NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
FIELD INSPECTION OF ADVANCED RESEARCH AND TECHNOLOGY
LANGLEY RESEARCH CENTER
LANGLEY STATION
HAMPTON, VIRGINIA

FACT SHEET
LUNAR LANDING RESEARCH FACILITY

The Lunar Landing Research Facility will provide a controlled laboratory in which scientists of the National Aeronautics and Space Administration will work with research pilots to explore and develop techniques for landing a rocket-powered vehicle on the Moon, where gravity is only one-sixth as strong as on Earth.

The facility, currently being checked for final acceptance by NASA preparatory to beginning research operations in about two months, includes a rocket-powered man-carrying flight test vehicle which will be operated while suspended from a 250-foot high, 400-foot long gantry structure-- used to provide lunar gravity simulation.

The research vehicle is designed primarily as a multipurpose flight test bed equipped with hydrogen peroxide rocket motors to provide the main thrust and attitude control. While the vehicle is not an exact replica of the Apollo lunar excursion module, it is essentially the same size and weight as the LEM and will provide, with proper adjustments, the same performance, control characteristics, and cockpit visibility.

As much currently available hardware and equipment as possible was used in the design of the vehicle to expedite its construction in the most economical manner. For example, an H-13 helicopter cab was used for the pilots' compartment.

The research program planned through use of this facility will include a systematic variation of the vehicle control characteristics, cockpit

visibility, flight instrumentation and piloting techniques. For some tests, the cockpit will be modified to duplicate the actual LEM design features.

The test vehicle will be flown at speeds up to about 17 miles an hour within the confines of the overhead structure, which provides travel of 400 feet down range, 50 feet cross range, and 180 feet vertically. At one point in the NASA research program, the vehicle will be hoisted to the overhead platform where two cables from the trolley units on the lower horizontal truss structure will be prepared for catapulting the vehicle down range at speeds up to 35 miles an hour.

In research operations, a vertical lifting force equal to five-sixths of the flight vehicle's weight is applied by two support cables to oppose the pull of Earth's gravity and simulate the low gravitational force at the Moon's surface. The cables are attached to a servo controlled hoist system in a dolly unit mounted under the traveling bridge. The hoist system is controlled automatically by load cells in each support strut. As the vehicle moves down range or cross range in response to the pilot's controls, the bridge and dolly respond to signals from the vehicle and from cable angle sensors at the top of the cables so as to stay directly over the vehicle at all times and keep the cables vertical. The bridge and dolly system are hydraulically driven to provide a very responsive servo controlled system.

Safety features are provided in the facility to prevent the vehicle from crashing or the bridge and dolly from overrunning their tracks in the event of malfunction of equipment or the pilot exceeding the safety limits of the system.

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AMES RESEARCH CENTER EXHIBIT DEPICTS
ADVANCES IN LIFE SCIENCES RESEARCH

FOR RELEASE:
IMMEDIATE

An exhibit depicting step-by-step advances in life sciences research is featured at the Field Inspection of Advanced Research and Technology being conducted by the National Aeronautics and Space Administration at the Langley Research Center.

Highlights of NASA's research programs, as well as summaries of man's accomplishments which led to the space age, are shown graphically and described by a narrator in the walk-through display. The life sciences exhibit was developed at NASA's Ames Research Center, which has primary responsibility for basic research in the life sciences for NASA.

A full scale model of a capsule which will orbit biological organisms up to thirty days to determine long-term effects of weightlessness has been cut-away for the exhibit to show internal detail. Ames Research Center has management responsibility for Project Biosatellite.

For an additional exhibit, the Ames Research Center has sent an instrument originally developed for space research which has been adapted by the Food and Drug Administration to detect possible detrimental effects new drugs might have on human embryos. The ballistocardiograph was developed by Vernon Rogallo of the Ames Instrumentation Division to detect micrometeors in outer space. Mr. Rogallo slightly revised his ultrasensitive device so that it could detect the heartbeat of the embryo in a chicken egg.

Ames bioinstrumentation scientists have devised a 3/4 inch biological function transmitter, complete with battery and antenna, to be worn by pilots

to permit continuous monitoring of their physical condition. In the demonstration, visitors may view their own heartbeat patterns measured and transmitted by FM radio and displayed on a television screen.

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HIGH SURFACE TEMPERATURES MAJOR PROBLEM
IN STRUCTURAL DESIGN OF HYPERSONIC AIRCRAFT

FOR RELEASE:
IMMEDIATE

The structural problems caused by temperatures which would be as high as thousands of degrees Fahrenheit on the surface of hypersonic aircraft in flight at many times the speed of sound are subjects of intensive research by scientists of the National Aeronautics and Space Administration. The heat is generated by compression and friction of air molecules in contact with the aircraft's exterior.

Hypersonic pertains to speeds at five times sonic velocity or higher. A major problem of designers in this speed region is to keep the environmental heat from vaporizing the fuel, particularly if liquid hydrogen is used, visitors to the NASA Field Inspection of Advanced Research and Technology at the Langley Research Center were told.

In a summary of test information, NASA reported that, at seven times the velocity of sound, the hottest area is the lower lip of the air inlets, which reach 2,500 degrees F. The nose cap reaches 2,300 degrees F., with the thermometer climbing to 1,700 degrees F. on the leading edge of the ventral fins, and 1,600 degrees F. on the forward section of the wing. Lower temperatures occur over the remainder of the vehicle, but all surface heat on the structure is high.

Since the outer surface of the aircraft in hypersonic flight is hot, some insulation or thermos-bottle effect must be provided between the structure and the tanks. The structure must carry the vehicle loads, sustain high external temperatures, contain the fuel, and at the same time provide the required insulation.

NASA research is providing new concepts to solve these structural problems. Two design approaches that show great promise were discussed by Langley scientists and included a hot monocoque structure and a multiwall structure.

In the concept of the hot monocoque structure, carbon-dioxide gas is introduced between the hydrogen tank and the outer structure to prevent air from entering the sealed area. Should air get in around the tanks, it would liquify and freeze-- adding excessive weight to the vehicle.

Some of the carbon-dioxide gas condenses as a frost within the fibrous insulation bonded to the tank, which is conceived as of an aluminum waffle-plate construction. The frost, which serves as insulation and cools the fuel tank, sublimes during flight-- absorbing heat that would otherwise be transferred to the fuel.

The concept of the multiwall structure calls for multiple layers of metal properly connected to produce an insulating effect. The structure is a sandwich of dimpled and flat sheets that are joined by welds at the crest of the dimples. The polished outer layers form reflective shields that resist the transmission of heat. The spaces between these layers are evacuated. The inner layers form the primary load-carrying structure, and serve as the tank wall.

Large structural specimens of the two concepts, structural elements, and materials are being investigated to provide the structures technology needed for the development of hypersonic aircraft capable of flight at many times sonic speed.

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NASA EARTH, LUNAR LANDING STUDIES
CONDUCTED IN ADJACENT FACILITIES

FOR RELEASE:
IMMEDIATE

Landing on Earth and touching down on the Moon are operations which normally would be taking place nearly a quarter-million miles apart-- but research on these flight problems soon will be going on in two adjacent laboratories at the National Aeronautics and Space Administration's Langley Research Center, Hampton, Virginia.

Newest of the two is the Lunar Landing Research Facility, a 250-foot high, 400-foot long gantry structure which will be used by NASA scientists and research pilots to explore and develop techniques for landing on the Moon. A short distance away is the Landing Loads Track, a facility for studying Earth-landing problems of flight vehicles.

Suspended from the 25-story Lunar Landing Research Facility is a rocket-powered research vehicle resembling the lunar excursion module which will carry astronauts to the Moon. The research vehicle will be operated in a study of the problems of the landing maneuver from an altitude of about 180 feet down to the lunar surface, where the gravity is only one-sixth that of Earth.

Lunar gravity will be simulated by a special crane traveling along the gantry which rises above a wooded section. The crane is capable of supporting research vehicles weighing as much as 20,000 pounds, and will sustain five-sixths of their weight. The remaining one-sixth-- matching lunar conditions-- will be supported by the craft's hydrogen peroxide rocket system during landing research.

A series of special pivots called gimbals will give the vehicle the same

freedom to move in any direction that it would have in space, with pilot control being provided through main support rockets and smaller maneuvering rockets. Linear motions will be 400 feet lengthwise, 50 feet crosswise, and 200 feet vertically. Initial velocities of 50 feet a second horizontally and 30 feet a second vertically will be obtainable. NASA is checking out the unique facility preparatory to putting it into operation in about two months.

The Landing Loads Track, operated the past several years in research on problems of landing impact, taxiing, braking, and ground handling of aircraft and spacecraft, includes a 50-ton test carriage which is catapulted along a 2,200 foot track by a hydraulic jet. The carriage is propelled up to 150 mph in three seconds in a distance of 300 to 400 feet.

The carriage carries a test specimen such as an aircraft landing gear, which is impacted on a concrete runway as the transport vehicle travels in free roll along the track. All actions aboard the carriage, which is halted by cables stretched across the track, are automatically controlled. Research information is recorded on board for later analysis by NASA scientists.

The facility has been operated to study landing gears, the action of tires on the runway, skids, brakes, loads developed in the craft when encountering bumps on the runway, and the character of the takeoff and landing surface itself.

Because of the high-speed, straight-run capability of the facility, Langley has been able to conduct research on shimmy on the X-15 nose gear on dry, wet, and sand-covered concrete; study skid materials for application to reentry vehicles; investigate the important effects of tire tread pattern and tire wear on the braking effectiveness of a tire on a wet runway; and scientifically probe the retarding effect on tires of a deposit of slush on the

runway and the hydroplaning of tires on wet surfaces.

Hydroplaning, a phenomenon of importance to airplanes and automobiles, may occur at a certain speed in heavy rain-- with the tire riding on a film of water and acting like a water ski. Hydroplaning speed is proportional to the square root of the tire inflation pressure. For an aircraft tire at an inflation pressure of 100 pounds, the hydroplaning speed is approximately 104 miles per hour; at 25 pounds, typical of today's motor cars, the hydroplaning speed is about 52 mph.

When a tire hydroplanes, braking or traction friction drops to a low value, as does the vehicle directional control, or steering. The result: the airplane or automobile has a great increase in braked stopping distance. In addition, both would be more adversely affected by crosswinds and experience a loss in steering. A hydroplaning tire frequently stops rotating completely without application of brakes, which become useless under such conditions.

Visitors attending the Field Inspection of Advanced Research and Technology at the Langley Research Center today were shown the Lunar Landing Research Facility, with the research vehicle suspended from the gantry crane, and witnessed a demonstration of an airplane tire being tested under hydroplaning conditions at the Landing Loads Track.

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NASA-FAA SST SIMULATION STUDY
LINKS LANGLEY, ATLANTIC CITY

FOR RELEASE:
IMMEDIATE

Simulation studies to assure that the projected U. S. supersonic transport will mesh smoothly into the nation's air traffic control system are now underway in a joint program between the National Aeronautics and Space Administration and the Federal Aviation Agency.

An advanced supersonic transport flight simulator is installed at the Langley Research Center at Hampton, Virginia, supported by a battery of analog computers and accessory equipment for navigation, communication, recording and power.

At the FAA's National Aviation Facility Experimental Center at Atlantic City, New Jersey, there has been established a simulation capability for reproducing an entire Air Route Traffic Control Center (ARTCC), a partial adjoining ARTCC for fringe traffic, and an airport approach control and tower complex.

Communications and data channels link the two facilities, to bring together NASA's special competence in performance, stability and control, and operating problems of supersonic aircraft and FAA's vast experience in air traffic control.

The complex arrangement has been set up in anticipation of several related problems which will arise when a supersonic airliner is introduced into a traffic control system largely populated by subsonic airplanes with different flying characteristics.

For example, the supersonic transport will use fuel at a high rate and hence would be heavily penalized by extensive traffic delays. Its particular

characteristics will limit its choice of flight paths and will probably cause an increased workload for its crew.

From the traffic control viewpoint, SST speeds will create problems of safe separation distances between planes and an increased workload for traffic controllers.

Answers to some of these expected problems must be found in advance, so that it will be possible to design both the airplane of the future and the traffic control system of the future to work more efficiently together.

The Langley Research Center simulator consists of a four-place cockpit like that of a present-day jet. There are stations for a pilot, co-pilot, flight engineer and navigator. Instruments have been changed to cover speeds over 2,000 miles per hour and altitudes to 100,000 feet.

The analog computer linked to it can be programmed to simulate the flying characteristics of several different SST concepts. Such characteristics come from wind tunnel experiments which NASA has conducted on SST concepts for many years. Signals from the pilots' control motions initiate simulated aircraft motions which in turn are reflected in changed instrument readings in the cockpit.

At the FAA installation at Atlantic City a large group of electronic instruments simultaneously create an air traffic control environment. The complex traffic patterns centered around Kennedy International Airport in New York are used for the SST simulation work. As the FAA controllers at Atlantic City work with the artificially-created traffic as presented on their radar scopes and through communications, a spot of light representing the SST being flown by simulation at Langley appears on their viewing screens. The controllers then bring the SST from cruising altitude down to final approach or

simulate a take-off and acceleration to cruising altitude.

The simulated flights are conducted on the same time scale as an actual approach or take-off would be, thus realistically putting before both the flight crews and controllers situations with which they must deal on the spot.

Airline jet pilots and co-pilots will perform most of the simulator "flying," supplemented by NASA research pilots and FAA flight personnel.

Simulation studies are expected to continue during the next several years.

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USEFULNESS OF AIRCRAFT EMPHASIZED
IN HIGH-SPEED AERONAUTICAL RESEARCH

FOR RELEASE:
IMMEDIATE

High-speed aeronautical research by the National Aeronautics and Space Administration is leading to increased usefulness of aircraft such as the supersonic commercial air transport of the future and advanced military airplanes.

There has been a spectacular increase in maximum speed, the primary advantage of aircraft, from the World War I fighters of approximately 100 miles an hour to about 2,000 miles an hour for current military aircraft and projected supersonic transports.

But the emphasis no longer is just on further speed increases. Research now seeks to extend the usefulness-- in terms of velocity, range, payload, and operating flexibility-- of this new class of aircraft.

At the Field Inspection of Advanced Research and Technology at the Langley Research Center, NASA scientists discussed aerodynamic problems associated with high-speed flight, and cited recent research advances which are making possible new levels of aerodynamic performance in both civil and military aircraft.

For example, research advances have made possible the application of the variable sweep wing principle to practical aircraft such as the F-111 fighter-bomber now under procurement, and have provided NASA with the means for attaining aircraft efficiency in cruising flight at supersonic speeds.

The variable-sweep wing, a revolutionary concept for improving aircraft performance, has been a subject of interest at the Langley Research Center since 1945. Later, the NACA, Air Force, and industry combined in

developing the variable-sweep X-5 research airplane, which flew in 1951. Stability considerations in the X-5 required that the whole wing be translated fore and aft as the wing was swept-- imposing a penalty in increased weight and complexity.

Research on the problems of variable sweep was continued in wind tunnels, and Langley found in 1959 that a structurally simple wing pivot could be used, requiring no wing translation. This research advancement, combined with the urgent need of the military services for a multipurpose aircraft led directly to the concept of the F-111, which is currently undergoing study in NASA research facilities.

In a variable-sweep aircraft, wings are swept forward for takeoff and landing to provide maximum wing span and flap effectiveness. The wings are swept to an intermediate angle of approximately 45 degrees for optimum subsonic cruise, and to about 70 degrees for maximum efficiency in high-altitude supersonic flight. For high-speed operation at low altitudes, where the aerodynamic forces are high and little wing area is required, the wings are folded back on top of the fuselage to minimize the aerodynamic drag and the gust response of the aircraft.

There are overriding requirements for increased payload and range in high-speed aircraft. These performance requirements, along with design considerations of aircraft noise and sonic boom, demand an aircraft of the highest possible aerodynamic efficiency.

Of these aircraft, the supersonic transport is the most demanding. It must be safe, economically sound, and have acceptable noise and sonic boom characteristics. The critical requirement is the level of supersonic cruise efficiency-- producing the required lift with a minimum of drag. The attainment of high cruise efficiency serves to reduce the weight of aircraft for

a given mission and thereby reduces the airport noise and level of sonic boom.

NASA scientists have evolved in NASA wind tunnels the last few years a series of configurations to study the aerodynamic problems of the supersonic commercial air transport (SCAT) and to establish a level of potential aerodynamic efficiency. They include fixed-wing (SCAT 4 and 17) as well as variable-sweep configurations (SCAT 15 and 16) and encompass a wide range of wing planforms, control surfaces, and engine installations. Results from these studies have been utilized by industry in their design proposals relative to the National Supersonic Transport Program.

The aerodynamic background which led to this SCAT series was based on research conducted in the early Fifties, when a comprehensive experimental wind-tunnel and flight program was undertaken to check the validity of basic theories, to establish appropriate restraints, and to provide an insight into new concepts. Out of this intensive program of experimental and theoretical correlation there gradually evolved a capability to optimize and to predict the aerodynamic characteristics of a broad range of configurations. NASA scientists say they now have learned to realize in fact the improvements and gains that theory indicated were there.

Within the last six months, the aerodynamic technology that had evolved over the past several years has been programmed into high-speed electronic computers. Results on aerodynamic performance can now be available in hours, rather than weeks, making the computer useful as a design tool.

NASA recently employed this new aerodynamic technology to optimize an aircraft concept for high-speed flight. Using the mission requirements of the supersonic transport as a basis, a configuration has been evolved which

establishes new levels of aerodynamic efficiency.

The resulting concept has a fuselage which is long and slender and is carefully integrated with the wings; leading edges and trailing edges of the wing are highly swept, while the wing is twisted and cambered to optimize the drag-due-to-lift characteristics; the engine nacelles are attached to the undersurface of the wing behind the point of maximum thickness to provide favorable lift and drag interference effects; and the fuselage is cambered to optimize the flow for the lifting condition.

The ultimate check of any calculated procedure must be made in a wind tunnel, which has the further capability of permitting visualization of the air flow and thereby providing an insight into the physical phenomena involved. NASA is making wide use of wind tunnels and other laboratories in the conduct of high-speed aeronautical research leading to significant advances in faster-than-sound aircraft design.

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PLASMA ACCELERATION RESEARCH SHOWING PROMISING GAINS, NASA SCIENTISTS SAY

FOR RELEASE: IMMEDIATE

National Aeronautics and Space Administration scientists stated today at the agency's Field Inspection of Advanced Research and Technology that continued gains are being made in laboratory efforts to produce and control extremely high temperature plasmas for space technology applications.

In discussions of the relatively new science called magnetoplasmadynamics, they pointed out that astrophysicists now recognize that more than 99 percent of the universe is in the plasma state and that laboratory studies are opening new avenues for an increased understanding of cosmological phenomena.

A plasma is most simply defined as an ionized gas which conducts electricity. The motion of such ionized gases is called plasmadynamics. Whenever an electrically-conducting plasma moves through a magnetic field, forces are produced on the plasma. Studies of this complex phenomenon gave rise to the term magnetoplasmadynamics, frequently shortened to MPD.

Scientists are pursuing MPD research vigorously because:

1. It offers a way to accelerate gases to very high speeds for use in aerodynamic research, particularly for wind tunnel studies of reentry problems.

2. There are prospective applications of MPD for spacecraft propulsion and power generation systems of the future.

3. Controlled thermonuclear fusion research is heavily dependent upon magnetoplasmadynamics, and the Atomic Energy Commission is engaged in an extensive MPD effort toward that goal.

Perhaps the most dramatic natural manifestation of MPD principles in action is found in the Sun. The solar disc as it is normally seen is called the photosphere: its surface temperature is about 11,000 degrees F. Between the photosphere and the corona there is a thin boundary region known as the chromosphere, a very turbulent, complex structure.

Magnetoplasmadynamic shock waves travelling outward through the chromosphere are believed responsible for the enormously high temperatures -- several millions of degrees -- in the solar corona. The gas in the corona accelerates to high speeds and becomes the solar wing which has been observed and measured by several United States satellites and space probes.

Laboratory experiments with a magnetically compressed plasma give scientists an opportunity to generate and study a small sample of the solar corona. Laboratory-plasma studies are providing basic knowledge in atomic physics at very high temperatures where such information does not now exist. They are also forming key elements in an improved understanding of the Sun's corona, important because the solar wind flowing from it directly affects the radiation belts around the Earth and causes magnetic storms which interrupt communications.

A theory of the corona will accelerate understanding of these phenomena and will complement measurements made by astronauts, space probes, and space laboratories.

Plasma acceleration research is receiving considerable attention by NASA because of its direct application as a laboratory tool for dealing

with the problems of hypersonic flight and entry into planetary atmospheres. Such studies are now made in shock tubes and related devices, but facilities are needed with longer running times and much higher speeds. Plasma accelerators offer very good possibilities for meeting the requirement.

Plasma propulsion and power generation are considered to have useful applications for very long term space missions of the future. Basic research in these areas is going on at the NASA's Ames, Langley, and Lewis Research Centers, while applied research for direct development of MPD propulsion systems is underway at the Lewis Research Center.

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LIGHTWEIGHT PROJECTILE IN NASA GUN FACILITY
PUNCHES HOLE IN METAL IN METEOROID SIMULATION

FOR RELEASE:
IMMEDIATE

A special gun facility that propels a small, extremely lightweight mylar plastic disc at speeds great enough to punch a large hole in a thick aluminum target was demonstrated today by the National Aeronautics and Space Administration at the Field Inspection of Advanced Research and Technology at the NASA Langley Research Center, Hampton, Virginia.

NASA scientists, seeking through research to obtain true meteoroid simulation in ground laboratories to provide information useful for designing cabin walls in manned orbital space stations, announced that two advanced gun facilities are under construction.

One is an electrostatic facility which will fire a stream of fine dust-like particles at meteoroid velocities. The speed of meteoroids is estimated to range from about 27,000 mph to as high as 140,000 mph. This facility is expected to go into operation in 1965.

The other, of which a pilot model is the facility demonstrated at the Inspection, is an explosive foil gun capable of propelling a single particle heavy enough to penetrate structures. The prototype facility will be completed late this year and will be capable of simulating realistic meteoroid velocities.

Such devices will provide valuable tools to prove the reliability of cabin wall construction before astronauts are exposed on long space station journeys to meteoroids, radiation, heat, and other hazards.

The pilot model of the explosive foil gun is powered by a bank of large

capacitors charged by a high-voltage power supply. The capacitors are discharged through a switch into a thin strip of aluminum foil-- which is exploded by the momentary heavy current.

The gun breech contains the aluminum foil and a diaphragm of material used to simulate a meteoroid. A disc-shaped mylar plastic particle, punched from the diaphragm by the exploding foil, speeds down the plastic tube gun barrel into a vacuum chamber and strikes the target at nearly 14,000 mph, about seven times as fast as a bullet from a modern military rifle.

Although this is only one-tenth as fast as some meteoroids, it illustrates that even a small particle can inflict substantial damage at these speeds. The importance of protection from meteoroid impact is evident when it is realized that even one penetration could result in an aborted mission.

SPACE CABIN WALLS PROTECT AGAINST HAZARDS

The space cabin wall not only forms a protective barrier between the astronaut and meteoroids, but from other hazards of the space environment as well.

Cabin walls reflect heat arriving directly from the sun and that reflected from the Earth's surface. They also must radiate to space the excess heat generated by men and equipment inside the space station. This means that the walls must insure a delicate thermal balance between these factors to maintain a comfortable temperature where the astronauts are living and working.

Another function of the cabin walls is to attenuate harmful ionizing radiation, charged subatomic particles with energies so great that no practical wall construction could stop all of them. But the flux of these particles can be reduced-- so that they are not a hazard to the men and equipment inside for a reasonable time in orbit.

NASA research shows that for short stays in space, the pressure require-

ment is the only critical design condition. For longer durations, the radiation environment or the meteoroid hazard is the critical design condition, depending on the orbit.

If one man stays in a space station for a very long time, even in a low orbit between the upper atmosphere and the lower fringe of the ionizing Van Allen radiation belt trapped by the Earth's magnetic field, radiation protection requirements become critical.

Scientific investigation into the characteristics of meteoroids has disclosed that a cabin wall composed of several layers is more effective, pound for pound, than a single aluminum sheet. The outer wall shatters the meteoroid, forming a cloud of smaller particles and spreading the projectile energy over a large area of the second sheet-- reducing the probability of damage.

Making use of this so-called bumper phenomenon, a composite cabin wall can be designed for meteoroid protection that is about one-third the weight of an equivalent single sheet.

NASA scientists described two types of cabin walls which were designed on the basis of an analysis of the known characteristics of the space environment and its effect on structures and materials. Whether the designs will perform as desired must be determined by subjecting them to a simulated space environment through advanced research facilities such as the exploding foil gun and similar devices, they said.

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CRUCIAL LUNAR MISSION EVENTS ARE DUPLICATED BY LANGLEY SIMULATORS

FOR RELEASE: IMMEDIATE

About 72 hours after launch from Cape Kennedy, the crew of the first United States lunar expedition will brake their complex spacecraft into a parking orbit somewhat more than 100 miles above the Moon's surface.

After careful computations and repeated systems checks, the Lunar Excursion Module (LEM), carrying two astronauts, will separate from the Apollo Command Module to begin a gradual descent to the Moon.

As the distance lessens, lunar surface features become larger and larger. At the low point of the first LEM orbit, roughly 10 miles above the surface, the pilots will make a close inspection of the landing site.

When all necessary calculations and adjustments are complete, they will guide the LEM into a descent trajectory, beginning about 170 miles from the intended landing place.

A flare maneuver will bring the LEM to a hover about 200 feet above the Moon's surface. The commander will then manually guide the spacecraft down to a selected landing area.

The last 200 feet demand the utmost in piloting skills, until finally -- touchdown.

Then -- the first astronaut places a tentative foot on the Moon!

Following brief hours of exploration, the all-important lift-off, precisely timed to permit rendezvous with the circling Apollo command module, waiting in orbit above.

Radar contact, orbit adjustment, visual sighting, gradual approach and

finally, a careful, gentle docking maneuver before preparations for the return to the home planet Earth.

These are the main, critical elements of America's program of manned lunar exploration.

Every one is being studied in detail now at the NASA's Langley Research Center, in theory, with small scale models, and most importantly with full sized, man-carrying simulators which are coming into being to assure that every phase of the lunar mission will have the most thorough understanding and analysis that advanced research can provide.

Simulators have been used in research for many decades, to create in the laboratory controlled conditions that can be repeated easily and economically for prolonged study.

The lunar mission has called into existence a whole new group of simulators, each capable of providing a realistic duplication of the strange and unknown environment man must master to be first on the Moon.

They begin at 200 miles above the lunar surface, in a still-to-be-completed device known as LOLA -- the Lunar Orbit and Landing Approach simulator, a complex blend of electronics and optics which will produce for a pilot the porthole views he might expect during a descent and landing on the Moon.

They continue in a piloted, rocket powered vehicle, ingeniously suspended to match lunar gravity, which is only one sixth that of Earth. The vehicle, mounted in a giant gantry structure called the Lunar Landing Research Facility, will be flown by pilot control to final touchdown at a selected landing site.

Lunar walking?

That, too, can be simulated, in a simple contrivance compounded of canvas slings, steel cables, a small trolley, and a plywood moon surface. The

unexpected aspect of the device is that it matches lunar gravity, by tilting the walking experimenter about 80 degrees from the vertical. In the new vertical plane in which his customary body motions then take place, he experiences the equivalent of Moon gravity. To prove it, he makes 12 foot jumps with ease and rapidly ascends a "vertical" pole single handed.

Rendezvous in orbit? NASA scientists provide that experience as well, in a piloted simulator suspended beneath the roof of a huge hangar. It is presently being used to study the finer points of the Gemini-Agena orbital rendezvous, but it works equally well for a lunar orbit rendezvous between the LEM and the Apollo.

The Rendezvous Docking Simulator is a skillful blend of mechanical ingenuity and computer expertise, providing a sensitive vehicle which responds by direct, sensible motions, to the control changes provided by the research pilots who use it.

Its counterpart is the Visual Docking Simulator, which provides nearly everything except the motion cues furnished by its more elaborate relative. The pilot remains fixed in his seat, and a computer driven optical image, projected through a closed television system, gives the illusion of closing on and docking with the target vehicle flying in orbit.

From all of these unusual devices, NASA scientists are accumulating the body of knowledge and experience which must come before the first manned lunar expedition. Advanced research in the laboratory, research with simulators, research keyed to practical problems of flight is laying the foundations for success of our national space program for the lunar and future space missions.

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FACT SHEET
POWERED LIFT RESEARCH FOR JET TRANSPORTS

Research on boundary layer control (BLC) by the National Aeronautics and Space Administration has produced a detailed understanding of the aerodynamic principles of such high lift systems. Heightened interest in BLC is based on its promise as a way of increasing the lifting ability of a wing and hence allowing an aircraft to land at lower speeds. The widespread use of jet engines has provided the margin of power needed to translate these aerodynamic principles into practical improvements in aircraft performance and operating safety.

Closely coordinated efforts in the aircraft industry have provided the mechanical means for exploiting BLC powered lift techniques, and a NASA-industry program is now making systematic flight investigations of two large aircraft sepcially equipped with BLC systems.

One, a Boeing 707, is at the Langley Research Center, Hampton, Virginia, under a 90-day contract with the manufacturer. The other, a Lockheed C-130, is flown from the Ames Research Center, Moffett Field, California.

The Boeing airplane is typical of the large, swept-wing jet transports in current airline use. The C-130, a straight-wing airplane, has four turboprop engines and is a standard military transport.

Both machines have been equipped by their manufacturers with auxiliary BLC systems and hence are of important flight research interest.

BLC promises a workable way of improving the slow-flying abilities of a high speed airplane. The lowered landing speeds which result are very desirable from the standpoint of reducing landing distance, or required runway

length, lowering weather minimums, and obtaining greater safety.

Boundary layer control systems are designed to maintain the largest possible amount of aerodynamic lift on an airplane's wing and flap surfaces, even though the flaps are sharply deflected for landing. High lift is attainable only if the air adheres closely to the curved aerodynamic shape of the wing and flaps. If it does not, areas of stall occur and lift is lost.

A pilot's choice of flap angle is usually limited to about 50 degrees because at higher angles, the air flow will not follow the contour of the wing-flap combination.

The BLC system permits flap deflections of as much as 70 degrees without separated airflow and stall. The higher flap angles and BLC provide more lift and hence allow slower flight speeds.

The Boeing 707 airplane used for research at Langley was specially equipped at the manufacturer's expense with special large wing flaps, the boundary layer control system, a thrust modulating system, and a large amount of instrumentation to measure its flight capabilities.

In preliminary tests, the 707, prototype of the current series of Boeing jetliners, has flown at speeds well below 100 mph on approach to landing and has touched down on a runway at 90 mph. In one experimental flight, airplane flying speed was reduced to 75 mph before stall occurred. Normal speeds for the 707 are 150 mph on approach and 135 mph at touchdown.

The air supply for the boundary layer control system on the 707 is obtained from bleed ports in the high pressure sections of the airplane's four large turbofan engines. The compressed air is routed through a collector ring at 100 pounds per square inch pressure and a temperature of 650 degrees F.

From the collector, the air is piped inside the wing to ejection slots at

the leading edges of the flaps. For safety reasons, there are two separate ducting systems each covering the total span of the flaps. The BLC blowing nozzles alternate between the two distribution ducts to minimize the loss of lift in the event one system fails. The primary nozzles blow air out through ejector nozzles, entraining secondary air which increases blowing effectiveness.

In order to operate the 707's engines at the high powers required for the BLC system and still obtain the low thrust settings needed for landing approach conditions, a thrust modulation system has been provided. It offers a quick-acting and powerful glide path control and is also used as a part of an automatic speed control system.

NASA pilots are flying the 707 to study flight characteristics at very low speeds for jet transports with powered lift systems and to help establish preliminary flying qualities requirements for such aircraft.

Engineers explain that the special high lift devices, when fully developed for operational use, will serve to reduce the landing, takeoff and approach speeds for jet transports without affecting the cruising or top speeds of the airplane. It is possible that large jet transports of the future may be able to operate from unimproved airstrips as well as from modern airports.

The Lockheed C-130 airplane equipped with boundary layer control has been flying from the NASA Ames Research Center for several years. It is a straight-wing military transport aircraft, with power for the boundary layer control system supplied by two auxiliary jet pods mounted on the wings.

The BLC C-130 is equipped with a flap that can be deflected 90 degrees when the boundary layer control system is operating.

Both airplanes are flying in a program sponsored by NASA's Office of Advanced Research and Technology, through which NASA is seeking to prepare the aeronautical technology required for future advances in flight capability.

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May 18, 1964

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
FIELD INSPECTION OF ADVANCED RESEARCH AND TECHNOLOGY
LANGLEY RESEARCH CENTER
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HAMPTON, VIRGINIA

NASA FACILITY WILL PROVE RELIABILITY
OF HYPERSONIC CONCEPTS AND COMPONENTS

FOR RELEASE:
IMMEDIATE

The 8-Foot High Temperature Structures Tunnel, which will be operated by the National Aeronautics and Space Administration to impose realistic flight environments on structural specimens or hypersonic vehicle components at seven times the speed of sound, is the only facility of its kind in the United States.

The tunnel will be completed later this year at the NASA Langley Research Center, Hampton, Virginia, and will provide this country with a unique capability-- that of being able to ground test structural concepts and large components of hypersonic aircraft to prove their reliability before committing them to a flight vehicle.

Many engineering problems must be solved to achieve and contain the gas temperatures needed for very high-speed flight simulation. In the operation of this facility, a fuel will be burned in the air-- which is to be stored under 6,000 pounds pressure. This mixture will generate the desired temperatures-- and the resulting combustion gases will be accelerated to seven times sonic speed and used as the test medium.

The facility's combustion unit is designed to deliver the gas at 4,000 degrees F. and 4,000 pounds pressure-- at a flow rate of about 1,000 pounds per second. Fuel stored at 6,000 pounds pressure will be injected into the air and burning will take place before the gas enters the tunnel nozzle. Practical achievement of such gas temperatures at the large gas flow rates through the nozzle dictated the use of a combustion process.

Models will be held out of the tunnel test section while the facility

is being started. Once test conditions are established, an elevator-- which has a carriage capable of supporting large three-dimensional models-- will raise the test specimen seven feet and inject it into the gas stream in just one second-- even though the model and elevator will have a combined weight of about 15 tons.

The facility, called a blowdown type wind tunnel because it exhausts the test gases through a diffuser into the atmosphere, has been under development and construction since 1958-- the same year the NASA's other wind tunnel facility for structures testing was put into operation.

This is the 9 by 6-Foot Thermal Structures Tunnel, a blowdown facility operating at three times sonic speed. It uses a storage type heater, composed of 300 tons of stainless steel housed in a chamber, to achieve the desired test temperature. This mass of steel is heated to 660 degrees F. by circulating hot air through it before each run. During a test, the air is raised to the temperature of the steel as it passes through the heater. Recently, propane burners have been added to elevate the central core of the test gas to 1,800 degrees F.

During the past six years, the tunnel has been used for research on dynamic problems of aerodynamically heated structures and to define and solve a number of important structural problems for actual flight vehicles, including the X-15 research airplane, the Project FIRE entry research vehicle, and several large launch vehicles.

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May 18, 1964

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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NASA RESEARCH EVALUATING PROBLEMS OF FUTURE MANNED ORBITING LABORATORIES

FOR RELEASE: IMMEDIATE

While scientists and engineers of the National Aeronautics and Space Administration continue energetically to pursue the goal of manned lunar exploration in this decade, research is preparing a systematic foundation of knowledge on which to base national decisions about the future course of the United States space program.

Multi-manned Earth satellites, capable of sustaining a crew in space for a year or more, constitute one area of major research concern. Although there is no approved program for building such spacecraft, research to furnish the basis on which sound technological choices can be made is already well along.

The projected lifetime of a Manned Orbiting Research Laboratory (MORL), which is one concept under research evaluation, would require a method for replacing crew members and sending additional supplies into orbit. Scientists are convinced that both tasks could be done by using the principles of rendezvous and docking to be developed in the Gemini and Apollo programs.

Other concepts envision much larger orbiting stations, which would probably be expanded into a final configuration after being placed in orbit.

All of the concepts being considered, however, share a number of common problems, and the research being done to find workable solutions will be applicable to any one of a wide range of possible choices.

Air density and its accurate measurement is a good example of one such common problem. The small amounts of air which exist several hundred

miles above the Earth's surface exert a retarding force, or drag, on any orbiting object. Gradually, the drag will lower a satellite orbit so much that the spacecraft will spiral back into the denser portions of the atmosphere.

To solve the problem of selecting proper orbit altitudes, NASA has launched a number of Explorer class satellites to get accurate measurements of air density at extreme altitudes. From the precise measurements, correct decisions can be made on the best altitudes for manned satellites of various configurations.

Another problem facing designers of future spacecraft is the danger of radiation and its effects on both astronauts and space vehicles. High energy protons and electrons in the Van Allen belts, ionizing radiation from cosmic rays, and particles flung outward by the Sun during solar flare events can have a lethal effect on the crew of an orbiting laboratory.

In a new research facility now under construction near the Langley Research Center, scientists will soon have a laboratory tool with which to investigate the radiation problem systematically.

The Space Radiation Effects Laboratory will have as its primary research tool a 600 million electron volt synchrocyclotron capable of simulating one of the most hostile aspects of the space environment.

Just as man on Earth strives constantly to perfect new ways to keep comfortable in changing weather conditions, so space scientists and engineers are experimenting with new materials and techniques to provide an efficient working environment for space crewmen of the future. In the search, special materials are being evolved with which to construct the walls of space cabins, which are subjected to drastically changing tempera-

tures as the orbiting spacecraft moves alternately through the sunlit and shaded portions of its orbit about the Earth.

Experiments to be flown on future launches of the giant Saturn rocket will also aid designers of spacecraft intended to orbit the Earth after Apollo. NASA and industry engineers and scientists are now working on the design of several satellites for orbital flights beginning next year to provide definitive information on the materials needed to shield spacecraft from micrometeoroids -- the tiny particles of matter which are moving through space at extreme speeds and which cause the phenomenon of a meteor or shooting star when they enter the Earth's atmosphere as a fiery streak of light. The Saturn-launched experiments will extend knowledge already provided by several micrometeoroid satellites in the Explorer series.

When future manned space missions of extended duration are considered, research findings now being assembled by the NASA will be available to support many different choices, and designers will have at hand the knowledge required to protect America's astronauts against the dangers of radiation, temperature extremes and micrometeoroids.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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COMPUTERS INDISPENSABLE AS TOOL
FOR AMERICA'S CONQUEST OF SPACE

FOR RELEASE:
IMMEDIATE

Long before a spacecraft is mated to its launch vehicle and long after a satellite is successfully in orbit, National Aeronautics and Space Administration scientists and engineers rely on the versatility and speed of computers to solve many stubborn problems of space technology.

Every NASA Center uses the computer in many different forms as a technical tool, in contrast to its better known functions in bookkeeping, inventory, and accounting.

Langley Research Center is one of the elements in the complex NASA organization charged with responsibility for a portion of the agency's aeronautical research mission. In carrying out this role, Langley has just completed a series of computer studies for the Federal Aviation Agency on tomorrow's supersonic transport. The computer makes feasible complex analytical processes which would be too cumbersome and time-consuming if done by hand methods. In doing so, it has contributed importantly to the national program for design and construction of the 2,000 miles per hour airliner of the future.

In dealing with advanced theory, computers have also proved their worth many times over. Recently, Langley scientists completed a series of theoretical studies of the phenomenon of radio attenuation during atmosphere entry -- the familiar "blackout" caused by ionization which builds up around a spacecraft during its return to Earth, blocking radio communications between the astronaut and his vital ground stations.

Using computers in concert with experiments in actual flight as well as

laboratory studies with ground facilities, NASA scientists are moving closer to a solution of the blackout problem which has harrassed America's astronauts during critical reentry maneuvers. Computers make possible analysis of the highly complex phenomena of aerodynamics, thermodynamics and physical chemistry which combine during high speed reentry to produce the troublesome phenomenon.

A relatively new application for computers discussed by NASA scientists during the Field Inspection of Advanced Research and Technology is in spacecraft and launch vehicle checkout.

When a spacecraft has been attached to its rocket vehicle on the launch pad, a very comprehensive program of checks is required, for it may be the first time that a multitude of subsystems from many different manufacturers has been assembled in a final unit.

A complex spacecraft like Gemini or Apollo may require the testing and verification of as many as 1,500 individual items or quantities, each one involving up to 400 separate measurements per second, taken periodically during a 72 hour countdown procedure when time is at a premium. The task would be clearly beyond the limits of human possibility were it not for the aid of the computer.

The computer can be effectively used to complete a multitude of complex mathematical operations in a minute fraction of the time that a human operator would require. It cannot reproduce the human attributes of judgment or creative thought, but it has been used by NASA scientists and engineers as a tool without which many complex and vital operations in space could never be attempted.

During the launch of the Project Mercury spacecraft, for example, only 30 seconds were available after the launch vehicle rocket engines burned out in which to determine whether the spacecraft was headed into the proper Earth orbit. If it was headed off course, even a small fraction of a degree, the

flight would have to be aborted to bring the craft down safely in a contingency recovery area near ships in the Atlantic Ocean. Otherwise, the astronaut might land in a desolate area of the Atlas Mountains in Africa. In that vital half minute, however, computers assembled sufficient information to permit the mission director to make the crucial decision to proceed.

Computers are extensively used at Langley and other NASA Centers in performing simulation studies for research on guidance, navigation and control of both spacecraft and aircraft. Used in this manner, the computer becomes a very flexible research facility for many types of study, and computers can often be employed on a variety of research tasks in a single day.

The same computer, for example, has been used to simulate an Apollo problem in the morning, an aircraft landing gear experiment in the afternoon, and a supersonic transport control problem during a night shift.

NASA's role in carrying out research and applying the principles acquired to the development of technology and equipment for the Nation's space and aeronautical programs is challenging and very complex. Without the aid of the computer, the task would be extremely difficult. In fact, it has been said, "Our present national aeronautical and space efforts would be impossible without the use of electronic computers."

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May 18, 1964

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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RESEARCH IN LOW SPEED AERONAUTICS
AIDS SPACECRAFT, V/STOL AIRPLANES

FOR RELEASE:
IMMEDIATE

While the United States program of space exploration has engaged the minds and energies of thousands of scientists, engineers and technicians, the National Aeronautics and Space Administration is continuing energetic research to support needed advances in the art of low speed aeronautics.

Studies in flight and in the laboratory are producing knowledge useful for advanced airplanes as well as for lifting reentry vehicles still in the concept stage.

Aeronautical research experts at the NASA Ames Research Center, Flight Research Center and Langley Research Center are making a concerted effort to improve the flying qualities of a class of aircraft capable of fast forward flight combined with unusually slow landing and take-off speeds. Such airplanes are generally called V/STOL (vertical/short take-off and landing) aircraft, and the effort to develop them has introduced many new problems in research because they fly so slowly.

Systematic research is underway in wind tunnels and in flight to learn more about the dynamic behavior of V/STOL aircraft. Ever since the helicopter demonstrated the practicality of hovering flight, designers have sought to combine its versatility at very low speeds with the high cruise speed capability of conventional airplanes.

One promising concept is the tilt-wing method for achieving both qualities in the same aircraft. It uses a mechanism for rotating wing and propellers through an arc of 90 degrees -- with the combination vertical

for landing and take-off and horizontal for conventional forward flight. Transition from hovering to cruise position has been demonstrated to be feasible by flying test bed aircraft such as the VZ-2.

Sufficient technology has been developed by NASA and industry efforts to support construction of a military aircraft embodying the tilt-wing V/STOL concept. The resulting airplane, the XC-142A assault transport, is designed to move a four ton payload at speeds above 300 miles per hour. First flight of the XC-142A is expected later this year.

NASA efforts in V/STOL research include studies of the X-22 airplane which is equipped with four ducted fans pivoted to tilt through 90 degrees to permit transition from hovering to forward flight. NASA research has also supported the effort to develop and build the XV-5A airplane, intended to rise vertically with lift generated by two large fans buried in the wings. For forward flight, the XV-5A's lifting fans will be shut down and covered over and the jet engine used to drive the fans will be employed to provide conventional thrust.

Principles of low-speed aerodynamics are also being applied to spacecraft recovery, and NASA scientists are at work on several different approaches to the problem.

Spacecraft of the Gemini or Apollo type have only small amounts of aerodynamic lifting capability, and hence must be recovered by some auxiliary means such as a parachute, rotor or parawing. The parawing is a light, flexible auxiliary wing which can be packaged like a parachute and deployed when needed.

Lifting body concepts for more advanced spacecraft require that some modest amount of gliding capability be built into the vehicle design, and

NASA is carrying out a tri-center research program at the Langley, Ames and Flight Research Centers to find the best shapes for multi-purpose reentry vehicles which might be suitable for a variety of missions.

Two lifting-body concepts have received the most extensive research attention -- the HL-10 configuration, originated at the Langley Research Center, and the M-2 concept devised by researchers at Ames.

Both are sufficiently promising to warrant further research. Flight experiments have been made at the Flight Research Center with a light, plywood model of the M-2, towed aloft by a DC-3 airplane, and successfully flown to a controlled, glide landing by a research pilot.

On the basis of the flight and laboratory experiments conducted so far, a contract was let earlier this year for the construction of two flight test vehicles, one based on the M-2 concept and the other on the HL-10. They will be built according to conventional low-speed aircraft construction practices, and designed so that their weights can be varied from 4,000 to 8,000 pounds, providing a wing loading test range from 25 to 50 pounds per square foot.

Even in the age of space flight, low-speed research is a continuing necessity, to improve the versatility of spacecraft, and to exploit the advantages of low speed for uses on Earth.

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May 18, 1964

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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STEADY IMPROVEMENT IN HEAT SHIELD MATERIALS
ACHIEVED THROUGH RESEARCH IN PAST FIVE YEARS

FOR RELEASE:
IMMEDIATE

An order of magnitude improvement in the efficiency of reentry heat protection materials over the past five years was reported today at the National Aeronautics and Space Administration's Field Inspection of Advanced Research and Technology.

Scientists of the Langley Research Center described a recently-developed material for spacecraft heat shields which represents a major advance over the substance used successfully on the Project Mercury spacecraft.

The new material is a silicone elastomer containing hollow glass spheres and hollow plastic spheres embedded in a plastic honeycomb matrix to provide structural strength. It has been specially tailored to combine the chemical and physical properties which produce unusually high thermal efficiency.

It is one of a class of materials known as charring ablators. Its low density provides good insulation characteristics to prevent heat from reaching an internal structure.

During thermal decomposition, such as would occur in a reentry, enough gases of the right composition are generated to block incoming heat, and a tough carbonaceous char layer is formed to re-radiate heat through high surface temperature operation.

Charring ablator heat shields protect a spacecraft by a complex physical-chemical process. At first they begin to decompose chemically,

absorbing some reentry heat in the process. During decomposition, gases are evolved, and act as an insulating blanket as they pass over the heat shield surface.

And finally, at the surface, a charred layer of coke-like material develops, capable of operating at very high temperatures to radiate heat away from the spacecraft.

The new material described by NASA scientists performs very efficiently in all of these ways, and hence is a very promising substance for space vehicle heat protection use.

It was pointed out, however, that accurate and detailed ground tests of promising new heat shield materials are essential to determine precisely how they will respond to various environmental changes.

A material that is satisfactory for Gemini reentry speeds may not work well at the escape speed reentry requirements of Apollo. Other variables such as the heating rate, which changes with flight speed and altitude, the severity of char oxidation environment, and increases in surface aerodynamic shear stress must be carefully evaluated.

Present test facilities, it was noted, cannot duplicate the proper combination of all conditions encountered in the entry of advanced manned vehicles, nor can they provide a sufficiently severe value of all the important factors.

The design of future heat shields is considered to require further development of adequate engineering theories to extend existing research information so that the performance of many different materials under widely varying conditions may be accurately predicted.

NASA research is diligently seeking the solutions to these important

problems. Tests in ground facilities are being supported by flight tests of promising materials, and a systematic effort is going forward to provide the technology needed for the future requirements of America's space program.

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May 18, 1964

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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DYNAMICS RESEARCH PROVIDES SIGNIFICANT INFORMATION ON LAUNCH VEHICLE, SPACECRAFT DESIGN AND OPERATION

FOR RELEASE: IMMEDIATE

Advanced research on the dynamics of launch vehicles and spacecraft is providing significant information which is vital to the success of the nation's manned and unmanned space flight programs.

The nature of the problems, the phenomena involved, and the research facilities and flight techniques used to provide information for solutions were discussed today by scientists of the National Aeronautics and Space Administration at the NASA Field Inspection of Advanced Research and Technology at the Langley Research Center.

Before launch, at launch, and during flight through the atmosphere and into the vacuum of space, a vehicle is subjected to many types of pulsating forces--causing the vehicle and its components to vibrate. Such vibrations pose problems for those who design and operate launch vehicles and spacecraft, because they produce fatigue and failure of structural elements and reduce operational capabilities of astronauts.

An essential task is to reduce the vibrations, which are caused by disturbances such as ground winds, engine starting shocks, noise pressures, fluctuations in engine thrust, and forces from sloshing propellants and winds aloft -- or design the vehicle to withstand the loads.

This requires a knowledge of the forces and the physical characteristics of the structures, and the development of the necessary analytical and experimental techniques to permit scientists to predict the resulting vehicle motions.

Even on the launch pad, space vehicles experience dynamics problems. Steady and unsteady winds blowing past a launch vehicle on the ground produce stresses in the vehicle and tie-down mechanism-- and in some cases actually dictate the design of vehicle structures. Wind tunnel studies at Langley with the use of large models indicate that steady winds cause a vehicle on the pad to vibrate, a phenomenon which may produce large stresses and may interfere with launch operations. Gusts, which always occur in natural winds, make the problem even more difficult.

NASA scientists pointed out that the first phases of the flight of a launch vehicle, the ignition of the engines, is a very violent transient or shock phenomenon which has about the same effect on the vehicle instrumentation as dropping a fine watch on the floor. The instrumentation in such a vehicle has to be able to take the shock loads.

On lift-off, the noise from the engines is reflected from the ground and the associated pressure fluctuations produce vibrations which are damaging to the vehicle structure and payload. This noise is also transmitted through the air and ground, and the high sound-pressure levels, which may reach 170 decibels near the launch pad, will damage conventional buildings at distances up to several miles. This is a major reason why launch sites are widely separated from population centers.

As launch vehicle size increases, most of the acoustic energy occurs at lower frequencies and a substantial part of the noise is below the audible range. An observer may feel the pressure pulses, but may not hear much of the sound. A facility has recently been constructed at Langley to study the effects of low-frequency noise on the vehicle, the payload, the surrounding structure, and on man himself.

The Low-Frequency Noise Facility permits NASA to produce and study controlled high-intensity noise pressures in the frequency range from one to 50 cycles per second. The large test chamber is adequate for research investigations of the response of payloads as large as the Apollo command module, or the Lunar Excursion Module. The facility's 14-foot-diameter noise generator is driven by a 20,000-pound hydraulic shaker.

Ascending through the atmosphere, a vehicle encounters strong and variable winds-- particularly at the jet stream altitudes of about 30,000 feet. A launch vehicle feels these winds as a series of fluctuating forces, representing severe dynamic loading conditions which must be coped with for successful design of the structure and the vehicle control system.

The nature of the winds above the launch sites has been investigated by a smoke trail technique developed at Langley. A solid-propellant rocket fitted with a nose cone which contains 150 pounds of smoke-producing chemical is utilized in the research. Launched on a near vertical trajectory, the rocket produces a continuous and highly-reflective smoke trail to altitudes of 75,000 feet. The smoke is blown by the winds and the trail outlines the complete wind profile which is photographed by ground-based camera stations and analyzed by NASA scientists for a determination of wind speeds and directions. These upper winds are currently under study in a Langley program at Wallops Station, Wallops Island, Virginia, and at the Kennedy Space Flight Center, Cape Kennedy, Florida.

A complex interaction of structure and control system takes place as a launch vehicle ascends through winds while maneuvering to stay on the correct flight path. The vehicle responds as a flexible structure-- not as a rigid body. The gyro in a booster senses both the bending motions and the rigid

body motions, and under certain conditions, when the vehicle is disturbed, it will continue to oscillate. Such oscillations can be destructive and both analytical and experimental research is being conducted to develop means to avoid them.

Throughout the intermediate regions of launch vehicle flight trajectory, the sloshing of fuel may become a problem unless proper precautions are taken during design. As the vehicle moves in response to the motions of the control system, the massive quantities of free-surface propellants also move and generate forces on the vehicle. These forces are reduced by damping the fluid motions with various types of baffles, and by designing the control system to minimize its reaction to the sloshing forces.

NASA research has demonstrated that an economical and efficient way to obtain a detailed understanding of the natural frequencies, and damping of the structure is to construct and test dynamic models, a technique which continues to be widely used in the development of all types of aircraft. The same basic principles and techniques are applicable to dynamic models of space vehicles, providing a substantial lead time and readily facilitating investigation of the effects of modifications in payload, propellant conditions and structure.

Langley scientists are currently working with the Air Force and the Martin Company on a study of the dynamics of Titan III. They expect that tests of the one-fifth scale dynamic model being used in this research will provide a sound basis for future analytical studies and eliminate the need for costly full-scale tests. In about a month, Langley will begin an investigation of a one-tenth scale replica model of the Saturn V to supplement research currently being conducted on a relatively simple 1/40-scale model. The results of the Langley studies will provide needed information for future Saturn V payloads,

as well as for Apollo.

As the velocity of a launch vehicle nears the speed of sound, it may encounter large oscillatory pressure forces known as buffet and which are caused by flow separation and/or wake impingement. Associated problems of panel and payload vibrations are minimized by reducing the fluctuating pressures. Other possibilities under study include the use of damping materials and isolation techniques-- techniques similar to those used in designing a good ride in a modern automobile, although the application is much more difficult.

Considerable research is in progress to obtain a better understanding and solution to the so-called Pogo oscillations, a severe longitudinal instability which has occurred on numerous flights of liquid propellant launch vehicles and which involves an interaction of all components of the system. The resulting large amplitude low frequency oscillations throughout the vehicle are troublesome for delicate payloads-- including astronauts. For some time, the Pogo problem was very critical on Titan II, the Gemini vehicle. It has since been solved by modifications to the propellant system. A full-scale Thor-Agena vehicle, which has also exhibited the Pogo problem, is being prepared for tests this summer at Langley, with one of the primary objectives being a study of the coupling of the structure and propellant systems in the Pogo mode.

A recent problem of considerable concern is fuel-dome impact, which can happen if engine cut-off occurs while the vehicle is accelerating through the atmosphere. The aerodynamic drag forces act to reverse the direction of the acceleration and move the remaining propellants forward relative to their container and impact on the dome. The forces imposed on the dome, when superimposed on existing forces, may cause the domes in the tanks to burst, posing substantial dangers. Langley is using models to measure the forces and

pressures on the tank dome and scaling the results to predict full-scale loads.

Another problem area is one of separation of the spent first stage from the remaining stages. Shock loads are imposed by separation devices which usually involve use of explosives such as shaped charges, primer cords, or explosive bolts. Highly transient loads are imparted to the upper stages and payload. Research objectives in this area include reduction of separation forces and proper design of the upper stages and payload attachments to withstand these forces.

As a payload moves through the launch phase and into space, it is subjected to radiation, micrometeoroids, and vacuum. The effect of the space environment on spacecraft is simulated by testing in vacuum chambers, including a Langley chamber which is 55 feet in diameter and 68 feet tall. It has a large whirl table mounted below a removable floor where payloads can be subjected to combined environmental conditions of acceleration, vibration, and vacuum. It contains an air lock, viewing ports, and a 20-foot access door. Altitudes up to 70 miles can be simulated and very large payloads can be installed and tested under variable environments. The air lock and the emergency pressurization system provide the capability for man-rating the chamber. Some potential uses of the facility include inflation and erection of space structures such as the Echo balloons and space stations, research on highly accelerated vehicles such as anti-missile missiles, and problems associated with highly expanded nozzle flows.

The vacuum chamber is part of Langley's Dynamics Research Laboratory, which is designed for carrying out research on launch vehicles and spacecraft structures, equipment and materials under various environmental conditions. Other features of the laboratory include a 60-foot diameter free-body dynamics

sphere, a 7-foot environmental chamber (combining the environments of vacuum, extreme temperatures, and vibration), a 1,000-pound shock tester, an analog computer, and vibration shakers ranging in size up to 30,000 pounds output. The vibration room of this facility is presently being doubled in height to 100 feet to accommodate a full-size launch vehicle to study vibration and other problems.

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May 18, 1964

News

NASA LEWIS RESEARCH center

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Release 64-42

A comprehensive propulsion exhibit representing work being done at the National Aeronautics and Space Administration's Lewis Research Center, Cleveland, Ohio, will be presented May 18 - 22 at the Langley Research Center during a detailed review of NASA's accomplishments in advanced research and technology.

The exhibit on OART work at Lewis covers four areas of propulsion--chemical, nuclear, electric and air-breathing.

One of the significant advances in air-breathing propulsion may well be for a supersonic transport aircraft. Military aircraft are flying faster than the speed of sound, but supersonic technology has yet to be adapted to a large commercial vehicle. The air-breathing exhibit explains a current concept of the powerplant for a supersonic transport. Such an engine would run hotter and more efficiently than the conventional turbo- or fan-jet engines now flying.

Lewis' work in chemical rockets extends from basic research on combustion instability to operational launches of Atlas and Thor-Agena vehicles and their various spacecraft. Development of the nation's first high-energy liquid hydrogen/liquid oxygen fueled rocket, Centaur, is also under Lewis direction.

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A 1/20th scale model of the M-I engine is included in the chemical propulsion exhibit. This gigantic engine that consumes 100 tons of its high-energy propellants every minute is being developed by Lewis with future missions beyond the Moon in mind. But, because of the drawbacks of chemical propulsion for manned planetary missions, both nuclear and electric rockets are being researched and developed also.

When the time comes for deep space missions, there should be several means of propulsion available and they, like the current stable of conventional rockets, will no doubt perform differently for different missions.

The nuclear propulsion exhibit illustrates some of Lewis' current research in nuclear and materials technology and includes models of the NERVA (nuclear engine for rocket vehicle application) and a tungsten water-moderated reactor.

The electric propulsion exhibit features a conceptual design of a manned Mars spacecraft and an animated movie explaining how such a ship would take eight men on a 500-day round trip to Mars.

Research and development work in electric propulsion is represented and a model of a large ion engine is displayed. This model is typical of electrostatic engines now being studied at Lewis in a thrustor-scaling program designed to determine the upper limits of electrostatic engine size.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
LANGLEY STATION
HAMPTON, VIRGINIA

LRC SCHEDULES ADVANCED RESEARCH
FIELD INSPECTION AND OPEN HOUSE

FOR RELEASE:
P. M.'S TUESDAY, APRIL 28, 1964

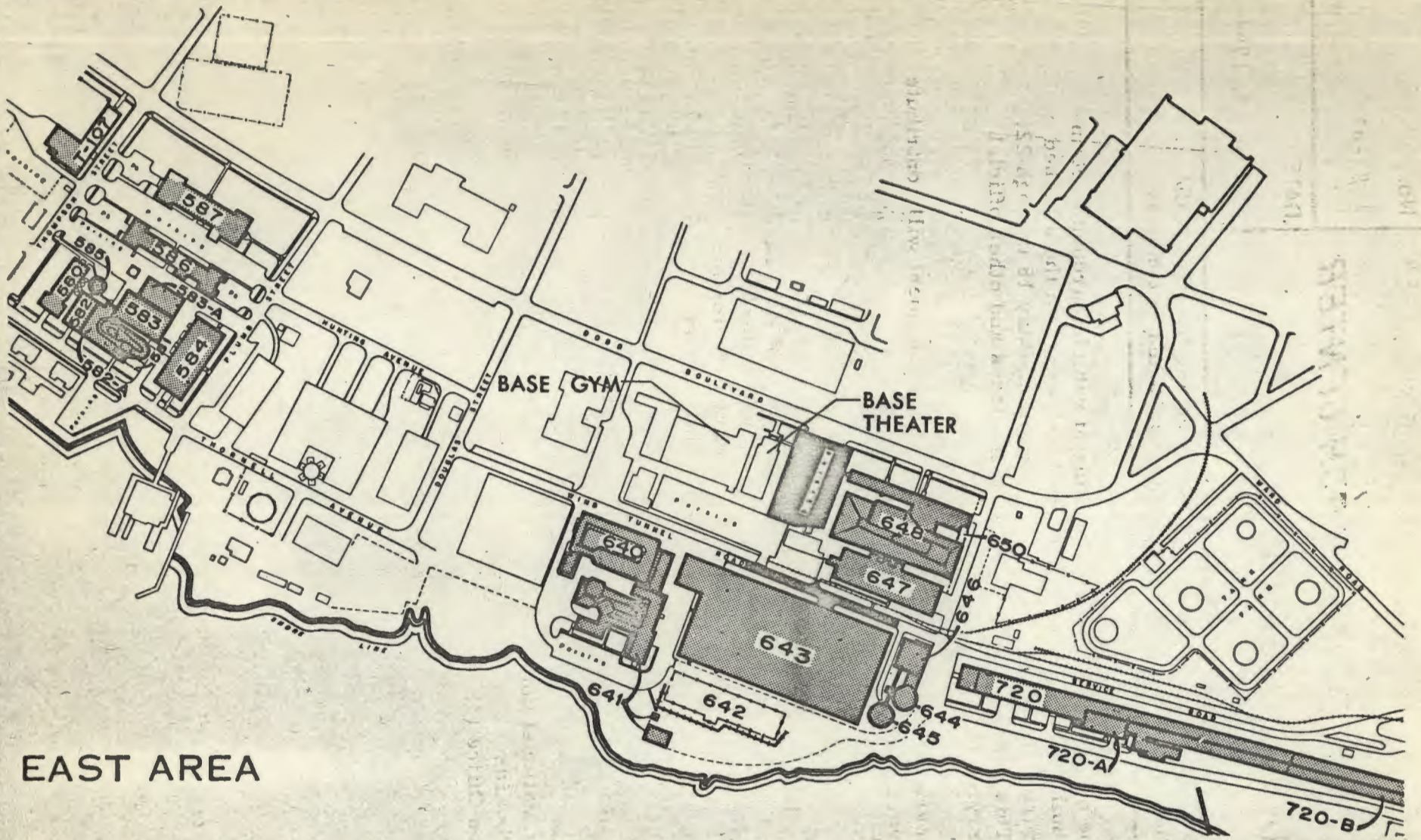
Hampton, Virginia -- A detailed review of recent accomplishments in advanced aeronautical and space research by the National Aeronautics and Space Administration will be held at the NASA's Langley Research Center, Hampton, Virginia, during the week of May 18 through 22.

Two thousand management leaders in the aerospace industry, representatives of the Congress and the Federal government, educators, civic officials, and others concerned with NASA activities will attend a Field Inspection of Advanced Research and Technology at the NASA Langley Research Center.

The 400 guests who will attend the Field Inspection on each of the five days, will receive first-hand accounts by NASA scientists of research being conducted by the Centers.

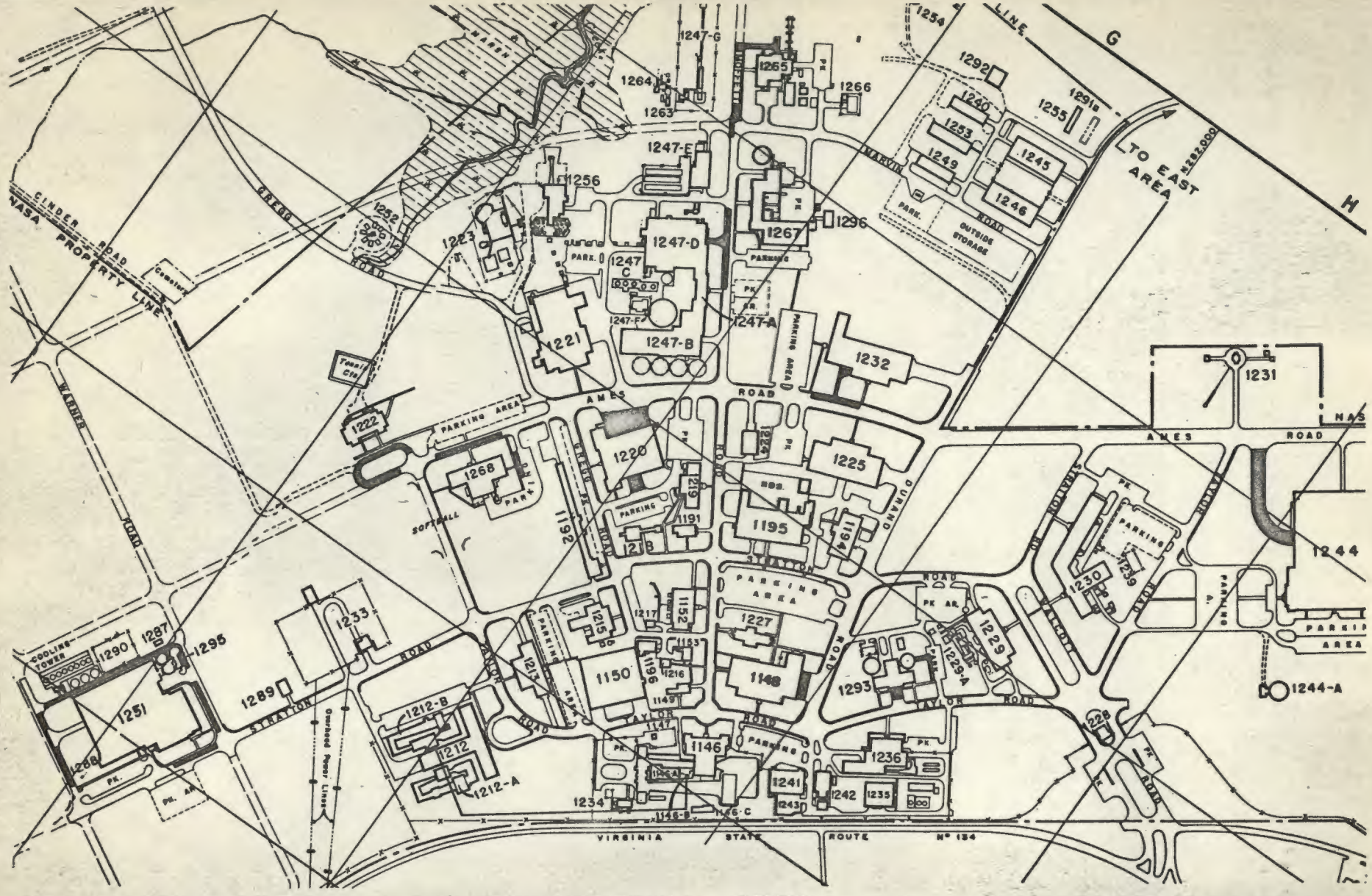
Among the research activities to be discussed will be low speed flight, aircraft operating problems, space flight simulation, innovations in instrumentation and data handling, specialized computing techniques, launch vehicle and spacecraft dynamics, structures and materials, hypersonic flight and reentry problems, magnetoplasmadynamics, and space environment investigations.

On Saturday, May 23, the Langley Research Center will hold an Open House for citizens of Virginia and nearby areas who have expressed a continuing and growing interest in NASA activities. Specially-prepared exhibits and other items of interest which will form part of the Field Inspection of Advanced Research and Technology, will be open to the general public on that day from 10:00 a.m. to 4:00 p.m., E.S.T.



EAST AREA

DENOTES NO PARKING



WEST AREA

DENOTES NO PARKING