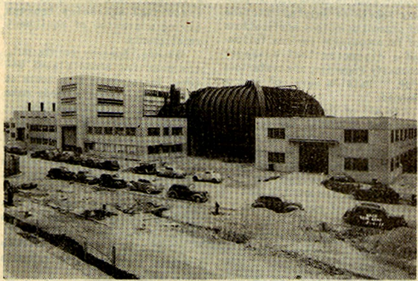
START BIGGEST BOND DRIVE

From page 1

BONDadiers have been appointed in almost all divisions. Not yet appointed are workers in the Buildings and Grounds and Auditing Divisions. Others are: Engine Components, Clara Dornon; Engine Research, Catherine Varian; Instruments; Helen Saxer, Ida Rusnak, and Jean Menke; Flight Research, Phillip Pragliola; Fuels and Lubes, Phyllis Hayes; Manager's Office, Charles E. Cooper; Icing Research, Willis Kenyon and Richard Lyons; Thermodynamics, Christine Montgomery; Design, Evelyn Lasch; Engine Installation, George Darchuk; Supercharger, Fred J. Hartwig, Jr.; Fabrication, George Krynak; Expediting, Robert Schmidt; Engineering Services, E. Daniel Williams; Executive Engineers' Office, Ferris L. Seashore; Administrative, Arline Grentzer; and Cafeteria, Helen Thompson.

FEATURES AERL WIND TUNNEL



"Much of the research into future aircraft engines will come from laboratories being built at Cleveland Airport by the government's National Advisory Committee for Aeronautics," says Business Week in a recent issue. "Main feature of this project is the huge wind tunnel that's designed to test gas turbines and other experimental power plants at all practical temperatures and simulated altitudes."

AERO DIGEST - August 1, 1944.

NEW NACA WIND TUNNELS

Two new wind tunnels recently placed in operation by the NACA will make possible a greatly expanded research program, and are expected to develop valuable information on the performance of engines and airplanes under conditions not hitherto reproduced in wind tunnels.

One of these tunnels is located at the research laboratory of the NACA in Cleveland, and the other at Moffett Field, Cal., where it forms part of the Ames Aeronautical Laboratory.

The Cleveland tunnel is the first designed especially for investigating aircraft powerplants under altitude conditions. It is the most complete equipment yet developed for getting the "bugs" out of entire powerplants designed for high-altitude operation before the airplane goes into production. The tunnel was rushed to completion for secret investigations of new military powerplants, including jet propulsion systems.

The tunnel is constructed of a steel alloy especially adapted to temperature changes, and is supported through steel rollers on concrete piers in such a manner as to provide for movement in any direction, to permit expansion and contraction of the steel shell. Heat losses are minimized by an insulating layer of glass wool which is, in turn, covered by a steel casing. An 18,000-hp electrical motor drives the 31-ft diam, 12-bladed propeller on an extension shaft from outside the tunnel shell.

The diam of the tunnel test section was fixed at twenty ft by propeller requirements for engines of 3000 hp or greater. The altitude at which it was desired to conduct tests influenced the determination of the tunnel capacity. It is designed to simulate the sub-zero temperatures encountered at 30,000 ft, and is strong enough to simulate pressures encountered at 50,000 ft.

The refrigerating plant provided to produce altitude temperatures in the test section has a refrigerating capacity which, if utilized for ice making, would manufacture 10,000 tons of ice each 24 hr. Twenty thousand gallons of cooling water per minute are required to transfer the heat removed to the surrounding air, via the cooling tower.

The total power required by the tunnel to investigate a 3000-hp aircraft engine at 30,000 ft and 500 miles per hr airspeed is in in excess of 50,000 hp.

Because of the fact that powerplants are operated in the tunnel, provisions had to be made for cooling the air in the tunnel and disposing of the engine exhaust gas. The installation therefore includes cooling radiators, an intake-air duct and an exhaust-air scoop that are not normally parts of an aerodynamic wind tunnel.

Low/pressures are maintained within the tunnel by means of four large reciprocating exhausters located in a nearby building and connected by large ducts to a streamlined scoop downstream of the model.

The tunnel and the engine being investigated are both controlled from a soundproof control room adjacent to the test chamber. The tunnel operator, with the help of engineers in nearby buildings housing the refrigeration and exhausting equipment, is able to control the pressure, temperatures, and air speeds within the tunnel, the angle of attack of the model and the operation of the engine and propeller. Any desired combination of temperature and pressure can be obtained in the tunnel. Instrumentation is provided to indicate the forces on the model in addition to the complete performance data of the test engine and its accessories.

The tunnel at Moffett Field is the world's largest wind tunnel for full-scale airplane testing.

The tunnel is 868 ft in length, and has a ceiling height of 180 ft. Its width at one end is 399 ft, and 353 ft at the other. Unlike the usual cylindrical-shaped tunnel, the unit is box-shaped with exterior bracing - leaving the interior unobstructed for air flow.

Six 6000-hp motors, each driving a 6-bladed fan with a diam approximately the height of the average 4-story building, produce a wind velocity of more than 200 mph. The tunnel is constructed as a closed circuit, and 3888 curved vanes at the four corners turn the air at right angles without turbulence, achieving the greatest velocity at the minimum section of the tunnel, which is the test section.

The new tunnel is large enough for testing planes with wing spans up to 72 ft. This includes all present pursuit and fighter types, and even medium bombers.

The tunnel at Moffett Field is designed to test aerodynamic characteristics such as "lift" or "drag." By means of this type of testing NACA has usually been able to provide at least 20 additional mph to the speed of a new model airplane about to go into production.

Equipment previously installed at the Ames Aeronautical Laboratory, which was built by the NACA, includes three smaller wind tunnels as well as flight research laboratories and instrument shops.

NACA WIND TUNNEL IS IN OPERATION

More Than 50,000 Horsepower Is Required to Duplicate the Stratosphere Conditions for Investigating Aircraft Engines

The National Advisory Committee for Aeronautics has prepared and released for publication through its secretary, John F. Victory, the following article giving long-awaited facts about the altitude wind tunnel now in operation at the Aircraft Engine Research Laboratory at the Cleveland Airport. *Electrical Production* prints this authoritive article in full.

NACA officials have announced that the important Altitude Wind Tunnel has been placed in operation at the NACA Aircraft Engine Research Laboratory in Cleveland. Disclosure of the completion of the new tunnel, first of its kind in the world, marks the addition of a valuable unit to the nation's aeronautical research facilities. The tunnel has been rushed to completion for investigations of new military power plants, including jet propulsion systems.

The NACA Altitude Wind Tunnel is unique from several standpoints. It marks another in the NACA's long history of wind tunnel "firsts". It is the first of its kind for investigating under altitude conditions aircraft power plants as installed in airplanes. It is the most complete equipment as yet developed for getting the "bugs" out of entire power plants designed for high altitude operation before the airplane goes into production.

The diameter of the tunnel test section was fixed at twenty feet by propeller requirements for engines of 3000 horsepower or greater. The altitude at which it was desired to conduct tests influenced the determination of the tunnel capacity. The tunnel is designed to simulate the sub-zero temperatures encountered at 30,000 feet and is strong enough to simulate the pressures encountered at 50,000 feet.

The refrigerating plant provided to produce altitude temperatures in the tunnel test section has a refrigerating capacity which, if utilized for ice making, would manufacture 10,000 tons of ice each 24 hours. Twenty thousand gallons of cooling water per minute are required to transfer the heat removed to the surrounding air via the cooling tower.

The total power required by the tunnel to investigate a 3000 horsepower aircraft engine at 30,000 feet and 500 miles per hour airspeed, is in excess of 50,000 horsepower.

Because of the fact that power plants are operated in the tunnel,

GUIDE VANES for turning high-velocity air stream in the altitude wind tunnel, NACA Aircraft Engine Research Laboratory, Cleveland. This, the only wind tunnel of its type, is used to aid in improving aircraft engine performance

ELECTRICAL PRODUCTION MAGAZINE

Volume XVIII | August, 1944 | Number 2

Published by the Electrical League of Cleveland, J. E. North, president, Stanley Strunk, secretary. Title registered in U. S. Patent Office. Address communications to Electrical Production, 18th floor, Midland Building, Cleveland.

The National Advisory Committee for Aeronautics has announced that the vitally important wind tunnel at its Aircraft Engine Research Laboratory, Cleveland Airport, has been rushed to completion for "investigations of new military power plants, including jet propulsion systems."

While many of the facts about this new wind tunnel must be kept secret, NACA has prepared and released for publication through its secretary, John F. Victory, an article describing some of the interesting electrical installations. Beginning on the next page, *Electrical Production* prints this authoritative article in full.

In view of the increasingly important part that electric refrigeration is playing in many industries, you will be interested in NACA's description of the refrigerating plant now in operation at the Cleveland Airport laboratory. This plant, which makes possible the simulation of temperatures encountered at 30,000 feet and above, would produce 10,000 tons of ice each 24 hours if used for that purpose.

The article refers to other interesting electrical applications. In fact, when you read what NACA has to say about the use of electricity in its multi-million dollar plant, it will be apparent to you that a decisive factor that caused NACA to locate its new laboratory in Cleveland was the availability here of a dependable, ample supply of electricity at reasonable rates.

★ ★ ★

Speaking about an ample, dependable supply of electricity and what it means to industry, The Cleveland Electric Illuminating Company's 1940 annual report had this to say about the location of the NACA laboratory here:

"In keeping with its policy of doing all within its means to contribute to the progress of the communities it serves, the Company in 1940 assisted in bringing to its territory a considerable number of new enterprises. Largest of these is the Government's aircraft engine research laboratory, which the National Advisory Committee for Aeronautics is building at the Cleveland Municipal Airport. This laboratory is planned to improve aircraft engines and to expedite their production. It is expected that the presence of the laboratory also will add to Cleveland's long established importance in aircraft parts manufacturing."

★ ★ ★

Postwar, one of the great problems that will have to be solved, if our employment is to reach the required level, involves bringing to this area new industries to utilize the scores of fine modern plants built for war production.

Join in the effort to bring new industry to Greater Cleveland. Help this great industrial area to thrive postwar, too!

★ ★ ★

Another article in this issue we want to call to your particular attention is that by Mr. Charles Sanford, assistant to the president of the Cleveland Hardware & Forging Company. Mr. Sanford, beginning on Page 6, tells about the modernization of lighting in various departments in his plant. The new lighting reduced glare, helped to eliminate errors, promoted greater efficiency and contributed to greater plant safety.

★ ★ ★

Beginning on Page 8, Mr. A. B. Efroymson, president of the National Trminals Corp., describes how his warehouse met the greatly expanded demand for low-temperature food storage during the war.

★ ★ ★

Plug-in bus duct power distribution is being used more widely every day. One of the largest bus duct installations in the Greater Cleveland area, at The White Motor Company, is discussed in an article beginning on Page 10.

★ ★ ★

For a description of electric heat-treating furnaces as they are used in the metallurgical laboratory at the Cuyahoga Works of the American Steel & Wire Company turn to Pages 12 and 13.

OUR COVER PICTURE shows the new fluorescent lighting in the inspection department at Cleveland Hardware & Forging Company where girls check dimensions and thread measurements and for cold shots, underfills. Work now is accomplished with greater accuracy, fewer parts are returned.

provision had to be made for cooling the air in the tunnel and disposing of the engine exhaust gas. The installation therefore includes cooling radiators, intake-air duct and an exhaust-air scoop that are not normally parts of an aerodynamic wind tunnel.

The tunnel is of steel construction using an alloy especially adapted to temperature changes and is supported through steel rollers on concrete piers in such a manner as to provide for movement in any direction to permit expansion and contraction of the steel shell. Heat losses are minimized by an insulating layer of glass wool which is in turn covered by a steel cover.

The tunnel and the engine being investigated are both controlled from a sound-proof control room adjacent to the test chamber. From this location the tunnel operator, with the help of engineers stationed in nearby buildings housing the refrigeration and exhausting equipment, is able to control the pressure, temperatures, and air speeds within the tunnel, the angle of attack of the model and the operation of the engine and propeller. Instrumentation is provided to indicate the forces on the model in addition to the complete performance data of the test engine and its accessories.

Low air pressures are maintained within the tunnel by means of four large reciprocating exhausters located in a nearby building and connected by large ducts to a streamlined scoop down stream of the model.

The ventilating air removed by the exhausters is replaced by dried and refrigerated air and admitted into the tunnel through a pressure-controlled valve which is upstream of the tunnel cooling radiator and through a directionally-controlled nozzle located at the converging section of the tunnel and adjusted for each test model to direct the entering air toward the power plant air intake.

The main refrigeration of the wind tunnel is accomplished by means of a copper-plate fin type of heat exchanger located in the 51-foot dia-

(Continued on Page 27)

THIS 31-FOOT DIAMETER propeller is drivi electric motor and is on an extension shaft from

NACA ~~Wind~~ Tunnel Is In Operation

(Continued from Page 5)

meter end of the wind tunnel and connected to fourteen Carrier refrigerating units installed in the Refrigeration Building.

One of the chief purposes of the tunnel is to save time in clearing for production new types of airplanes designed to operate at the highest attainable altitudes. Nothing, however, takes the place of final flight tests. The NACA Altitude Tunnel can be used to study power plant performance at speeds and altitudes in excess of those attainable by the "Flying Laboratory." In addition, the tunnel allows control of air conditions manually. Any desired temperature and pressure combination may be obtained and reproduced for consecutive or repeat tests—a condition that is not available in flight testing, and a consideration that results in much delay in flight testing. Information obtained in the new NACA Cleveland tunnel will materially aid the war effort.

LABORATORY left to right: Altitude control equipment, altitude wind tunnel, temperature control equipment (largest refrigeration plant in the world). This tunnel is expected to gain for America a decided advantage in designing aircraft

Stratosphere HURRICANE Made To Order

Lab Outdoes Nature for Engine Test

NATURE in her most violent temper never equaled the bad weather to be created in the high altitude wind tunnel now under construction at the recently dedicated Aircraft Engine Research Laboratory of the National Advisory Committee for Aeronautics at the Cleveland Airport.

The tunnel will bring the frigid stratosphere down to earth and provide winds of higher velocity than airplanes have attained for the testing of aircraft engines.

This is the only high altitude wind tunnel in the world, unless Germany has secretly built one. Many wind tunnels for the testing of planes have been in use in America for years, but they are not refrigerated. Many refrigeration chambers are in use, but do not have wind. Many wind tunnels operate under air density conditions existing at sea level, but do not provide the rarefied atmospheric pressure of the stratosphere. This tunnel is the only one providing high wind, sub-zero frigidity, and the rarefied air encountered at high altitudes.

It is one of the most expensive single instruments for aeronautical research ever built, and will be of enormous significance in the aircraft program. It is expected to give American aircraft a definite advantage over enemy aircraft by improving their performance at high altitudes.

A man trapped in it could live but a few seconds while it is in operation. Suppose the unfortunate individual locked in the tunnel could survive with an oxygen mask. His next discomfort would be cold. The temperature would drop down and down to 67 degrees below zero, a point supposed to be constant in the stratosphere.

A properly equipped man might survive both the rare air and the extreme cold, but he would never survive the wind to be created by a giant fan. The wind will have a velocity of 500 miles per hour, and would flatten a man like a pancake against the walls of the tunnel.

No wind in nature has ever been measured at half that velocity. During the Florida hurricane of 1926 the weather bureau instruments broke after recording 132 m. p. h. The greatest natural wind velocity ever measured was 231 m. p. h. on the summit of Mt. Washington, N. H. Special instruments were used. Tornado velocities have been computed from after effects at 500 m. p. h., but never actually recorded by instruments.

The electric power required to raise this bottled-up tornado in the tunnel would light a medium size city. The giant fan is driven by 18,000 horsepower — sufficient energy to haul five freight trains of 100 loaded cars each. A total of 50,000 horsepower is required to operate the wind tunnel, together with its refrigerators and exhaust systems. This is enough to haul a train of about 1,000 loaded cars.

The toughest cooling problem ever tackled by engineers was involved in the building of the tunnel. The temperature on the outer surface of the insulation on a hot summer day may be 150 degrees, which means that 217 degrees difference may exist inside the tunnel and outside. Overcoming the surrounding temperature is comparatively simple. The tunnel walls, of course, are heavily insulated. The great problem is in dissipating the heat thrown off by the fan and the engine under test. This is estimated to be equivalent to the heat energy output of several railway locomotives.

"By ordinary methods of flight testing it has taken six months to a year to eliminate the bugs from a new model high altitude aircraft engine installation," said John Victory, secretary of the N. A. C. A., when he was here on a recent inspection. "With this tunnel we can eliminate the 'bugs' before the high altitude airplane goes into mass production, and get superior planes in the air far more quickly than by other methods. Time is what counts most in this war."

The tunnel will be used chiefly to develop more efficient aircraft power plants. Other N. A. C. A. tunnels which have long been in operation will continue to test wing designs, tail assemblies and other parts of the airplane for their aerodynamic properties.

Engines will be mounted in the tunnel with their propellers and wing sections. Instead of going to the stratosphere, the stratosphere will come to the engine. Instead of the plane moving through the air at 500 m. p. h., the air will be moving past the engine at that speed. Thus the engines will be tested under identically the same conditions that would obtain were a pilot to fly six or seven miles high to make the same test.

How long do you suppose the engine in your automobile would run in a stratosphere tornado. It would freeze stiff in 30 seconds.

Specific information concerning the size, shape and construction of the tunnel is a military secret of the first order. "Any exact information might be very valuable to the enemy," said Mr. Victory. "I believe the N. A. C. A. has the best wind tunnel designers in the world. At Langley Field alone we have more than 20 wind tunnels. The tunnel here is the result of our past experience in building others. WhenI tell you it will accommodate an engine of 4,000 h. p., that will give you some indication of its size. No aircraft engine of such horsepower has yet been used.

"What sort of engine problems will the tunnel help solve?" he was asked. "Give an example."

"Let's suppose you are flying a plane in Alaska," Victory answered. "At 30 below zero ordinary motor oil becomes very stiff. Planes fly in air that is much colder. Thus, lubrication of engines for efficiency over an extreme range of temperature is one of the problems. The artificial stratosphere will also be valuable for testing superchargers. A great many problems are so technical that to even tell what they are would be of value to the enemy. We do not want him to know either our weakness or our strength.

"Our goal is an engine with less weight and more power. We can't talk about the technical steps we take to reach the goal. We have come a long way, and we will go a lot farther."

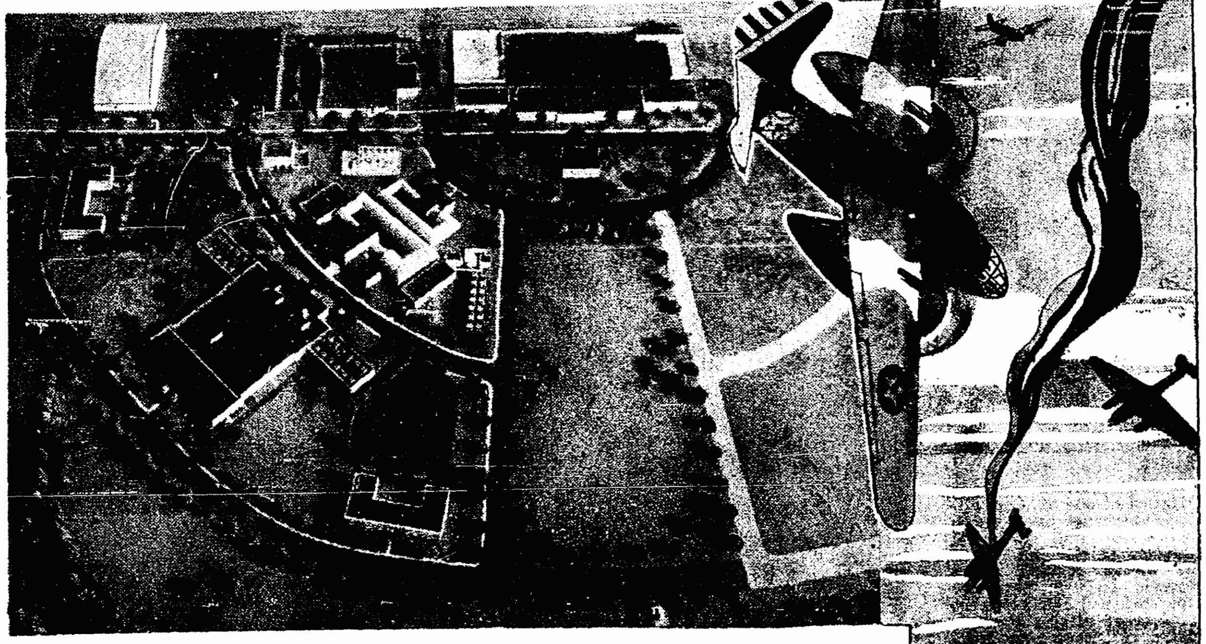
When ground was broken for the laboratory a little more than two years ago the tunnel was planned to reproduce conditions at a ceiling up to 30,000 feet and create a wind velocity of 300 miles per hour. The tunnel design has since been changed to reproduce the stratosphere at a considerable higher altitude—40,000 feet under certain conditions—besides adding 200 m. p. h. to the wind.

Next to the high altitude tunnel is a second smaller tunnel for the creation of another sort of bad weather. The temperature inside it will be almost 100 degrees warmer than in its big neighbor, but the "weather" will be just as uncomfortable. A high wind, humidity and a temperature of 30 degrees will reproduce sea level icing conditions.

Ice forms on plane wings at temperatures between 28 and 32 degrees, sometimes so rapidly that a flyer finds his plane out of control before he can seek a warmer layer of air to take it off. Aerodynamic designs and devices to prevent the formation of ice will be tested in this tunnel. It is not for engine work.

Let other cities brag about climate. We will brag about the brands of the world's worst weather, made to order for the purpose of developing planes for war and for peace that will fly safely and swiftly in any old kind of weather.

L. J. H.



Model of the Aircraft Engine Research Laboratory. The wind tunnels are the two white rectangular objects in the center of the photograph, the larger being the high altitude tunnel in which stratosphere hurricanes will be created

Cleveland Plain Dealer
June 6, 1943