planes

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NEEDED: 50,000 FIRMS TO BUILD AIRCRAFT

Computer 'Flies' Jet Engines

U. S. aircraft industry ingenuity has now come up with a new cost saving, time saving device — a giant computing machine that can save up to two years and several million dollars in the development of advanced-design jet engines.

One of the largest ever built, this unique analog computer will enable engineers to "fly" jet engines *before* they are built and to forecast performance characteristics of control systems for jet engines that are still on the drawing boards.

The computer will become the "brain" for a jet engine simulator that will reduce costly wind-tunnel testing and cut down the time and cost of flight-testing.

"Flying" the computer, an engineer can become a "test pilot" and in a matter of a few hours can see how his blueprint engine reacts to such conditions as giving it the throttle at 20,000 feet altitude, 40 degrees below zero air temperature and at a speed of 1,260 miles an hour.

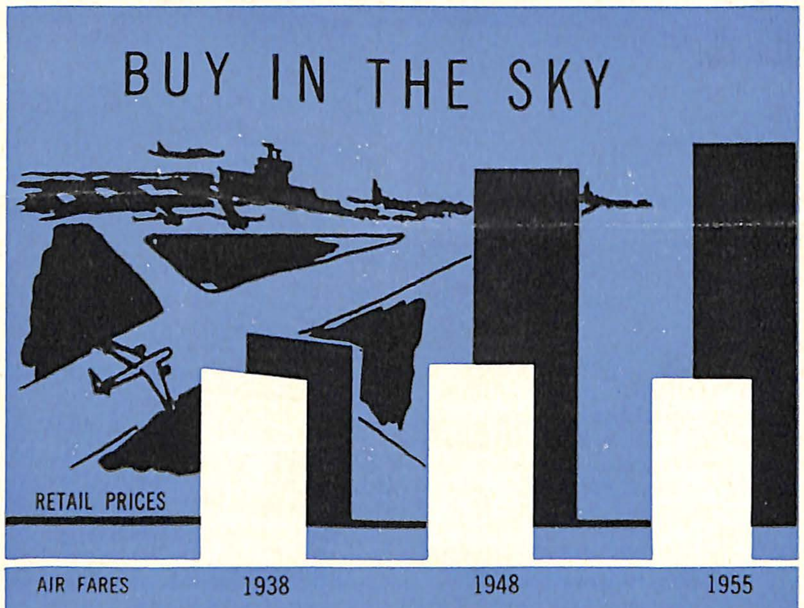
Previously it was not possible to check out a pre-production engine control system on a sufficiently large number of engines of one type. In many instances, the engine is either not available and its expected performance data is lacking, or, if an experimental prototype of the engine is available, engineers have been unwilling to risk the expensive prototype in gruelling tests.

Checking out an experimental engine control system normally takes up to six months and costs several million dollars in the wind-tunnel and flight test phases.

The machine works this way:

Engineers study the specific problem at hand and reduce it to mathematical form. They then convert it into equations. The computer works out these equations electrically and comes up with the answer in the time it takes an air molecule to pass through an actual engine.

The computer, which took six years to build, measures 35 by 100 feet and is 12 feet high. It covers a floor area of 2,635 feet, roughly the equivalent of three average-sized homes, and uses 40 tons of air conditioning, equivalent to air conditioning 15 average-sized homes.



Fares charged by the scheduled air transport industry have increased less than 4 per cent since 1938, while retail prices soared more than 105 per cent. In terms of 1938 dollars, air fares have been cut 50 per cent. The low fares are due to the larger, faster, more economical transports built by the aircraft industry and the efficient operations of the airlines.

— PLANES

Revolutionary Chemical Etching Process 'Mills' Intricate Steel, Titanium Aircraft Parts

A revolutionary process of precision milling of steel and titanium by chemical etching has been developed by the aircraft industry in its constant efforts to cut costs and improve production methods.

The process removes unwanted metal from complex, fragile formed parts or simple parts without warpage or rejection that might result from machining. Aluminum alloy parts have been subjected to the chemical etching process in the past. However, the need for higher-strength, more heat resistant materials in modern aircraft and missiles accelerated the development of a process to etch steel and titanium, and a pilot plant is now in operation.

Most important contributions made by the process are the reduction in weight and the number of parts in assemblies. Aircraft engineers are no longer limited in their design ideas to what is possible through conventional machining. There is considerable time saved in the process since many parts can be etched simultaneously. The only limiting factor is the size of the tanks containing the chemicals. The cost of removing the aluminum alloy by this process is only one-quarter that of a comparable machine tool operation.

The process essentially consists of leaving the area of a part to be "milled" bare and covering the remaining area with a protective coating. The part is then placed into a caustic bath so that the unnecessary metal can be etched away. It permits making broad or narrow cuts with sharp corners and close tolerance tapering.

The pilot plant now being used for steel and titanium parts proves that the chemical facility occupies less space than those used by the equivalent in machine tools.

Industry Sets Up Aid Program

By George Hannaum

Director of Industry Planning Service
Aircraft Industries Association

This is the age of specialization in the world of industrial organization just as it is in the fields of science and medicine. The ever-increasing productivity of American industry is due in large part to the system of supply which utilizes the specialized skills and facilities of the entire industrial community. It is the nerve system that permits industry to fully use all of America's muscles of production.

This same law of efficient quantity production also governs the production of aircraft, guided missiles and their thousands of complex components. The aircraft industry uses the manufacturing skills of more than 50,000 subcontractors and suppliers. In size these suppliers range from a small shop with two or three employees to the largest automobile manufacturing concerns. More than 80 per cent of these outside suppliers are classified as small business, since they employ less than 500 people. Furthermore, most of these small, medium and large subcontractors and suppliers must call upon other members of the industrial community to help them perform their portion of the job.

Thus, a prime contract for the production of aircraft and aeronautical equipment is cut up into perhaps more than 100,000 separate pieces and scattered throughout the entire industrial structure of this country. This chain-reaction effect from the prime contractor on down through the many tiers of subcontractors and suppliers divides the job to be done among those companies which have proven ability to meet both quality and cost yardsticks.

The extent to which the aircraft industry uses outside sources in the development and production of aircraft and guided missiles sometimes gives the impression that these items are produced through the use of a rather elaborate do-it-yourself kit, with the prime contractor merely assembling the various parts. It is somewhat more than that.

First, few of the suppliers to this

(*See SUBCONTRACTING, Page 3*)

PLANES

Planes is published by the Aircraft Industries Association of America, Inc., the national trade association of the manufacturers of military, transport, and personal aircraft, helicopters, flying missiles and their accessories, instruments and components.

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Foster a better public understanding of Air Power and the requirements essential to preservation of American leadership in the air;
Illustrate and explain the special problems of the aircraft industry and its vital role in our national security.

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The Limitless Vista

Graduates of our universities and colleges who this month received their degrees in engineering or science have before them the limitless vista of man's progress through technological gains. It is an inspiring scene. Recent breakthroughs in scientific knowledge have brought us to the brink of an understanding of the very laws of nature — the composition of matter — so the scientists say.

This new crop of young scientists and engineers, spurred by the progress already made, are ready to assume key roles in a future that will pale even the imaginary world of science fiction.

There is only one barrier to the discoveries that will make a fuller life for all the world's people: lack of numbers in trained brainpower. That alone can prolong the solution to the problems that limit us.

There is strong evidence that the American public is becoming more and more aware of the need for engineers and scientists to unlock new doors of knowledge. A recent public opinion survey conducted by the Aircraft Industries Association points up this consciousness of the necessity of urging our youth to take up these exciting careers. The public was asked: "In view of the shortages of engineers and scientists, should algebra and geometry (as the doorways to higher mathematics) be required high school subjects for all boys?" The replies: 77 per cent said "yes"; only 12 per cent said "no," and the balance had no opinion.

This attitude is encouraging, particularly in view of the fact that as recently as 1949, the Department of Labor, in its *Employment Outlook For Engineers*, made this doleful prediction: "In the next few years, the number of graduates will greatly exceed the demand for graduate engineers. . . . Schools could admit even fewer students and still provide an adequate supply of engineering personnel."

It would be impossible to assess the harm caused by the statement, which spread through the nation's schools and colleges. The prediction could not have been more inaccurate. Last year, there were 70,000 job opportunities for the 22,000 engineering graduates. And there is no indication that the demand has reached a stable plateau.

The initial responsibility for encouraging youth to take up engineering and scientific careers is as intimate and close as the family itself. Parents who would insure their children a good share of the future should carefully weigh the advantages of promoting their natural interest in engineering and science.

The aircraft industry offers one of the most challenging futures, with its ever-widening fields of engineering and science. The challenge of developing the aircraft and missiles of the next decade embraces nearly every form of science and engineering. The aircraft industry represents a marriage of the highest skills and talents in these fields.

The engineer in the aircraft industry has come of age. He is no longer bound by the old and disproven idea that an engineer can only be an engineer. In today's involved technology, it takes a background of engineering and science to make the managerial decisions in a company. More and more persons with engineering backgrounds are becoming key figures in the management teams that are the backbone of our aircraft companies.

In aviation there are no horizons. The long-feared sonic barrier has been left far behind. Mach 2 (twice the speed of sound) has been passed, and new multiples are being set up for future travel. Atomic power, which will allow aircraft to circle the globe without landing, is in early prospect. In the upcoming geophysical year, man will make his first venture into outer space with an earth satellite. The intercontinental ballistic missile soon will appear. Researches into the thermal barrier (the terrific heats created by multiples of the speed of sound) are in immediate prospect. There is even a serious research project to explore anti-gravitation — a plan to use the power in the pull of gravity. All of these are definite aircraft industry targets.

The drama and adventure in these scientific developments provide a solid basis for youth interest. General Thomas S. Power, commander of the Air Research and Development Command, recently stated the case with wisdom and wit: "Like the Soviets, we must stimulate the desire for scientific careers in our youth, and we must erase from their minds the pathetic picture of the impractical dreamer whose only rewards for accomplishment are the plaudits of other dreamers. Instead, we must create the picture of a 'Davy Crockett' of science, the modern pioneer fighting on the frontiers of human knowledge."

Tomorrow belongs to these frontiersmen.

Plane Views

— PLANES

New Plane Lubricants Beat the Heat

Constantly searching for new ways to beat the heat and stress caused by supersonic speeds in modern jets, the U. S. aircraft industry is now experimenting with high-temperature aircraft lubricants that will operate between 1,000 and 2,000 degrees Fahrenheit—more than three times hotter than existing lubricants.

The new compounds will open up entire new horizons in aircraft engine design. They will apply to both hydraulic and bearing systems.

Today the upper limit is around 500 degres in aircraft hydraulic systems and around 350 in bearings. Silicone fluids can take up to 700.

The new lubricants mark an extremely significant breakthrough in the thermal barrier. The problem of cracking the thermal barrier in lubrication has been one of the most critical bottlenecks in developing supersonic planes.

Some of these compounds have such a fantastically high boiling point that they will actually freeze at temperatures around 400 degrees.

The challenge to the aircraft industry scientist is to design these stable, high-boiling molecules so that they will be fluid at lower temperatures, and will have the necessary oiliness characteristic.

Air Quote

"The bomber production of a potential attacker is a factor in determining the number of air defense interceptors and radars we need. Whether he has 1,000 more or 1,000 fewer interceptors than we do is meaningless in our air defense problem because interceptors do not fight interceptors.

"The number of his interceptors is important, however, in determining the number of offensive airplanes we would need for success in our retaliatory attacks.

"We need enough offensive airplanes — fighter bombers, light bombers, and heavy bombers, to successfully penetrate the air defenses of a hostile nation and to attack the air bases that support strikes against us. We need enough to neutralize his military forces. We need enough to eliminate his ability to hurt us.

"In short, we need enough defensive weapons to stop a potential enemy and enough offensive weapons to defeat him, if he attacks." — General Thomas D. White, Vice Chief of Staff, USAF.

Subcontracting Gives Mobilization Base Depth for Emergencies

(*Continued from page* 1)
industry, unlike those engaged in production for the commercial markets, supply standard off-the-shelf items. Many of these complex components and parts have been specially designed by either the prime contractor or the subcontractor. Units are designed for functional output and limited installation space which further complicates design. Much of this equipment is under development at the same time as the airframe, and like the airframe it has "bugs" in it which must be found and corrected before the whole article can be delivered in acceptable form.

Often, for mobilization purposes, the extent of subcontracting in the aircraft industry goes beyond the point where it would normally be considered economically feasible. It must be remembered that with highly technical advances, such as we are now making, come complexities both in management and product that make it more and more difficult to convert, in case of a national emergency, from the production of automobiles to airplanes; TV sets to bombsights; or typewriters to fire control mechanisms. It can be done, but not overnight. It is this system of outside suppliers, with its roots going deep into the industrial structure of the nation, that gives the mobilization base its production strength. A broadened mobilization base scatters the target for enemy bombers, but a mobilization base in depth provides the ability to accelerate production rapidly in an emergency.

These circumstances require not only more careful consideration in the selection of a subcontractor and supplier, but a much closer liaison between the prime contractor and the subcontractor during performance.

The overriding factor in the selection of a subcontractor or supplier is the maintenance of high standards of quality, on-time delivery, and economy. To insure that these requirements are met, subcontractors and suppliers are carefully screened on these major factors:

1. **Stability of manpower and level of technical know-how available.**
2. **Availability of suitable facilities and manufacturing space.**
3. **Ability to meet specifications and quality requirements.**
4. **Past performance, including economy of operation and reliability.**
5. **Financial responsibility and business reputation.**

Once a contractor has signed a subcontract, the duties, risks and responsibilities have only begun. The prime contractor, or higher tier subcontractor, is responsible for the performance and workmanship of the complete aircraft or missile, regardless of who manufactures the components. In the case of a single-source supply of a major component, the entire success of a prime contract rests squarely on the subcontractor's performance.

Prime contractors and many of the larger subcontractors, therefore, have established an extensive program to assist the subcontractor and insure proper performance of the contract. The program includes these features.

1. Field teams provide constant liaison with suppliers on problems concerning production performance, conformance to drawings, quality control, blueprint interpretation, materials handling, securing of essential materials, coordination of engineering changes and inspection. The field liaison insures that the collective effort of all suppliers will result in the parts arriving at the right place at the right time. Great stress is placed on the requirement for precision workmanship.

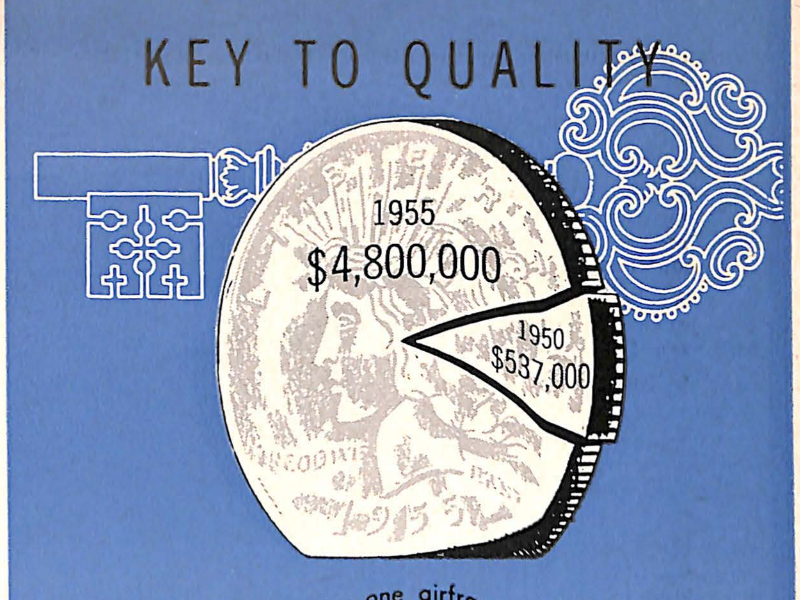
2. The contractor's management organization is made available to assist the subcontractor. Key people visit the subcontractor's plant, and in some cases, representatives are assigned on a semi-permanent basis to work with the subcontractor.

3. Varied techniques are used to bring subcontractors and suppliers into the prime contractor's family. Subcontractor representatives are invited to attend symposia organized by the prime on tooling, quality control, material conservation, manufacturing, and similar matters. Specialists in each field provide these representatives with the latest information to help solve their problems. These meetings are a two-way street; the prime is also able to learn from the subcontractor.

4. The prime contractor also periodically reviews the subcontractor's performance and progress. Analysis of supplier production control data provides warning of slowdowns in deliveries. When this occurs, task forces are assigned to assist in finding solutions before the time delay becomes critical enough to delay production.

Despite the necessity for subcontracting for economic reasons, as well as for mobilization purposes and despite the continual urgings by Congress to expand subcontracting and outside purchases, particularly among small business, the prime contractor is often penalized financially for expanding his subcontracting activities. The rate of earnings that he is permitted to retain by the Renegotiation Board on this portion of his total sales volume is considerably lower than the profits he may retain on the manufacturing done within his own organization. Generally, the same will hold true within the military insofar as the negotiation of profit rates is concerned.

There is no question that subcontracting must continue at a high rate. But the incentive to do subcontracting should be clear-cut, and the penalty removed to give the aircraft industry the fullest possible freedom in furthering the program.



Funds expended by one airframe company for research and development increased from $537,000 in 1950 to $4,800,000 in 1955, a gain of 793 per cent. This reinvestment of earnings illustrates the efforts of the aircraft industry to retain America's qualitative air power lead.

—PLANES

Rugged Engine Test Series Involves Bombarding Turboprop with Salvos of Ice Balls

Aircraft engines must be able to operate in all kinds of weather. And the aircraft industry has devised some amazing tests to prove their ruggedness and reliability.

For example, a turboprop engine was recently put through a series of tests that demonstrated its ability to operate in ice and hail. The engine was set up on a rigid test stand and operated at 13,838 revolutions per minute without its propeller. Spheres of ice ranging in size from a half inch to three inches in diameter were prepared, weighing nearly a half pound each at the maximum. The spheres were stored at zero temperature until shortly before use and then were warmed slowly to 25 to 30 degrees for maximum toughness.

A special gun was devised which fired them into the compressor inlet at speeds up to 425 miles per hour. The rig was tested with a two-inch rubber ball which penetrated a sheet of plywood, three-quarters of an inch thick.

The tests started by firing small ice pellets at 200 miles per hour and worked up to firing one-and-a-half-inch ice balls directly into the air inlet at 425 miles per hour. Salvos of four one-inch balls peppered the inlet guide vanes.

High speed movies at 6,000 frames per second showed the ice balls shattering against the inlet guide vanes and the fragments passing into the compressor. The vanes oscillated as much as a quarter of an inch for a fraction of a second under the impact. The only discernible damage was a dent in the leading edge of one vane and two other vanes were slightly bowed.

In another test, an air inlet duct from a military turboprop aircraft was installed on the engine, and ice balls up to three inches in diameter were fired into the duct while the engine spun at 13,838 revolutions per minute. Multiple salvos of 30 ice balls of various sizes totalling two pounds in weight were fired.

The tests clearly proved that even under these simulated hail conditions, which exceeded those encountered in actual flight, the engines would continue to operate.

As an additional backstop, modern turboprop aircraft will use storm detecting radar which would keep the aircraft clear of such areas in the first place.

Radioactive Material Aids Safety Drive

A radioactive material has been turned into a safety agent by the aircraft industry.

One knotty problem in aircraft production is insuring the removal of rivet bucking bars and other small tools from the aircraft and component sub-assemblies prior to flight.

The aircraft industry, after lengthy study and testing, developed a method of imbedding a small amount of radioactive material—Cesium 137—in the body of each tool. The tool is absolutely safe to handle, but still gives off sufficient radiation that can be detected by scintillation counters.

Many methods of tool recovery were tested before this system was adopted. The gamma rays given off by Cesium 137 are energetic enough so that minor obstructions between the source and the detector do not seriously limit detectability. No adverse change in radiation output occurs during the average life of the tool.

Water Triggers Life Jacket

A new life saving device that automatically inflates a pilot's "Mae West" life jacket upon contact with water has been perfected by one of the nation's large aircraft companies. The automatic life jacket inflator compares in importance with such standard safety features as the automatic lap belt and automatic parachute release.

The entire automatic inflator assembly weighs five ounces, and will inflate a life jacket within 15 seconds after immersion in water. Formerly, pilots falling unconscious into the water usually drowned because the inflator was not automatic.

The new device consists of a cap, a piston, a spring-loaded plunger, a soft rubber flapper valve and an effervescent pill (60 per cent tartaric acid and 40 per cent sodium bicarbonate) that is about the size of an Alka Seltzer tablet.

The automatic inflator does not interfere with the normal manual operation. As the pilot drops into the ocean, water rushes through an opening in one end of the metal cap, forcing open the rubber flutter valve. The water passes through the valve and strikes the surface of the tablet causing it to dissolve and produce a cloud of gas. The gas pushes the flutter valve back into place at one end of the small chamber and forces down the piston at the other end. This in turn releases the spring-loaded plunger, which strikes the manual operating lever with the force of a hard yank by a man, fires the cartridge and thus inflates the jacket.

The device cannot be set off accidentally by rainfall, heavy dew or accumulated moisture, such as might be encountered by military pilots under field conditions, because the flutter valve holds the opening closed until it is forced open by the pressure of a body of water on the outside.

Precision Gages Set Industry Standards

Precision is the hallmark of the aircraft industry and the gage is accuracy's final authority.

One aircraft engine manufacturer uses more than 47,000 precision measuring instruments. It is not unusual to find tolerances of parts, such as certain ball bearings, held to 50-millionths of an inch — less than $^1/_{24}$ the thickness of a human hair. One gage is capable of taking 18 different measurements at the same time.

The necessity for these critical tolerances is due to the great gains made by aircraft engine manufacturers in the horsepower-to-engine weight ratio. At the end of World War I, an aircraft engine developed one horsepower for each two-and-a-quarter pounds of weight. At the end of World War II, the weight was down to one pound per horsepower under combat conditions.

Today a modern jet engine delivers the equivalent of six horsepower for each pound of weight. Only by quality, which is based on strict precision, can this be achieved — and the gage sets the standard.

Jet Ground Noise Drastically Reduced By New Attachment

Another important advance in ground jet engine noise suppression has been made by the aircraft industry.

A new noise control attachment will drastically cut the jet exhaust sound, thereby permitting mechanics to work in a more comfortable environment, and substantially reduce the noise in areas immediately behind the exhaust during ground run-ups.

The device is a perforated sheet metal cylinder around which are wrapped three conical shrouds. It is about six feet long, two feet in diameter and weighs 150 pounds. It is equipped with a simple clamp which permits easy attachment to the engine tailpipe.

Its value was dramatically demonstrated during a recent field test in which it was attached to the engine of a long-range jet bomber. The engine was started and, after idling it for a few minutes, its power was increased to where it normally would be developing more than 10,000 pounds thrust. After the test was completed, one of the spectators standing about 100 feet away inquired as to when they were going to start running the engines.

The new noise control device is not a silencer in the strict sense of the word. It controls the turbulent flow so that what noise is produced is of such a high frequency it is not audible to the human ear.

MATS Crosses Ocean Once Every Hour

Military Air Transport Service, which marks its eighth anniversary this month, has carried approximately 3,770,000 passengers, and its planes have crossed the Pacific and Atlantic Oceans more than 93,000 times — an average of a plane an hour around the clock.

A new turboprop cargo aircraft, capable of carrying a payload of 100,000 pounds for 1,000 miles, is scheduled to join the MATS fleet this year. The aircraft industry has consistently provided the military with a series of high-speed, long-range transport aircraft to enable MATS to carry out its global logistics assignment.

Altitude Simulator Hits New High

Capable of simulating altitudes which at the present time can be reached only by rocket-powered aircraft, a new mammoth laboratory facility recently installed in Phoenix, Arizona, is helping to propel the U. S. aircraft industry's continual drive for better, faster, more efficiently produced aircraft.

Illustrative of the vast sums being invested by industry in research and development projects, this privately financed $5 million production test facility makes it now possible to test, research and develop, at a record rate, hundreds of aircraft components and accessory systems. These are a major part of the vast and complex auxiliary systems required by today's and tomorrow's ultra-modern jet aircraft.

An intricative compressed air system in the test facility requires hundreds of miles of piping to channel off air at different pressures and temperatures to all parts of the laboratory for mass production testing purposes. Vacuum pumps used in operating the compressor system are 4500 times more powerful than a household vacuum sweeper.

Products which can be mass production tested at the new test facility are gas turbine engines, air turbines, air turbines starters, pneumatic controls, cabin pressure regulators, hot and cold air valves, refrigeration turbines, heat transfer equipment, as well as complete systems employing these components.

Vital pressurization and cooling equipment for ever higher flying aircraft are put to extreme testing in the new facility's giant altitude and cold chamber. Measuring 15 feet in diameter and 32 feet long, atmospheric conditions from more than 1000 feet below sea level to more than 75,000 feet above sea level may be created in the cabin atmosphere altitude chambers. Here any type of aeronautical produce may be tested.

Banks of instruments outside the chamber control its atmosphere. It can climb from sea level to 70,000 feet in one minute. Temperatures range from −75 degrees Fahrenheit to 500 degrees Fahrenheit—and an extreme low of −125 degrees Fahrenheit can be reached.