CLIMATIC LABORATORY

LINEAGE

STATIONS

ASSIGNMENTS

COMMANDERS

HONORS
Service Streamers

Campaign Streamers

Armed Forces Expeditionary Streamers

Decorations

EMBLEM

EMBLEM SIGNIFICANCE

MOTTO

NICKNAME

OPERATIONS

1. PURPOSE OF THE PROTECT

The United States Air Force requires that all aircraft, aircraft ground and personal equipment used by the Air Forces operate satisfactorily under all climatic conditions or be capable of operating satisfactorily after undergoing minor modifications. The operating temperature criterion sets forth a range from -65 °F to +160°F. All design and manufacture must be directed towards operating under these conditions.

To meet the United States Air Force requirements and to insure satisfactory functioning of aircraft and equipment in all theaters of operation during all seasons of the year, a climatic testing program has been established. This testing program includes functional, engineering and developmental, comparative and procedural tests.

Previously, all testing of aircraft and equipment for operational suitability in extreme climates has been done in natural locations. This has involved many difficult problems such as:

a. The great distances of transportation to these natural locations of items to be tested, personnel to perform tests, and necessary supplies.

b. Time lost in waiting for temperatures suitable for testing and the short duration of these temperatures.

c. Lack of necessary close coordination between the designers, manufacturers, and the testing organization due to distances involved.

d. Time lost after required modifications and redesign have been accomplished waiting for natural testing conditions.

To supplement and reduce the required fields testing program and still make possible year-round testing under controlled temperatures and other climatic conditions, the Climatic Hangar has been constructed at the Air Proving Ground, Eglin Air Force Base, Florida.

2. SCOPE OF THE PROTECT

Testing Facilities. The Climatic Hangar consists mainly of an insulated hangar 200 feet by 250 feet, 70 feet high; an equipment and engine test room 30 feet by 133 feet, 25 feet high; a cold test room, hot test room, desert test room, jungle test room, and tropic-marine test room, each 13 feet by 13 feet; an all-weather room for physiological testing, 13 feet by 34 feet; and a refrigerated strato-chamber, 10 feet by 14 feet. An armament strato-chamber, with facilities for absorbing concussion of small arms, is installed in an adjacent building.

Temperatures within some of the facilities may be controlled from -100 °F to +165 °F, with corresponding control of humilities above 32°F. Provisions have been made for localized wind storms up to 100 m.p.h. in combination with sleet, snow, rain, dust, and sand. Artificial sunlight equivalent to noonday desert sun is provided. Thus all normal and extreme climatic conditions can be simulated within the hangar or test rooms. There are no provisions for opera-ing the main chamber under reduced pressures; however, a refrigerated variable pressure chamber (strato-chamber) is provided for high altitude and climb testing of personnel and personal equipment.

Types of Testing Possible. The great size of the hangar makes it possible to subject the largest military airplane now designed or under construction to climatic functional testing. Facilities are provided so that all types of aircraft, including jet engine and prop-jet aircraft and their parts, can be tested. Engines can be run up and ground tested, weapons fired, bombs dropped, simulated landings and takeoffs made to test landing gear struts, brake action checked, and the functioning of electrical, hydraulic and heating systems tested. Motorized ground vehicles can be driven within the hangar and subjected to simulated road tests. Ground equipment can be subjected to climatic tests to determine its suitability. The physiological testing facilities are such that personnel and personal equipment can be tested in all climatic conditions, at all operating altitudes, and under flight-climb conditions. Also, test facilities are provided so that climatic tests of long duration can be made to determine weathering effects on both stored material and operating equipment.

In planning the Climatic Hangar, the objective has been to provide facilities which will simulate service conditions. Thus climatic testing in the hangar can be closely coordinated with service testing at natural climatic lactations. Salt spray and fungus tests at high temperature and humidity can be accomplished.

3. HANGAR

a. Functional operational testing of completely assembled aircraft. This will cover all systems, integral assemblies and parts, including engine starts and ground run-ups with engines installed in the airplanes.

b. Testing of all ground equipment used in the operation and maintenance of aircraft.

c. Testing of motorized ground vehicles by operating on a road testing course.

d. Testing of personal clothing and equipment for determination of the types which give maximum efficiency in performing maintenance work on aircraft

e. Study of the effects of extreme weather conditions of personnel.

f. Study of the time required to perform maintenance work under different extreme weather conditions.

General Description. The hangar, has a clear working space 250 feet wide and 200 feet long. The height is 35 feet at the sides, increasing to 70 feet at the center. The total volume in closed is approximately 2,900,000 cubic feet. Cooling end heating are provided by air circulation through ducts from eight plenum chambers located in the adjoining south lean-to. A refrigeration system with Freon centrifugal compressors supplies cooling. A steam heating plant with steam coils provides the heating.

Floor. The floor consists of a working surface of 12 inches of re-enforced concrete laid in blocks 12-1/2 feet square. This surface is designed for a 150,000 pound concentrated load which gives bearing strength for a 300,000 pound airplane. The re-enforced concrete rests on insulation of 15 inches of cellular glass block, vapor sealed with roofing felt on top and bottom. The top layers of felt are approximately 1/2 inch thick and provide a cushion between the re-enforced concrete slab and the insulation. An 8 inch concrete slab forms the sub-floor structure. One inch mastic filled, copper flashed expansion joints in both slabs allow for expansion and contraction with temperature changes. The copper flashing prevents water from leaking into the insulation. The top slab is graded toward sixteen 6 inch drains uniformly spaced over the floor. Aircraft grounding connections, tow rings, tie-down anchors, and test service ducts and openings are conveniently located to facilitate testing procedure.

Roof Trusses. The north and south walls are re-enforced concrete and tile construction, from the floor to a height of approximately 28 feet. Above the concrete and tile the structure is of steel. Nine arched trusses 24 feet in depth, span the 254 feet between the north and south walls to support the roof and insulated ceiling. All of the steel and concrete wall and roof members are outside the space subjected to extreme temperatures. The east wall structure is of frame steel.

The hangar is designed to withstand a wind stress of between 30 and 40 pounds per square foot. This is the stress at approximately 100 m.p.h.

Ceiling. The method of supporting the insulated ceiling is a unique design. The ceiling is built on the top of a corrugated steel deck. This deck is supported on I-beams which are hung from the trusses by chains. Except for a few electrical conduits, the chains are the only members piercing the insulation, and thus, the heat transfer through the insulation by structural members is small. The chains allow the ceiling to be semi-flexible and this assists in accommodating it to thermal expansion. Expansion and contraction is accommodated between sections of the steel deck by "U" metal inserts. Special rubber sections are provided to allow for the two directional movement, which takes place at the intersection of the longitudinal and transverse expansion joints.

Lighting. The hangar is equipped with 161 concentrating type high bay light fixtures. These are suspended from the hangar ceiling in a symmetrical pattern with wattage, spacing, and mounting height increasing from each side wall to the center. The lights total 88,650 watts or approximately 1.78 watts per square foot of floor area. This provides 10 foot candles of illumination at the floor. The lights are controlled from any of three control stations located in the north and south locks, and the south observation room. Pilot lights at each station indicate the groups of lights on and off. Relamping of fixtures which are from 30 to 63 feet above the floor, is accomplished from cars riding on monorails suspended along each row.

Portable incandescent floodlights are used where needed to provide higher light intensities around and under airplanes being tested and at test centers.

Doors. Access to the hangar interior is through seven doors sized to meet the intended use. In addition, five gun port doors are located in the east wall at three elevations to permit firing of fixed and flexible weapons from within the hangar.

Main Door The main hangar door which closes the open side of the hangar is self supporting and self-propelled. It is built in two sections, each weighing 200 tons. The trucks supporting the sections run on pairs of rails 25 feet apart. When the sections move into place to close the hangar, hooks on the sections engage in catches about the perimeter of the opening. A power drive draws up on the hooks and the sections move toward the hangar approximately 6 inches, sealing sponge rubber gaskets to form a tight seal around the opening. Also, a cam forces rubber pads at the bottom of the door into contact with the hangar floor. The main door can be opened in seven minutes. A vertical lift door 50 feet wide and 15 feet high is located in the north half of the main door. This door is counter wigtted and electrically operated. Small aircraft and other equipment can pass through this opening without opening the main doors. The 50 foot door can be opened in 2 minutes. The entire door is insulated with 13 inches of glass wool board enclosed on both sides with welded steel vapor barriers. Auxiliary Doors. The other principal doors of the hangar me un the north and south sides. The one on the north is for personnel only, and that on the south for personnel and equipment. Both doors are provided with entrance locks to prevent loss of hangar air when the doors are opened. The south -door is 10 feet square with a lock of sufficient size to permit the entrance of»large pieces of equipment.

At the four corners of the hangar are e-emergency personnel doors opening to the outside. These are not provided with entrance locks.

Door Heaters. During cold testing, it is necessary to prevent doors from freezing closed. For this reason all doors are provided with strip heaters which are installed around the entire perimeter in contact with the metal pressure plates. These strip heaters liberate approximately 4 watts per linear inch when power is on. A thermostatic switch maintains just enough heat to prevent freezing.

Heaters on emergency doors are connected to emergency circuits which, in case of failure of normal power supply, are automatically switched to a standby gasoline driven generator. Each door is equipped with a red and green pilot lamp. The red lamp indicates that the power is on but sufficient heat is not present to prevent freezing. The green lamp indicates that the door is ready to open.

The north and south doors and the main hangar door are similarly connected and equipped with heaters, and in addition, each door, both inside and outside, has a local control switch, so that the heater can be turned off when not needed, for economy ana to avoid introducing unnecessary heat into the hangar.

The gun port doors in the rear wall are equipped with control switches which turn on the heaters, and when sufficient heat to thaw the doors has been provided, motors automatically open the doors.

Floor Insulation. Cellular glass block was selected as the material for floor insulation because of all insulating materials investigated, its physical properties appeared to be best suited to the extreme conditions in the hangar. Cellular glass block will not deteriorate in the high temperatures of the hangar (+165°F). It has sufficient bearing strength for the high concentrated loads on the hangar floor (150,000 Ibs.). It is impervious to moisture and will not absorb it. Also, being inorganic it will not rot. These are important properties because it will probably be impossible to prevent some moisture from getting into the floor insulation through the expansion joints of the top concrete slab. To obtain the low over-all thermal conductivity desired, 15 inches insulation thickness is used. This is laid in three 5 inch layers with all joints offset. The individual blocks are laid in hot asphalt. The bottom vapor barrier is two layers of 55 pounds tar impregnated felt mopped on with hot asphalt, and the top vapor barrier in three layers laid in the same manner. The heat transmission on the floor is approximately .025 BTU per hour per square foot per degree temperature difference.

Temperature Gradients and Thermal Stresses in Floor. In order to acquire over all performance data and to detect unusual heat leakage, thermocouples have been placed at various points within the insulation, the concrete floor slabs, and the ground beneath the floor. Also, to obtain data on concrete thermal stresses, strain and deflection gauges have been installed within the 12 inch re-enforced concrete floor. Thermocouples and strain and deflection gauges are wired to a central point where readings can be taken.

Wall Insulation. The side and rear walls of the hangar are insulated with 13 inches of glass wool board enclosed on both sides with 22 gauge galvanized sheet metal welded on the inside and soldered on the outside. The insulating material is erected without asphalt binder and is supported with wood framing. Thermal contraction and expansion of the insulation is restricted by the close spacing of the framing. Thus, the over-all displacement of the insulation at any point will be small and cracks should not develop. The insulation is erected in in three layers, 4, 5, and 4 inches thick, respectively. The outer layers are framed vertically and the middle layer horizontally. Expansion and contraction of the vapor barriers are permitted by "V" expansion joints at 10 foot centers.

Insulation Air Space. Since it is expected that some moisture leakage will occur, air spaces 1-1/2 inches thick between the insulation and vapor barriers are provided. In cases of leakage, moisture will diffuse to the colder vapor barrier, condense and drain to the bottom of the barrier where it will be removed through valve copper tubing installed in a drip gutter.

Thermal Convection In Insulation. In view of the great wall heights and the air spaces between the insulation and the vapor barriers, thermal convection air currents through the insulation will be present. These currents are reduced by the installation of two layers of 15 pound tar impregnated asbestos felt between the middle and inner layers of insulation.

Ceiling Insulation. As previously stated, the ceiling structure is suspended by chains from the steel roof trusses. Like the walls, 13 inches of glass wool board is used for insulation. This material is sealed between two sheet metal barriers sealed at joints. "U" expansion joints allow for movement between sections of the barriers. The detailed construction as to framing, air spaces and convection barriers is the same as that of the wall.

Door Insulation. The insulation of the main door is similar to that of the walls except that air spaces are not provided and the interior and exterior vapor barriers are against the glass wool insulation.

Strength of Vapor Barrier. The insulation and the inner vapor barriers of the walls and ceiling have been designed to withstand a wind pressure of 20 pounds per square foot. This provides protection for the pressures from the concussion of weapons and from propeller blasts.

Wall and Ceiling Thermocouples. At each of sixteen locations within the walls and ceiling, five thermocouples are installed at varying depths in the insulation to provide data on the temperature gradients. These gradients will indicate the heat loss through the insulation, the time at which the hangar temperature conditions is stable, optimum rates of heating and cooling, areas of deteriorating insulation, and other useful information.

Insulation Testing In order to equalize the pressure between the space inside of the vapor barriers of walls and ceiling and the atmosphere, provisions have been made for breather pipes. These connect the vapor barrier spaces with the outside air through drying units.

Vehicle Testing. The floor of the Climatic Hangar has been planned so that a ground vehicle testing course, 14 feet wide and approximately 300 yards long can be laid out about the perimeter. Also, provisions have been made so that portions of this course can be covered with ice and other obstructions. Snow can be produced so that vehicles can be tested under snow conditions. The size of the hangar will make this testing course adequate for testing ground vehicles such as trucks, tractors, tugs, ice sleds, etc., under conditions closely simulating field testing.

Engine Operation. The capacity of the refrigeration of the Climatic Hangar is such that a 2500 IIP engine can be operated in the hangar for relatively long periods with only a slight rise in the temperature. When the temperature is at -70 °F a 2500 HP engine operating at full horse power for 20 minutes will raise the temperature from -70 °F to -65 °F. If the 20 minute tests are repeated at intervals of one hour, the temperature will stabilize at approximately -60 °F. At temperatures above -70 °F and up +165°F, the duration of engine tests can be increased and the intervals between tests decreased.

In the temperature range from 50 °F to 165 °F relative humidities can be held stable during full horse power engine operation from a minimum of 10% to a maximum of 55% at 100°F and 58% at 165 °F. During engine testing at less than full horsepower, relative humidities can be stabilized up to a maximum of approximately 95%, depending upon the temperature.

Jet Engine Operation. To make possible the operation of jet engines in hangar, refrigeration and air handling machinery has been provided which will supply 8600 pounds of cold air per minute. At low temperatures this will permit one full RPM test of 20 minutes duration to be made each hour. At the end of four tests the refrigeration coils will require defrosting. If the hangar is initially at-70 °F it will rise to -55 °F at the end of the first test and will stabilize at approximately -42°F for subsequent tests. Tests at temperatures up to +165 °F can be made with less limitations on duration and frequency of tests. Also, tests using less than the full air capacity will give less temperature rise and can be run for longer periods.

Wind for Engine Cooling. A mobile variable speed electrically driven wind machine has been provided for general purposes. The use of this wind machine to assist in engine cooling during ground tests in the hangar will allow ground tests of extended duration. See "Wind Machine, Special Test Equipment."

Preheating Engines. For preheating engines prior to starting, electric and gasoline burning heaters are used.

Engine Exhaust and Ventilation. Because of the large volume of the hangar - 2,900,000 cubic feet - engine runs of short durations can be made without special provisions for the exhaust gases. Detecting apparatus will give an alarm when carbon monoxide reaches the danger point and engine tests will then be discontinued until the normal ventilation of the hangar space has reduced the carbon monoxide concentration to a safe point. The normal ventilation of the hangar varies from approximately 5000 cfm at low temperatures to 30,000 cfm at high temperatures.

Engine Exhaust Ducts. To make possible the running of engines in the hangar for periods longer than one or two minutes, exhaust gas systems are provided so that exhaust gas can be piped directly from the engines to the outside.

One system consists of two 12 inch insulated steel pipes under the hangar floor. Exhaust gas collectors connect the pipes directly to the engines under test. The two pipes terminate in the service tunnel beneath the rear hangar wall. Removable sections may be installed in the tunnel to connect the pipes to the outside. The pipes are insulated with an inner layer of 1-9/16 inches of Superex and an outer layer of 3 inches of 85% Magnesia.

The outer exhaust system consists of two 12 inch and one 20 inch insulated steel pipes, the latter being for jet engine operations. All pipes are mounted on stands which support them approximately 2 feet above the hangar floor. The pipes are constructed so that sections can be removed or added and the lengths thus varied to meet the conditions of specific airplanes. The two 12 inch pipes connect to anyone of three insulated cast iron thimbles which extend through the rear hangar wall and "A" frame. The 20 inch pipe for jet engines is similar in construction to the 12 inch pipe except that it passes through an insulated 10 ft. by 10 ft. panel inserted in a gun firing port. The length of the 20 inch pipe is 42 feet and each of the 12 inch pipes 90 feet. These lengths can be increased by manufacturing additional sections. The insulation of the pipes is similar to that of the two underground pipes. Anchors are provided in the floor so that the exhaust pipes can be secured against movement due to the velocity of the exhaust gases or to propeller air blast. Exhaust Collectors. Adapters connecting engines to the exhaust pipes are manufactured locally. These adapters are designed for the particular e engines and aircraft being tested. Bomb Testing Pit. For the testing of bomb racks and release mechanisms, the hangar is provided with a pit 80 feet long, 10 feet wide, and 9 feet deep, located along the center line. This pit is covered with I-beams laid parallel and designed with bearing strength equal to that of the adjacent hangar floor. Airplanes can be towed into place over the bomb pit and the I-beams beneath the bomb bay can be readily removed by two men. Bomb release mechanisms and bomb racks can be tested by dropping dummy bombs into a sand bed in the bottom of e pit.

Mobile Bomb Pit. For the testing of bomb racks on lighter aircraft and light bombers, a dropping box has been designed and constructed locally. This is made of timber and carries a sand bed. It is mounted on retracting casters and may be towed to position below the bomb bay or bomb racks of an aircraft for testing purposes.

Weapon Testing. For the testing of weapons and guns lights, the back of the hangar is provided with five gun ports located at positions to accommodate all probable locations of turrets and fixed weapons. These gun ports are closed with 10 foot square super freezer doors and with additional auxiliary rubberized fabric panels. In use, weapons are bore sighted on the centers of super freezer doors. The doors are opened and firing takes place through the fabric panels. The fabric panels prevent flow of air either into or out of hangar. After firing is completed the super freezer doors are closed and the fabric panels replaced. The back of the hangar faces one of the firing ranges of the Proving Ground, and this area is entirely clear for firing purposes. The construction of the inner vapor barrier of the Climatic Hangar is such that it withstands the concussion of a 72mm cannon.

4. HANGAR Observation ROOMS.

South Observation Room. The south observation room is the nerve center of testing operations in the hangar. Its main functions, are, first to provide for direct observation and control of testing activities in the hangar; second, to serve as a collecting center for data on aircraft tests and hangar weather, and third, to centralize the control of alarms and certain items of emergency fire control equipment at a point outside of the hangar.

The south observation room is approximately 20 feet square with windows overlooking the hangar. It is located at the center of the south wall at a point 20 feet above the hangar floor. It is maintained at ordinary room temperature, and observation is made through multipaned, anti-frosting, anti-glare windows which command an unobstructed view of nearly the entire hangar. The observers are provided with telephone connections to the hangar machinery room, and with a microphone which connects with loud speakers in the hangar for general control of testing and issuance of instructions.

Recording Data. The function of collecting test data from the east and south test centers is performed by two panels mounting fifteen recording-indicating instruments, ten of multipoint type to record test temperatures on aircraft and equipment under test, and five for recording hangar weather conditions of temperature, humidity, barometric pressure, and wind velocity. The function of centralizing emergency controls is served by means of various automatic and manual alarm horns, bells, and signal lights for warning personnel of fire or of dangerous con--centrations of explosive or toxic gases.

North Observation Room. The north observation room has essentially the same functions as the south observation room, and is of similar size and construction. It is placed in the north wall of the hangar. The north and south observation rooms are approximately opposite each other. The instruments in the north observation room indicate and record test data only from the north test center, which is the area immediately above the north service room.

Mobile Observation Rooms. Where close observation testing is necessary, mobile, air-conditioned observation rooms are provided which can be rolled into close proximity to tests. Project officers and observers will occupy these rooms and will observe tests through anti-frosting windows. Three mobile observation rooms are provided. One is approximately 10 feet by 13 feet by 7 feet high; one is 11 feet by 7-1/2 feet by 7 feet high; and the .other is 6 feet by 10 feet by 7 feet high. Each room is insulated. All are provided with large observation windows, tables, heating and cooling units, lighting, instrument panels and important test instruments, connections for power and test instruments, loud speakers connected to the general hangar communications public address and alarm system, and telephones connected to testing personnel and to hangar observation and test service rooms.

5. HANGAR TEST SERVICE ROOMS

Purpose. In order to bring electric wires, instrument leads, tubes, hoses, pipes, etc., from outside the hangar into the main test space to supply electric power, water, compressed air, engine heat, steam and instrument connections as are required, the hangar is provided with three test service rooms located under the main hangar floor beneath the three test centers.

Service Access Openings. Six or more insulated access openings 12 inches in diameter with removable insulated covers, extend through the ceilings of each test service room into the hangar above. One or more of these openings can be used to provide passage for cables, thermocouple leads, tubes, and pipes, as required for testing. The remaining space of the opening around the cables, leads, etc., can then be packed with insulating material to prevent loss of heat by convection.

Motor Generators. Motor generators to supply electricity at from 12 to 35 volts DC are provided in each test service room. In both north and south test service rooms, 29 KW generator sets which will deliver 702 amperes continuously at 28-1/2 volts and can be overloaded to 125% for 2 hours without exceeding temperature limits are installed. The sets will deliver up to 900 amperes for leads of short duration with good voltage regulation. Two motor generators are provided in the east test service room an d are so arranged that they can be connected in series to deliver up to 70 volts, or in parallel to deliver 1404 amperes at 28-1/2 volts continuously and Up to 1800 amperes for short durations. These generators will be used to supply power for testing electric driven gun turret, landing gear and other aircraft equipment which, in normal flight, would receive energy from engine driven generators on the aircraft. Each generator is provided with a terminal panel having stud and plug type terminals to which heavy insulated cables can be attached and passed through the access openings to the hangar area above for connection to the external power terminals of the aircraft under test. Cables with two different types of insulation are available: One with 60% new rubber jacket stock which remains flexible down to -70°F and the other with polyethylene insulation for use at temperatures up to +165°F.

In order to maintain 28-1/2 volts at the aircraft at all times, compensating for the voltage drop in the cables, and for sudden changes in loads which occur in gun turret operation, the motor generators are equipped with "Rototrol" voltage regulators which hold voltages within 1/2 volt of any preset value from 12 to 35 volts. As a safety measure each generator is also equipped with an adjustable current limiting device so that a maximum value of current for testing can be preset. In case of a dangerous overload or short circuit which exceeds the preset value, this device instantly collapses the generator voltage by reducing the exciter voltage to a very small value. The generators are also provided with reverse current, overload, and voltage differential protection.

Motor generators, to supply direct current up to 150 volts and 200 amperes, are available. Similar equipment for 3-phase A.C., 400 cycle current up to 174 amperes at 120/208 volts have been installed in each service room.

Instrument Terminal Panels. The test service rooms also contain wall mounted terminal panels for leads to indicating and recording instruments located in the north and south observation rooms. Connections are made at these terminals to instruments and thermocouples placed in equipment being tested.

6. HANGAR.TEST CENTERS.

Within the hangar are three principal test centers. These are above the test service rooms, and are connected to them by access openings. The east test center is especially designed for testing of engines on complete aircraft. Two semi-flexible exhaust. ducts for reciprocating engines and one for jet engines are located in this area. Radiating from the three test service rooms to distributed points within the hangar are empty conduits. These conduits will accommodate the services for tests to be conducted at points in the hangar other than at the main test centers. Also, two additional reciprocating engine exhaust ducts are provided beneath the floor of the. hangar so that aircraft engines can be tested at' Other points than at the east test center. The east test center is located adjacent to the fixed bomb pit) The mobile observation rooms will facilitate testing at points other than the main test centers. A small instrument connection panel is installed at each of the three test centers. These supplement the panels in the test service rooms.

7. SPECIAL TEST EQUIPMENT.

Landing Gear Actuator. A landing gear actuator is provided for the testing of the landing gear of aircraft in a manner simulating landing and take-off. This actuator is a hydraulic operated mechanism which is placed under one wheel of the landing gear of an aircraft. The unit has a capacity of 20,000 pounds, and thus is suitable for testing aircraft weighing up to 40,000 pounds. The apparatus is capable of actuating the 20,000 pound landing gear load at a frequency from 28-1/2 cycles per minute at a 12 inch stroke to 114 cycles per minute at a 3 inch stroke. Controls are provided so that the length of the stroke, the frequency of the stroke, and the position of the mid-point of the stroke can be varied instantaneously and simultaneously by the operator while the machine is in operation. The apparatus is designed for operation in a temperature range from —70°F to +160°F. It is mobile on retracting casters and the height of the landing gear tire cradle, when the apparatus is in operating position, is 24 inches above the floor. The apparatus is actuated by two 20 HP explosion-proof electric motors. Safety provisions to prevent overloading have been incorporated into the apparatus.

Wind Machine. A wind machine mounted on wheels and adjustable as to height and angle of discharge is available. This will furnish a 100 mile per hour wind for use in tests which require the simulation of certain flight conditions. Apparatus is being designed which, in conjunction with this wind machine, will simulate sand storms, snow storms, rain, and icing conditions, for use in testing de-icers, propeller pitch control mechanisms, etc.

The wind machine consists of an axial flow fan 53 inches in diameter rated at 108,000 cfm with direct drive by a 250 HP, 3 phase 440 volt, 1750 RPM, electric induction motor. The fan outlet is 66 inches in diameter and reduces through a round to square transition nozzle 64 inches long with final outlet 42 inches square. With the reducer the velocity is 100 m.p.h. and without it 51 m.p.h. This entire assembly is mounted on a hydraulic lift and dolly assembly having two 3-stage hydraulic cylinders with respective diameters of 8, 10, and 12 inches for a total lifting travel of 15 feet. These cylinders are served by two pumps driven by a single motor with reversing control. The dolly is equipped with 20 inch casters and a towing tongue is provided. The wind machine can be placed rt any required position in the hangar or main test room and portable power cables are provided which can be plugged into receptacles in three different locations. Special provisions were made in the design of this machine to insure satisfactory operation at the temperature extremes under which it operates.

Special Towing Vehicles. For the purpose of towing aircraft and equipment to test positions in the hangar, two special 1 heavy duty aircraft tugs are provided. One, for cold operation, is equipped with an electric heater through which the engine coolant is circulated. The coolant then passes through jackets in the crank case oil sump and back to the radiator. Another thermostatically controlled electric heater maintains an insulated battery compartment at +70°F. The electric heaters are plugged into a power receptacle on the wall of the hangar when the tug is not in use. The tug is ready for instant start at any time while the hangar temperature is from -*30°F to -70°F.

The other tug is for use at temperatures from normal up to +165°F. It is equipped with an oversized, pressure type radiator. The battery case has provisions for packing with dry ice when the tug is in use. When not in use, the battery must be removed and stored where it is cool.

8. EQUIPMENT AND ENGINE TEST ROOM. Purpose. Principal uses of the equipment and engine test room are as follows:

a. Engine block testing including both reciprocating, jet, and turbo-jet engines.
b. Testing of motorized vehicles.
c. Testing of USAF ground equipment.
d. Testing of equipment exposed to dust and sand storms.

General Description. The temperature and humidity operating conditions for the equipment and engine test room are the same as for the hangar. Weather conditions are the same as in the hangar except provisions have been made for sand and dust storms. No provision is made, however, for elevation or reduction of air pressure. In general, tests in this room will be remotely controlled and personnel will make observations from elevated observation rooms on either side.

The equipment and engine test room occupies a separate wing adjacent to the south lean-to. It is 133 feet long, 30 feet wide, and 25 feet high. Within the room is the engine test stand. All walls and ceiling are constructed of 12 inch re-enforced concrete. Pilasters on 16 foot, centers give a designed structural strength of over 30 pounds per square foot.

Main Door. One large rolling door insulated with 13 inches of glass wool board closes the entire south end of the test room. This opening is approximately 30 feet wide and 25 feet high. The door is electrically operated, and rolls on a single track to clear the entire opening. The door is provided with sponge rubber gasketing to seal it with the opening when in the closed position. Electric heaters are provided around the perimeter of the door to prevent it from freezing in the closed position when the room is cold.

Tempering Room. On the southeast corner of the test room is an insulated lock 22 feet by 2 2 feet by 20 feet high with 10 foot by 10 foot doors. This lock is provided so that engines and other equipment can be taken in or out of the test room without losing conditioned air. The lock also serves as a pre-conditioning space in which equipment for test can be stored and partially heated or cooled before being taken in -to the test room. This will reduce the time required for the equipment to reach stable temperature conditions after it is taken into the test room. The lock does not have a temperature control, but will assume a temperature between that of the test room and the outside.

Auxiliary Doors. The test room is provided with two additional doors for personnel. One is provided with a. lock and the other is for access to the filters and does not have a lock.

Insulation. Insulation for the equipment and engine test room is similar to that of the hangar. The floor insulation is the same but the walls and ceiling differ in some detail. The outer vapor barrier is three ounce copper foil bounded to paper with a layer of asphalt. The barrier is mopped on the concrete walls and ceiling with cement. The insulation is 13 inches of glass wool board erected like the wall insulation of hangar. There is no outside air space. The inner vapor barrier is welded galvanized sheet metal with an air space, drain trough and drain tube similar to those in the hangar wall.

Traveling Crane. A 5 ton under hung crane is installed in the equipment and engine test room. The crane rolls on two 15 inch I-beams. The beams are 28 feet apart, and extend from the large doors back into the test room 73 feet. The beams are suspended from the test room ceiling by chains. The trolley of the crane can be pulled 26 feet 6 inches across the width of the test room. The hoist is a two speed type and its total lift is 21 feet from the floor. The crane is entirely manually operated.

Air Circulation. Air is circulated through the test room by insulated ducts on the roof items to provide heating or cooling, as desired. The air enters the room by a ceiling grill 8 feet by 22 feet on the south end of the chamber, and leaves from a ceiling grill 21 feet by 22 feet on the north end.

Sand and Dust Filters for Sand Storm. At the return end of the equipment and engine test room, the end opposite the main door, a series of bag type filters are provided for filtering dust and sand from the air circulating system during sand and dust storm operation. These filters are provided with mechanical vibrators to shake the sand and dust into a series of collecting troughs where the sand and dust can be reclaimed for use in the sand-storm machine. The filters are capable of handling 200,000 cfm air and for a 30 minute, period will collect 817 pounds of sand. The time required for reclean-ing the filters is 30 minutes. The mobile wind machine will have an attachment for the introduction of sand and dust to produce e this type of storm.

9. ENGINE TEST STAND

Purpose. An engine test stand in the equipment and engine test room provides for the testing of all types of reciprocating and jet aircraft to determine the difficulties encountered in operating under extreme climate conditions.

Description. The engine test stand is a welded steel structure 10 feet high. It is constructed so that it can be removed from the test room, if desired. The design is such that large 4-row, .radial or W type in-line engines and jet engines, in addition to more common types, can be mounted and tested. The engine mount allows the engine propeller shaft to be at the center of the room. Thus, it is possible to use propellers up to a maximum diameter of 24 feet. Also provided with the stand are heat exchangers for the oil and coolant systems, with all the necessary remote temperature control instruments, pumps for oil, coolant and fuel, automatic oil weighing scales, gasoline and kerosene flow meters, a carburetor air flow meter, engine instruments for engine operation, and precision recording and indicating instruments for testing.

In the test service room adjacent to the equipment and engine test room and beneath the east observation room, are located pumps, heat exchangers, mixing valves, filters, and their associated pipe work. The services for the engine test stand are piped from the test service room through a four foot by five, and one-half foot tunnel to the engine test stand. The inertia block which is the foundation for the test stand, is completely isolated with cork from the test room floor so as to prevent vibrations from being transmitted from the engine test stand to the building structure. Two wide flange I-beams, 25 feet long, are imbedded in the inertia block and act as a track on which the stand cau be moved in order that the engine's accessory section will always be over the hole in the inertia block, which connects with the four foot by five and one-half foot tunnel. An insulated streamlined service manifold, 10 feet high, is positioned between the legs of the stand and over the hole into the service tunnel. Piping and services will be routed from the east test service room, through the service tunnel, up the service manifold to the accessory section of the engine mounted on the engine test stand.

Jet Engine Testing. For jet engine operation a thrust measuring device is provided and may be mounted on top of the 10 foot stand. The capacity of the refrigeration and air handling machinery is such that a jet engine can be immersed in and consume up to 8600 pounds per minute of air at -42.5°F when the outside wet bulb temperature is 80 °F. With an outside wet bulb temperature of 40 °F, the temperature of the air supplied to the jet engine can be as low as -62 °F. Tests can be of a duration of 20 minutes during each hour with a maximum of four such 20 minute tests before the refrigeration system requires defrosting. Tests requiring less than 8600 pounds per minute of air or at higher temperatures can be of greater duration. Air controls, located on a jet engine air panel at the engine control and observation station, make acceleration tests of jet engines possible.

Engine Exhaust. The exhaust from reciprocating engines is taken directly from the engine to the outside through a system of two 12 inch pipes joining into a 20 inch pipe. These pipes are insulated with an inner layer of three inches Superex and an outer layer of 1-1/2 inches asbestos sponge. The exhaust for jet engines H taken to the outside through a straight insulated pipe 22 inches in diameter.

Measuring Carburetor Air. Among the facilities provided, is an adjustable orifice type meter for measuring the air supplied to the carburetor of reciprocating engines. It is an air operated, remote controlled instrument which will indicate on an inclined manometer air flow from 0 to 20,000 pounds per hour. The manometer has a multiplicity of scales on a single drum so that readings of eight orifice positions may be taken directly without reference to other charts or curves. The instrument also has provisions so that temperature and pressure compensation can be made. The controls are mounted on the control table of the engine control station. The air head and orifice of the unit is located in a 12 inch insulated pipe which connects to the carburetor. The pipe is so arranged that test room air with temperatures of -70 °F to +165°F can be supplied to the engine. Also, provisions have been made so that ramming the carburetor with outside air can be accomplished. When this is desired, a fan, filters, and other necessary equipment may be installed in a small shelter located on the roof of the observation room.

Fuel. Oil, and Coolant Systems. Gasoline, oil, and coolant can be provided to the engine at temperatures from -70°F to +165°F. Cooling coils, tanks, etc. are installed in the equipment and engine test room exposed to propeller air blast to simulate as closely as possible actual flight conditions. Provisions have been made to allow engines to be operated with oil and coolant radiators of the same type as used in aircraft so that bursting pressure congealing oil troubles, and cold starts with cold fuel, oil, and coolant, can be studied.

Sound Baffles. Sound baffles are located across the equipment and engine test room just in back of the engine test stand. These prevent sound from engine testing being conducted through the entire Climatic Hangar structure by the air ducts. The baffles are set across the full height of the test room and fill the entire cross section. They are placed 15-1/2 inches on centers. The chord of the baffles is 10 feet 7 inches. Twenty four baffles make up the complete installation.

10. EQUIPMENT AND ENGINE TEST OBSER¬VATION ROOMS.

East Observation Room. The east observation room which overlooks the equipment and engine test room through non-frosting windows, is the nerve center of the test room and serves the same principal functions of observation, data recording, and centralization of emergency alarm equipment that the south observation room does for the hangar. In addition, it provides a central control station for engine testing. The room is approximately 20 feet by 50 feet, and is of similar construction to the hangar observation rooms. The instruments and equipment are also of the same type.

Engine Control and Observation Station. The engine control and observation station with all the instruments and controls pertaining to jet and reciprocating engine test work is located in one end of the east observation room. The floor elevation of this station is 3 feet higher than that of the rest of the room. This brings the eye of operating and testing personnel to the level of the propeller shaft of the engine under test. The control table, instruments, roto-meters, etc., are located so that an operator will operate the engine while another observer will observe and record the test data. Data will be recorded on instruments mounted in an 8 ft. by 7 ft. panel just off the raised platform. North of the raised platform is a fireproof oil weighing room in which is located all oil weighing equipment with associated piping. This room is mechanically ventilated. A window in the wall between the oil weighing room and the control station makes possible the observation of the oil weighing apparatus. By photo electric cells and relays, engine oil flow rates are indicated on a chronotachometer mounted in the control table. The control table has remote control buttons for selecting grades of fuel, types of oil desired, adding oil or coolant to the system, and selecting and controlling oil and coolant temperatures. A chronotachometet for reciprocating engines, a strobotachometer for jet engines, controls for remote adjustment of the variable orifice used for measuring carburetor air flow, manometers, etc., are also provided. With the engine test facilities provided, operational and test personnel will not be required in the test room while testing is being accomplished.

West Observation Room. The purpose of the west observation room is to provide facilities for observation from the west side of the equipment and engine test room. This room is approximately 7 feet wide by 55 feet long, and is provided with one observation window of the same type as the other observation rooms. Limited test services and instrumentation leads for use in the test room are also available, connections being made through the west wall of the test room. No test recording instruments are installed in the west observation room since the test leads merely pass through it to connect with the instruments in the east observation room. Portable instruments can be connected in this room for short duration tests.

11. EQUIPMENT AND ENGINE TEST SERVICE ROOM.
Description. This test service room is 21 feet by 49 feet and is used to supply the services required for testing in the equipment and engine test room. There are a number of access openings through the insulated wall which separates the two rooms. Electric cables, thermocouple leads, pipes, etc., will pass through these openings. Like the three test service rooms serving the main hangar area, the equipment and engine test service room can provide services of electric power at 12-35 volts, DC, up to 702 amperes, water, compressed air, steam, and terminal panels for thermocouple and other instrument leads. Equipment for the engine test stand described under "ENGINE TEST STAND" is located in this room. A service tunnel previously described, connects the equipment and engine test service room with the west observation room.

12. PRESSURE RELIEF PORTS.
Description. To prevent the possibility of an excessive pressure differential between either the hangar space or the equipment and engine test room and the exterior, which might endanger the entire structure, a series of dampers and "blowout" doors are provided. These are set to operate at a preset differential below the structure strength. The dampers are controlled automatically through static pressure regulators. The doors are provided with gravity loaded latches that will open at a pressure of 25 pounds per square foot.

13. ALL-WEATHER ROOM.
Purpose. This room is used for physiological proof testing of personnel and personal equipment under extreme weather conditions.

Description. The all-weather room is located on the ground floor of the north lean-to and consists of a main chamber approximately 34 feet by 13 feet by 11 feet high and an ante-room or entrance lock approximately 15 feet by 9-1/2 feet by 10 feet high. The main chamber is insulated with corkboard 12 inches thick, covered with a stainless steel interior liner. Large non-frosting observation windows are provided for viewing testing from the outside.

Temperatures can be reduced in the main chamber from +70°F to -40°F in six hours, and to ~70 °F in twenty-four hours. Temperatures can also be raised from +70 °F to +170°F in two hours. The maximum relative humidities possible in the main chamber vary from 95% at 65 °F dry bulb to 45% at +165°F dry bulb. The minimum relative humidity is 5%. No provisions have been made for reducing the pressure within the room.

A rain and mist making apparatus is provided for simulating rainstorms from 1/2 to 15 inches per hour. Also, there is a built-in wind machine capable of air velocities of from 5 to 35 miles per hour. The room can be partially filled with water for the testing of life rafts, immersion suits, etc.

Provisions have been made for the future addition of sun lamps to simulate desert sun. Machinery. The air conditioning machinery of the all-weather room is as follows:

1 100 HP rotary type Freon compressor 1 75 HP reciprocating type Freon compressor

1 30 HP reciprocating type Freon compressor Finned type evaporators in the all-weather chamber Electric heaters

75 HP wind fan for creating wind Communication equipment, lights, and various thermocouples and test instruments

14. STRATOCHAMBER.
Purpose. In conjunction with the all-weather room, a strato-chamber is provided for tne physiological proof testing of personnel and personal equipment at conditions simulating various altitudes and corresponding temperatures and under flight-climb conditions.

Description. The strato-chamber consists of a main climb chamber and entrance lock, constructed of welded steel insulated with 13 sheets of a reflective metal insulation in the main chamber, and of 7 sheets in the lock. The chamber is constructed to withstand pressures from zero absolute to one atmosphere. Chamber size 9-1/2 feet by 13-1/2 feet by 12 feet high, lock size 10 feet by 4-1/2 feet by 12 feet high.

Temperatures can be reduced from +70 °F to -70 °F and reheating to +70 °F prior to test run, with 10 men in heated suits in the climb chamber. Temperatures can be further reduced to approximately —94 °F with 2 men in heated suits in the chamber.

Pressure can be reduced to 87 millimeters mercury absolute (corresponding to 50,000 feet) in approximately 12 minutes with _70 °F in the climb chamber. Pressures can be further reduced to 25 millimeters corresponding to 80,000 feet altitude.

Machinery. The air conditioning machinery of the strato-chamber as follows:
1 50 HP reciprocating type Freon compressor
2 40 HP reciprocating type Freon compressor Finned type evaporators in climb-chamber

40 HP vacuum pump

Necessary communications, oxygen, flight and test instruments and observation ports.

FACILITIES.
Complete chemistry laboratory Dark room for physiological and photographic work Machine shop for repair and modification of various equipment used in physiological testing

16 SMALL TEST ROOMS - HOT, COLD, GLE, TROPIC-MARINE, AND DESERT

Purpose. Because of the small size of these test rooms and as they are each equipped with individual air conditioning systems, small items can be tested at much lower operating cost than when tested in the hangar or equipment and engine test room. The desert, jungle, and tropic-marine rooms can be operated for long periods at cycled night and day weather conditions. This will permit determination of the effects of long weathering on equipment and material.

Hot Test Room. 13 feet by 13 feet floor area. Designed for inside temperatures varying from +70 °F to +165 °F with relative humidities varying between 10% and 95% when the outside conditions vary between 25 °F and 50% R.H., and 95 °F and 54% R.H.

The walls, floor and ceiling are insulated with 4 inches of glass wool board and 2 inches of asbestos block. The inner vapor barrier is soldered 18 gauge galvanized sheet metal.
Air conditioning is produced by an air washer equipped with steam heating coils, Freon cooling coils with Lectordryer dehydrator and a 3/4 HP reciprocating type Freon compressor.

Cold Test Room. 13 feet by 12 feet floor area. The temperature in the cold test room can be reduced from 95°F to ~70°F in 24 hours and can be held at ~70°F indefinitely with 10,000 pounds of test equipment in the chamber. Temperatures can be controlled at any degree from 50 °F to -70 °F. No humidity control is provided.

The floor, walls and ceiling are insulated with 12 inches of corkboard. The vapor barrier is 3 ounce copper sheet on the outer insulated surface and tongue and groove sheathing on the interior.

The air conditioning is produced by Freon cooling coils and two 40 HP reciprocating type Freon compressors.

Jungle Test Room. 13 feet by 13-1/2 feet floor. area. Conditions can be varied either way from 110 °F and 80% R.H. to 90 °F and saturation in 2 hours to simulate cycling day and night jungle conditions. This room is provided with a rain system to simulate 12 inches per hour rainfall. Provisions are made so that material can be infected with jungle molds and fungi.

Air conditioning is produced by an air washer equipped with cooling and heating coils. One 5 HP and one 1/2 reciprocating type Freon Compressor furnishes the necessary refrigeration.

Tropic-Marine Test Room. 13 feet by 13-1/2 feet floor area. Conditions can be varied either way from 105°F and 50% relative humidity to 70 °F and saturation within 3 hours time to simulate cycling of day and night conditions. 10,000 pounds of material can be subjected to these conditions. This room is equipped with a salt spray and rain making system to give 12 inches per hour rainfall.

Air conditioning is produced by an air washer with heating and cooling coils. One 3 HP and one 1/2 HP Freon reciprocating compressor furnishes the necessary refrigeration.

Desert Test Room. 13 feet by 13 feet floor area. The room conditions can be varied either way from 60 °F and 46% relative humidity to 120°F and 7% relative humidity in 2 hours to simulate cycling of day and night desert conditions. This room is provided with sun lamps which will simulate daytime desert sun.

Air conditioning is produced by steam coils and cooling coils. One 15 HP and one 5 HP reciprocating type Freon compressor furnishes the necessary refrigeration for dehumidification.

The desert test room is fitted with an angle iron rack suspended eight feet above the floor and occupying practically the entire ceiling area. This rack is in four sections, each section supporting 36 type RS sun lamps spaced on 10 inch centers. Each RS sun lamp is rated at 275 watts and each has an integral reflector. The RS lamps are combination mercury vapor arc and incandescent type with bulbs of ultraviolet transmitting glass. The entire bank of 144 lamps produces a close approximation of noonday desert solar radiation.

17. HANGAR AND EQUIPMENT AND ENGINE TEST ROOM AIR CONDITIONING

Description. The air conditioning system which supplies the hangar and equipment and engine test room consists mainly of five elements; a refrigeration plant employing approximately 100,000 pounds of Freon-12 and pro-duci.ig 780 tons of refrigeration at —70°F, a steam heating plant, an air delivery system, a series of cooling and heating coils in the air delivery system which are heat exchangers between the air and cooling medium (Freon-12) on the cooling cycle, and the air and the heating medium (steam) on the heating cycle, and a cooling tower for cooling water used in the refrigeration condensers.

The system can produce temperatures in the hangar or in the test room ranging from -70°F to +165°F. Relative humidities can be controlled from 10% to 95% or until a vapor pressure of 1-1/2 inches of mercury is reached at temperatures from 50°F to 165°F. Simultaneous operation of both the Climatic Hangar and the test room on either cooling or heating is possible. The air delivery system can be manipulated so that the air can be directed to either or both the hangar and test room. The internal heat load in the hangar or test room is the governing factor influencing the possible minimum temperatures which can be produced. On low temperature tests, the system is capable of reducing the temperature of the hangar and its contents to -70 °F, based on summer outside conditions, within 48 hours. Following the initial reduction of temperature a period of 24 hours is allowed for stabilizing the temperature before any heat producing tests are started. After the temperature has become stabilized and is -70 °F, an internal combustion engine can be started from zero output and gradually increased at a uniform rate for 10 minutes up to 160,000 BTU per minute heat output into the hangar and continued 10 minutes at this 160,000 BTU per minute constant heat output. (This represents the output of a 2500 HP engine.) The temperature in the hangar will not rise more than 5°F by the end of this 20 minute test. Four consecutive 20 minute tests at one hour intervals are possible. The temperature at the end of the four tests will be approximately -60°F.

For hot tests the hangar can be heated from 25°F ambient to +165°F in 16 hours without aay internal heat source.

Refrigeration Machinery The refrigeration machinery plant consists of:

3 Freon 12 two-stage condensing and cooling systems, each system consisting of the following equipment:

1 1250 HP centrifugal compressor - high stage

1 1000 HP centrifugal compressor - low stage

1 Condenser - where refrigerant gas is condensed to a liquid by cooling water

1 High stage intercooler - where the liquid refrigerant from the condenser is further cooled by expansion
1 Gas and liquid cooler - where gas from the low stage compressor and liquid from the high stage intercooler are further cooled by expansion.
1 Low stage intercooler - where liquid from the gas and liquid cooler is further cooled by expansion
1 Surge receiver - which is the final expansion chamber in the system. In this receiver a portion of the liquid refrigerant is circulated through the cooling coils in the air delivery system to absorb heat from the air. The liquid refrigerant at this point will leave the receiver at approximately — 94°F when the hangar is maintained at -70°F.
1 Storage receiver - where the refrigerant is stored during shutdown of each system.

There is also one 125 HP refrigeration system used for cooling the outside air required for ventilation during cold tests. It also has a dual purpose, in that it can be used to pump out or transfer die refrigerant In the cooling coils and

apparatus of the main systems to the storage receivers of each system. This eliminates the necessity of operating the larger machines to pump the refrigerant to the storage receivers.

Primarily, each of the three large systems furnishes refrigeration to two sets of cooling coils in the air delivery system, however, two of these systems are connected to the outside air cooling coils in the air delivery system, where with the small 125 HP refrigeration system the cooling of the outside air is accomplished.

Air Delivery System. The distribution system for outside air is designed to handle up to a total of 2000 pounds per minute of air. Outside air is introduced through a duct inlet at the roof of the south lean - to and is drawn through a system of filters to the outside air supply fan which is driven by a 20 HP motor. This fan delivers the outside air through the outside air cooling coils and a delivery duct to the six cooling plenums and/or the three heating plenums, as may be required. Dampers at the inlet of each plenum control the amount of outside air to each one.

Cooling Plenums. Each of six cooling p le-nums contains cooling coils and a 100 HP circulating fan capable of handling 78,000 cfm at -70°F. Each fan picks up the outside air and air returned from the hangar or test room, and circulates it through the cooling coils to four main trunk delivery ducts in the hangar and one main trunk delivery duct in the test room. Air is diffused to give even distribution in the hangar through anemostat outlets in the main trunk ducts. Returning air from the hangar is drawn through openings in the cooling plenums and similarly from the test room except a return duct is necessary for connecting the return from the test room to special return openings in the plenums. All openings and ducts have dampers which can be manipulated to direct and control the quantity of air to either or to both the hangar and test room.

Heating Plenums. Two heating plenums for the hangar are each provided with 100 HP fans each handling 110,000 cfm at 265°F. These fans pick up the outside air and return air from the hangar and deliver it through a system of steam coils to the four main trunk ducts of the hangar system. A similar and independent p le-num and fan is provided for the test room.

Cooling and Dehumidifying Outside Air. The outside air cooling system consists of two banks or stages. The first stage cools the outside air from 95°F and 80°F wet bulb to 40°F dew point. The second stage cools from 40°F dew point to 5°F dew point. The refrigeration of the first stage is furnished by the 125 HP compressor, whereas the second stage is from one or both of two of the large systems. In the second stage of outside air cooling, a system of ethylene glycol sprays is provided to prevent frosting in these coils. The regeneration of this ethylene glycol is in a concentrator system operating by steam. The process of cooling the air dehumidifies it. Thus, in all cases where low relative humidity is required, the outside air must be cooled. When desert conditions are to be produced in the hangar or test room the outside air is cooled to dehumidify it before it passes into the heating plenums.

Humidification. Water spray banks in the heating plenums and at the air outlets in the hangar, and spray banks in the test room furnish the moisture for humidification. Steam humidification in the supply ducts can be used if required.

Defrosting Coils. Each of the six cooling plenums described in the air delivery system has a bank of cooling coils cooled by refrigerant pumped from the main refrigeration systems. These coils cool the outside air and the return air from the hangar or test room to a temperature of approximately ~94OF. Defrosting is necessary after each 48 hour operating period, however, staggering of the de frosting is possible so only one plenum need be out at a time. One hour is required for defrosting.

Cooling Tower. An induced draft cooling tower furnishes the necessary atmospheric cooling of water used in the condensers. A total of 6400 gallons of water per minute is cooled from -t94°F to approximately 85°F with outside air at 80oF wet bulb. The tower is provided with three 30 HP fans for induced draft.

Flushing. In case of poisonous gas or explosive vapor' reaching a dangerous concentration, the hangar or test room can be flushed by the manipulation of plenum doors. Maximum flushing rate is 470,000 cfm.

18. TET ENGINE AIR CONDITIONING UNIT

Description. To provide for jet engines which use large volumes of air, it was necessary to provide an additional refrigeration system for cooling and a heating system for heating larger quantities of outside air. The jet engine air conditioning unit is capable of cooling 85,000 cfm of outside air entering at 95 °F dry bulb and 80 °F wet bulb to 40 °F leaving the outside air 80 °F wet bulb to 40°F leaving the cooling system. It can heat the same amount of air from 25°F to 165°F and humidify it to 1.4 inches mercury vapor pressure.

After leaving the jet engine air conditioning unit, the air is further cooled in the six main cooling plenums where it is mixed with return air from the hangar or test room, it is estimated that with the hangar at ~70°F prior to jet engine air being introduced, the temperature in the hangar will be -55°F when 8100 pounds per minute of outside air from the jet engine system and 500 pounds of outside air from the main system are introduced for a 20 minute engine testing period. Four 20 minute runs can be made at one hour intervals, at which time it is estimated that the temperatures will rise to -35°F. This is based on outside air entering the systems at 40F wet bulb. If the entering air is at 40°F wet bulb, the temperature at the end of four tests will be approximately -55°F. The main cooling coils will require defrosting after four tests. It should be noted that the foregoing data is for the hangar, whereas the data on page 14 is for the test room.)

On hot tests, the temperature in either the hangar or test room can be heated to +165°F with outside ambient of 25°F and maintained at this temperature continuously for jet engine operation. The jet engine system consists essentially of a single refrigeration system with two ataces of cooling coils, steam heating coils, and fan and duct system connecting into the re-tan from the test room to the six cooling Refrigeration System.

The refrigeration system consists of one 1500 HP centrifugal com-sressor, condenser, one intercooler for liquid ban condenser, two surge tanks, one for each stage of cooling coils with liquid refrigerant pumps on each stage. The system also has a avail 10 HP compre ssor for refrigerant pump-wit or transfer of refrigerant to the storage receiver.

Heating System. In the plenum chamber immediately following the cooling coils three banks of steam heating coils are installed. These coils are finned tube non-freeze type. By-pass dampers are arranged in parallel with these coils for modulating air flow. Steam will be supplied to these coils and automatically regulated to it the desired conditions based on return aii temperature.

Air Delivery System. The air is drawn through a series of filters into the cooling and heating coil plenum by a 150 HP fan capable ot delivering 103,000 cfm of air at 40 °F. Aftei the air passes over the coils it is delivered lirough a main supply duct to the main hangar coils entering the main hangar system at two points in the return duct from the test room. Thence the air goes to the main cooling or heating plenums of the hangar or test room, as required.There is a limitation that jet engines cannot run simultaneously at full rpm in the hangar and test room. Controls are provided so that the air can be. introduced automatically on demand of the engine when operating in the hangar or test room, however, in the test room if the jet engine is to be accelerated to full demand of air in only a few seconds, it is first necessary to start the full flow of jet engine air to the room manually and allow it to spill out of relief ports. As the jet engine is accelerated the amount of air spilling out decreases until at fullrpm the jet engine is consuming all of the air.

Humidification. Steam humidification is used in the main supply ducts of the hangar and test room to provide moisture for high relative humidity tests. Steam in quantities up to 11,000 pounds per hour can be supplied for humidification.

Cooling Tower. The cooling tower for the water from the condenser is similar to that of the main system. A total of 4200 gallons of water per minute IB cooled from 92°F to 85°F when the outside wet bulb temperature is 80°F.

19. STEAM HEATING PLANT.

Description. To provide heating for the office and work space during winter periods, and also for the high temperature conditions within the hangar and test room, a complete boiler plant is provided. This equipment is located in a separate building situated immediately southeast of the hangar.

Two duplicate B. & W. Sterling type cross drum water tube boilers, each having a 310 boiler horse power rating are installed. Each boiler is equipped with double burners designed for bunker C No. 6 oil. In addition, there is one horizontal fire tube oil fired boiler for supplying steam for low heating requirements.

All boilers are designed for an operating pressure of 125 pounds per square inch. The water tube boilers are equipped with complete automatic control within the limits of the design capacity, or any part of the equipment can be manually controlled, if desired.

The heating plant is complete in every detail. Some of the special refinements, in addition to the usual boiler feed pump, fuel oil heaters draft and water gauges, etc., are the following: Steam flow meters, induced and forced draft fans, soot blowers, portable ignition burner, and special condensate feed water heater. There are also many safety features such as non-return valves, electrical eyes for burner failure detection, and furnace air pressure regulators for the burners.

20. MISCELLANEOUS FACILITIES.

Instrument Laboratory. The instrument laboratory is equipped for the purpose of testing «d calibrating instruments and measuring devices of all types and for extreme temperature tnging of any material that may be required for tie operation of the hangar. These instruments iaclade both aircraft instruments and the electrical temperature measuring type of potentio-meters which are permanently mounted in the ervation rooms.

The laboratory is approximately thirty feet and is furnished with tables and work beaches for welding and electrical testing. The electrical test center is provided with its own ftnret distribution board to supply both AC and DC power to plug-in boxes in the laboratory and in tie five small test rooms immediately adjacent

Test Assembly Room. This room is used for setting up and adjusting of test items other than aircraft prior to testing in the various climatic chambers. The test assembly room has approximately 4000 sq. ft. of floor space. It is located on the ground floor of the south lean-to, a ground level loading door is provided and an elevator connects this room with the hangar, and the first and second floors of the south lean-to.

Shops. The machine shop provides emergency repair services for testing equipment and ae refrigeration machinery. The shop is located eat to the test assembly room. This shop approximately 850 square feet. Hand and machinery is provided.

Dressing Rooms. These rooms, adjacent to the main lock of the hangar, provide a space for changing and storing the special clothing worn by personnel while performing testing within the Climatic Hangar. Two dressing rooms are air conditioned so that they can be maintained at a temperature intermediate between ambient and the temperature which will exist in the hangar room. A special clothing storage and drying room is provided. This is supplied with dehumidified air for drying clothing after it is used in the test chambers.

Special Clothing; for Personnel. Due to the extreme temperatures which will be encountered at all times within the hangar and test rooms, special clothing must be worn. Special cooled suits are provided for use during hot testing and arctic and electrically heated clothing for cold testing. The suits used during hot testing are of the hooded coverall type, ventilated by cooled air (65 F). The cooled air is introduced through a tube attached to the suit and is exhausted around the legs, arms, and through a vision aperture in the hood. The individual using the suit breathes the air coming out of the vision aperture. Clothing for cold testing is both arctic ground clothing and heated suits. The electrically heated suits are supplied with power from mobile transformer units which can be placed at any location in the hangar or test rooms.

Clothing Air Conditioning Unit. To supply cool air for the special hot testing suits worn by personnel when high temperatures are maintained in the test chambers, a special air conditioning system is provided. Twenty suits can be supplied with 50 cfm of 65°F air at any place in the hangar with a thirty-five foot radius of operation for each person.

The air conditioning unit consists of two reciprocating type compressors, one 10 HP and the other 25 HP, operating with a stationary evaporator located outside the east hangar wall. Air is delivered to two fixed outlets in the east hangar wall where connections can be made to a system of movable ductwork routed to the principal test locations. At these points, manifolds with valve outlets for c connections of the flexible insulated hoses of the suits are provided. Hoses are 35 feet in length.

The system in the equipment and engine test room is essentially the same as that in the hangar except that there are provisions for only 10 suits. This system is cooled by a 10 HP reciprocating type compressor with two outlet manifolds at the wall of the test room where the suit hose can be connected.

21. CARBON MONOXIDE AND EXPLOSIVE VAPOR DETECTORS AND ALARMS.
Description. Personnel and equipment in the Climatic Hangar are protected against the hazards of carbon monoxide and explosive vapor by an automatic electrical detecting system which draws air samples continuously from eight points in the hangar and from four points in the test room. The recording instruments and alarms for the hangar are in the south observation room and those for the equipment and engine test room in the»" equipment and engine test observation room.

The recording instruments give a continuous record of the concentrations of carbon monoxide and explosive vapor. If the concentration of either carbon monoxide or explosive vapor reaches a dangerous value, the detection equipment will actuate a bell or horn and will light a red enunciator light corresponding with the area of the respective sampling point. The observer will then sound an alarm over the loud speaker system, and with the same system will direct activities within the test space until the dangerous condition is corrected.

22. FIRE PROTECTION.
Alarms. Because of the hazardous nature of aircraft testing much consideration was given to the selection of fire prevention and protection equipment. For this purpose seven different systems have been provided for the hangar and test room. These systems can be divided into two classifications, depending on whether they are manually or automatically controlled. The automatic systems can be made manually controlled when certain tests are performed, since the

conditions of these tests might operate the system without a fire existing. In case of operation of either the manual or automatic systems in the hangar, an alarm will be sounded in the hangar, in the south observation room, in the main refrigeration machinery room, and at the headquarters of the Base fire department. The observer in the south observation room takes control and directs operations over the loud speaker system.

The fire alarm system for the engine and equipment test room is similar to that of the hangar except that the alarm sounds in the east observation room and the fire is controlled from that point.

Water Fog. In addition to manual hand extinguishers of various types, and manual water hose systems which require no special description, both the hangar and test room have full coverage by water fog hand-lines. Each line is separately controlled by electric solenoid valves and has a nozzle with a 10 foot applicator for fog. This nozzle can be adjusted for full water stream.

Carbon Dioxide. Both the hangar and test room are also provided with carbon dioxide hand lines. The carbon dioxide is supplied from a centrally located storage having a capacity of 15,000 pounds. This storage is refrigerated by a separate small refrigerating system to limit pressure during periods of high ambient temperature.

In addition, the test room is provided with a conventional carbon dioxide deluge designed especially for the engine test stand although it can be used for any fire in the test room. It is operated by a remote control in the engine test stand observation room. In order to protect personnel, the carbon dioxide deluge will be made inoperative when personnel are in the test room.

Foam. Both the hangar and equipment and engine test room are provided with hand lines for the distribution of foam. The foam system is supplied from a separate building in the rear of the hangar which also houses the pumps for the water deluge system.

Water Deluge. In addition and most important, a water deluge system is provided for the hangar and test room, as well as for the shops and test assembly room. For control purposes this system is divided into two groups. The attic space above the main hangar has closed fusible heads with further protection provided by rate-of-rise of temperature actuators. This latter feature controls magnetic valves which release water to the system, however, the deluge will not operate until the heat fuses the sprinkler heads. The main hangar and test room are both equipped with dry line open sprinkler heads for water deluge and flow is normally automatically controlled but, if desired, it can be manually controlled from the south observation room. It is not contemplated that this system will be used unless other protection fails to control the fire.

Reservoir and Pumps. To provide water for the deluge system, a closed concrete reservoir having a capacity of 600,000 gallons has been constructed. This will provide a one hour supply with all heads flowing. Water is piped from this reservoir under gravity head to four 2500 gpm aad two 500 gpm pumps located in a pump building. These pumps are normally electrically operated by 125 HP and 60 HP motors respectively, but have automatic starting gasoline engines for use in case of electrical power failure. A signal is sounded in case the water La the reservoir approaches a dangerously low level.

23. EMERGENCY INTER-COMMUNICATION AND SIGNAL SYSTEM.
Purpose. In addition to standard dial telephones connected to the post telephone system, inter-communication and signal systems are provided. These are necessary for both normal and emergency operations.

Normally test operations in the hangar or test room require close coordination with the control centers in the observation rooms. This is accomplished by inter-communication between the machinery room, observation rooms, test service rooms, mobile observation rooms, personnel at the test centers of the hangar and test room, and personnel in aircraft and equipment raider test.

Emergency operations require an alarm system to warn and attract attention, and a loudspeaker system over which instructions can be given to control the emergency.

Telephone System. To satisfy the requirements for normal operation, the hangar is equipped with a 50 line private automatic dial telephone systeir with switching capacity to accommodate seven simultaneous conversations. A total of 23 phones are in use on this system. Certain phones are equipped with emergency break-in switches for use in interrupting conversations in cases requiring urgent action. All phones located where the noise level may be high are equipped with loud bells and anti-noise transmitters.

Because standard telephones will not function properly in the extreme temperatures of the hangar and test rooms, and also due to the fact that the personnel in these areas wear special clothing and head gear, they are provided with standard aircraft type head phones and microphones with long leads which plug into multiple jacks located around the exterior walls of the mobile observation rooms. Within each of these rooms is installed a loudspeaker and several microphones so that those inside are in constant contact with all personnel working outside. The mobile observation rooms are also equipped with dial type phones which by means of port¬able cables, can be plugged into any of ten jacks located around the hangar walls, and can thus be connected into the automatic dial system for communication with all parts of the entire facility.

Sound Powered Phones. In the equipment and engine test room, sound powered telephones are installed with jacks for phone and throat microphone extensions. Eight stations are located around the walls, in the east and west observation rooms, and in the test service room. These are equipped with magneto operated howlers to arrest attention.

Public Address System. For emergency use, the hangar is equipped with a public address system consisting of a total of 45 loud speakers located throughout the project, including 15 in the main hangar area. Microphones with push button operated howlers to demand attention are located in both north and south observation rooms, in the Chief Engineer's office, and in the Commanding Officer's office in the north lean-to.