has three test sections - one 6' by 9' for studying icing conditions on engines, cowlings, wing sections, and other aircraft components; another section 12' by 15' for conducting icing research on propellers; and a third section 26' by 29-1/2' for studying the icing of rotating wing aircraft.

In this tunnel the *Icing Research Division*, under Mr. Willson H. Hunter, tackles the problem of icing, probably the most serious limiting-operations factor in aviation. Both prevention of ice formations and elimination of ice are the subjects of this division's intensive research activity.

The huge ENGINE RESEARCH BUILDING, consisting of 5-1/2 acres of floor space, has nearly a hundred different research laboratories devoted to the study of all elements of aircraft power plants. To mention a few, there are numerous engine and gas-turbine dynamometer laboratories, supercharger test stands, jet-propulsion burner laboratories, and altitude chambers for testing engine accessories at low temperatures or air pressures. There are laboratories for research on piston rings, carburetor ignition systems, automatic ignition controls, cylinder barrels, fuel-injection systems, crankshaft connecting rods, bearings, and so on. Still other laboratories are devoted to fundamental and applied

Aircraft Engine Research Laboratory

research on problems of heat transfer, metallurgy, lubrication, combustion, waste heat recovery, vibration and stress of engine parts, and ice formation in aircraft carburetors.

The nerve center of this vast operation is a main control room in the mezzanine basement of the building. From this small room one man dispatches power, cooling air, cooling water, and provides reduced air pressures and temperatures which makes it possible to run tests on engines and components under simulated altitude conditions.

Virtually every research division of the laboratory conducts research within the Engine Research Building. *The Engine Research Division*, under Mr. John H. Collins, Jr., is concerned with research work on detailed engine parts such as cylinders, pistons, valves, and crankshafts.

The *Engine Components Research Division*, with Mr. Charles S. Moore as head, conducts research on engine auxiliary components such as carburetor and induction systems, fuel injection, ignition, automatic engine controls, and the like.

Upon the *Thermodynamics Research Division* falls, in a large measure, the far-reaching problems connected with jet propulsion and gas turbines. Mr. Benjamin Pinkel heads the work of this Division. Heat-transfer research in any type of engine, however, is the concern of the Thermodynamics group. Engine cooling consistent with maximum power output, and conversion of waste heat energy of exhaust gases into useful power are typical of these research fields.

Mr. Oscar W. Schey is chief of the *Supercharger and Airflow Research Division* which is also deeply involved in jet-propulsion and gas-turbine research. Compressor investigations represent the focal point of this activity. As the division title implies, the group also conducts research on supercharging and internal air flow including pumping and ducting.

The HANGAR houses the *Flight Research Division* and the numerous aircraft used in the work. There is still room for a B-29 Superfortress in the hangar in addition to the ten airplanes of various sizes now there. The aircraft range from single-engine fighter types to four-engine bombers and each of them is a flying engine laboratory. For example, the research instrumentations on the B-24 is so extensive as to provide 10,000 data readings on a research flight.

The three main functions of the *Flight Research Division* headed by Mr. Joseph R. Vensel are to conduct primary research on aircraft power plants that cannot be done under simulated conditions; to obtain fundamental power-plant operating data so that research projects can be planned; and to prove data obtained from other research methods.

The FUELS AND LUBRICANTS BUILDING contains chemical and physical laboratories where fundamental research is conducted on aircraft fuels and lubricants. Rare fuels, commercially unobtainable,

are synthetically produced in glass-lined reactors and purified in three-story high distillation columns. These fuels are studied to determine their qualities for aviation application. The laboratories are equipped with the latest in spectrographic equipment, an electron microscope capable of 30,000 diameter magnification, special equipment for studying combustion phenomena, and other advanced research tools.

The *Fuels and Lubricants Division*, under Mr. Addison M. Rothrock, has as its prime objective the investigation of methods of securing more power and range from power plants through the kinds of fuels and lubricants used. Considerable fuels synthesis research is conducted in this division's laboratories in the search for fuels with higher antiknock characteristics than possessed by current aviation fuels.

The JET PROPULSION STATIC LABORATORY contains test cells for the measurement of performance of jet engines at sea-level conditions. These cells correspond to the dynamometer rooms used for reciprocating engines, but thrust rather than horsepower is measured.

The ENGINE PROPELLER RESEARCH BUILDING consists of sound-proof test cells in which engines with propellers are mounted and operated at high powers. Electrically driven air fans draw air through ducts to create a stream of cooling air over the engines. Fuels tests, water-injection tests and cooling investigations are among the studies carried on here. At the moment one cell is being used for the investigation of V-1 buzz bombs with a view toward adapting them for our own uses.

The TECHNICAL SERVICE BUILDING houses the indispensable Instrument Division, under Mr. Robert E. Tozier, where the research instruments are developed and serviced. Also here are the machine shop, wood shop, sheet-metal shop, metallurgical heat-treat shop, and the others which contribute so heavily to the research effort.

The ADMINISTRATION BUILDING accommodates administrative personnel, and many research division heads. Also here is the technical library which maintains the latest research results from aeronautical groups in the United States and in foreign countries.

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