

ROCKETS

of the AIR FORCE

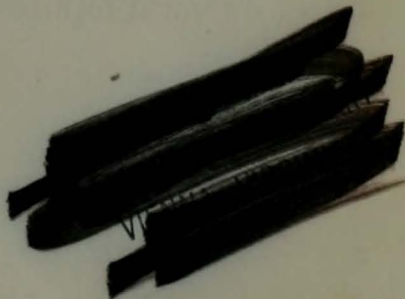
By Erik Bergaust

With a Foreword by

Brigadier General Homer A. Boushey

Assistant for Advanced Technology

Headquarters, U.S.A.F.



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ACKNOWLEDGMENTS

The power-packed story of the tremendous rocket efforts of the U. S. Air Force is presented between these covers. This is the story of how the Air Force became the largest rocket and space service in the United States and probably in the world. The entire book is based upon official Air Force information, releases, booklets, and fact sheets, although some of the specifications for some missiles are approximate.

In preparing this book I have received invaluable cooperation from Major General Arno Luehman, Chief, Office of Public Information, U. S. Air Force, and his staff in the Pentagon. The book contains what I believe to be the most up-to-date roundup of all Air Force rocket and space programs.

My special thanks to the Martin Company which provided the cover illustration (*Titan*) and to North American Aviation for the information on the X-15 program. All illustrations are official Air Force or Department of Defense photos except those showing the different stages of the X-15 rocket-powered research vehicle. These were provided by North American Aviation.

Thanks to Brig. Gen. Homer A. Boushey, Assistant for Advanced Technology, Headquarters, U.S.A.F., who consented to write the foreword.

I dedicate this book to all members of my office staff who are so devoted to rockets and space flight and who helped me put it together.

ERIK BERGAUST
Washington, D.C.
May, 1960

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FOREWORD

By Brig. Gen. Homer A. Boushey

*Assistant for Advanced Technology, Headquarters, U.S.A.F.

Air Force military developments in rocketry have provided the Free World with one of the foremost means of preventing war. This book, which covers the entire range of Air Force military uses of rockets and space vehicles, is therefore of special and timely interest.

The traditional aim of the Air Force—ever higher, ever faster—has finally culminated in achievement by it of space flight. Our present ICBM's and IRBM's, as well as the military space systems now under development, are possible only because of our past faith in rockets and their step-by-step development by our armed forces into the reliable, powerful boosters we now possess. These military rocket boosters have also become the work horses of our civilian space program, which is conducted by the National Aeronautics and Space Administration.

Today ballistic missiles which can span one-third of the circumference of our world in half an hour will be followed tomorrow by military space systems orbiting the earth. Air Force satellites will perform the vital defense missions of reconnaissance. They will provide warning of hostile ballistic missile attack, and they will enable military forces to communicate reliably

by means of satellites to any point in the Free World. They will also permit more accurate navigation on earth in all weather conditions.

Man himself will take his place in space soon after the introduction of the unmanned satellite systems. The singular attributes of man — his judgment, curiosity, and his decision-making abilities — require that man himself operate in the space environment. The X-15 is a step in this direction. NASA's Project *Mercury* carries man into orbit. The development of the basic rocket engine and its marriage with the supersonic research aircraft makes possible man's venture into space and return to a controlled landing. This is Dyna Soar, a concept with a great potential for man's future in space.

The future of rockets of the Air Force extends upward and outward toward the distant reaches of space, for Air Force developments can give valuable assistance to our scientific space explorations.

Mr. Bergaust has made a worthwhile contribution to an understanding of rockets and their role in man's future — not only in the defense of freedom of our own world but toward mankind's future in space as well.

* (Note: Brigadier General Boushey's current title was not received in time to be placed on the dust jacket)

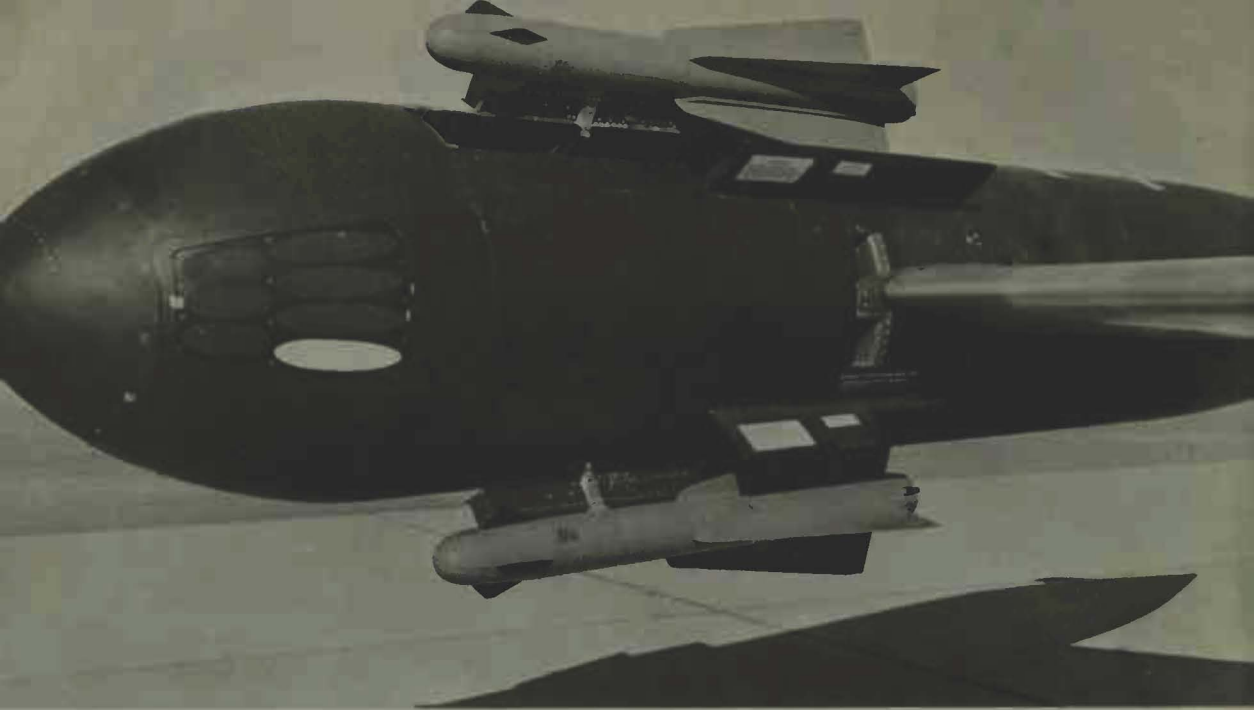


F-102 "Delta Dagger" fighter forms backdrop for Hughes GAR-1D *Falcon* guided aircraft rocket displayed by an Air Force sergeant. The *Falcon's* powerplant provides supersonic speed as its own guidance system directs it to a maneuvering target.

ROCKETS OF THE AIR FORCE

Three B-52 Stratofortresses loaded with secret rockets swoosh down on the landing field at an air base in Texas after a nonstop, globe-girdling, simulated bombing mission of 25,000 miles in 45 hours.

Thousands of miles to the east, at Thule, Greenland, an interceptor leaps to the sky, arcs supersonically toward its target and looses a salvo of *Falcon* air-to-air rockets to track down and destroy the "enemy" drone



An Air Force F-89H Scorpion showing left fuel and rocket pod attached with two of the Falcon GAR missiles it carries.

FALCON (GAR 1, 1D and 2A)

PRIME CONTRACTOR: Hughes • RANGE: 5 miles plus • VELOCITY: Mach 2 plus • FRAME: Manufacturer: Hughes; Length (over-all), feet: 6.5; Diameter (body), feet: 0.54; Span, feet: 1.7; Weight (gross), pounds: 100; Material (major): Magnesium • GUIDANCE: Manufacturer: Hughes; Type: 1D, 3 — radar; 2A, 4 — infrared, homing • POWERPLANT: Manufacturer: Thiokol; Propellants: Solid; Type and number: Cast (1); Thrust, pounds, 1D: 6,000

planes approaching many miles away.

In California a C-133A turboprop takes off with a 100,000-pound rocket; a moment later a C-124 lands and 200 troops equipped with antitank rockets begin marching out of it.

From Patrick Air Force Base in Florida an intercontinental ballistic missile roars into the blue, out across

the missile range stretching thousands of miles southeast into the Atlantic.

From Vandenberg Air Force Base in California a missile roars into orbit with complex satellite instrumentation.

These are mere glimpses of the United States Air Force in the early

An F-89H Scorpion interceptor displays a Falcon air-to-air guided missile in its firing position. The Scorpion carries an undisclosed number of Falcons in its wingtip pods in addition to standard 2.75-inch rockets.



The Falcon family of supersonic, air-to-air rockets are among the smallest missiles in production. They can be carried either internally or under the wings of interceptor aircraft. During development tests, even unarmed versions destroyed drone targets. Assigned to operational units of the Air Defense Command since 1957, the Falcon can be used on the F-89, F-101, and F-106.

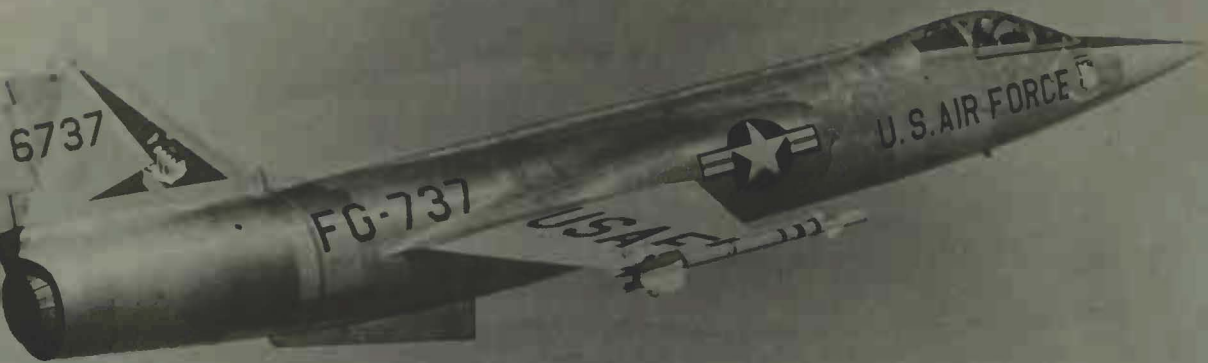
years of its growing missile program.

It has a thousand aircraft in the air at many points above the globe at this minute — and 24 hours every day.

Its bombers, fighters, fighter-bombers, interceptors, reconnaissance planes, cargo planes, transports, aerial refueling tankers, and helicop-

ters are only a portion of this vast organization. Rockets and missiles, in varying stages of development and operation, are being geared to take over those aircraft operations that can be accomplished better by unpiloted than by piloted air weapons.

Speed has always been a big word in the Air Force. Even the length of



Aircraft firepower combination is revealed in in-flight photo of the F-104A Starfighter armed with wing-installed Sidewinder guided missile. Lockheed's superswift Starfighter packs a Sidewinder on each wing, providing double knock and punch for defense of America's homeland. The seek-and-destroy missiles use an infrared tracking device to "home in" on targets. Able to climb as fast as it flies straight and level, the Starfighter is powered by General Electric's J-79 turbojet engine.

SIDEWINDER (USAF GAR-8) (USN AAM-N-7)

PRIME CONTRACTORS: Philco, GE •

RANGE: 6 to 7 miles • VELOCITY: Mach

2.5 • FRAME: Manufacturers: Hunter-Douglas, Norris Thermador; Length

(over-all), feet: 9.3; Diameter (body),

feet: .42; Span, feet: 2; Weight (gross),

pounds: 155; Material (major): Aluminum •

GUIDANCE: Manufacturers: Philco, GE;

Type: Infrared homing; POWERPLANT:

Manufacturer: Naval Powder Plant;

Propellants: Solid; Type and Number:

Uncooled, cast (1)

time it takes to tell the life story of the Air Force is short when you compare it to the time it would take to tell the story of the Army or Navy. For it was not quite 60 years ago — December 17, 1903 — that the first successful powered flight was made at Kitty Hawk, North Carolina.

The U. S. Air Force was born a short time later, August 1, 1907, as the Aeronautical Division under the Army's Chief Signal Officer. It started with a Signal Corps captain, two enlisted men, and three balloons.

Today's airmen speak knowingly about *Mach numbers* — which con-

Sidewinder was designed for destroying high-performance enemy fighters and bombers. The missile seeks the target by homing on the heat emitted from the aircraft. It is a relatively inexpensive and reliable weapon, which has very few moving parts and no more electronic components than an ordinary radio, and personnel require no specialized technical training to handle and assemble. Developed by the Navy Ordnance Test Station of the Bureau of Ordnance, China Lake, California, the missile became operational in July, 1956, and is now the most widely used guided missile weapon used by USN aircraft squadrons deployed in the Sixth Fleet in the Mediterranean and the Seventh Fleet in the Western Pacific. As of September, 1958, Sidewinder became the first guided missile to destroy an aircraft under combat conditions (Chinese Republic aircraft against Chinese Communist aircraft).



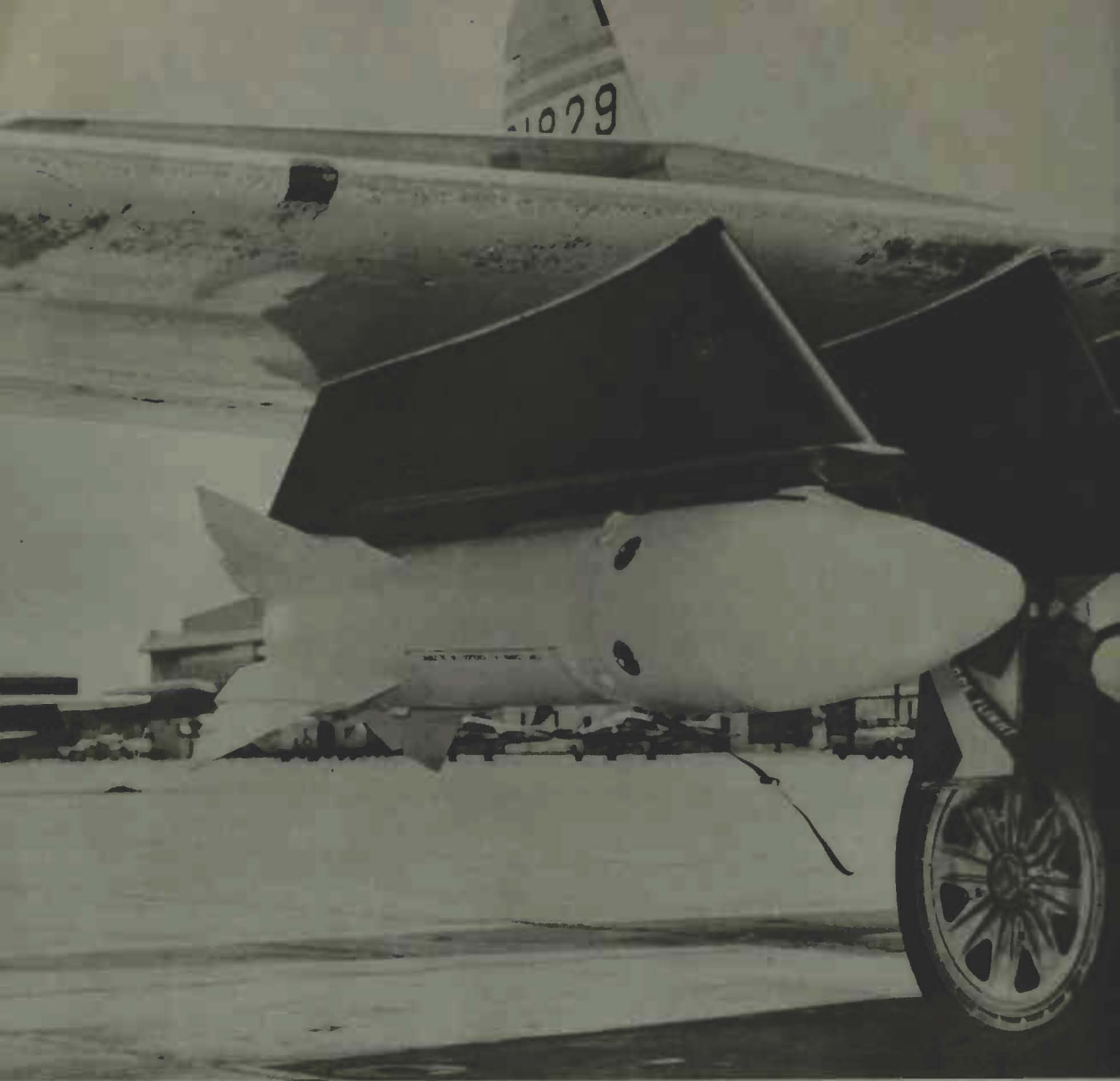
F-100 launches a Sidewinder missile on an air superiority training mission.

cern the plane's speed in relation to the speed of sound (about 720 miles per hour at sea level) — but when our first military plane was tested and accepted on July 30, 1909, it attained a top speed of 42 miles per hour.

By 1910, the Aeronautical Division

had two officers and nine enlisted men, plus one airplane, an airship (dirigible), and three balloons.

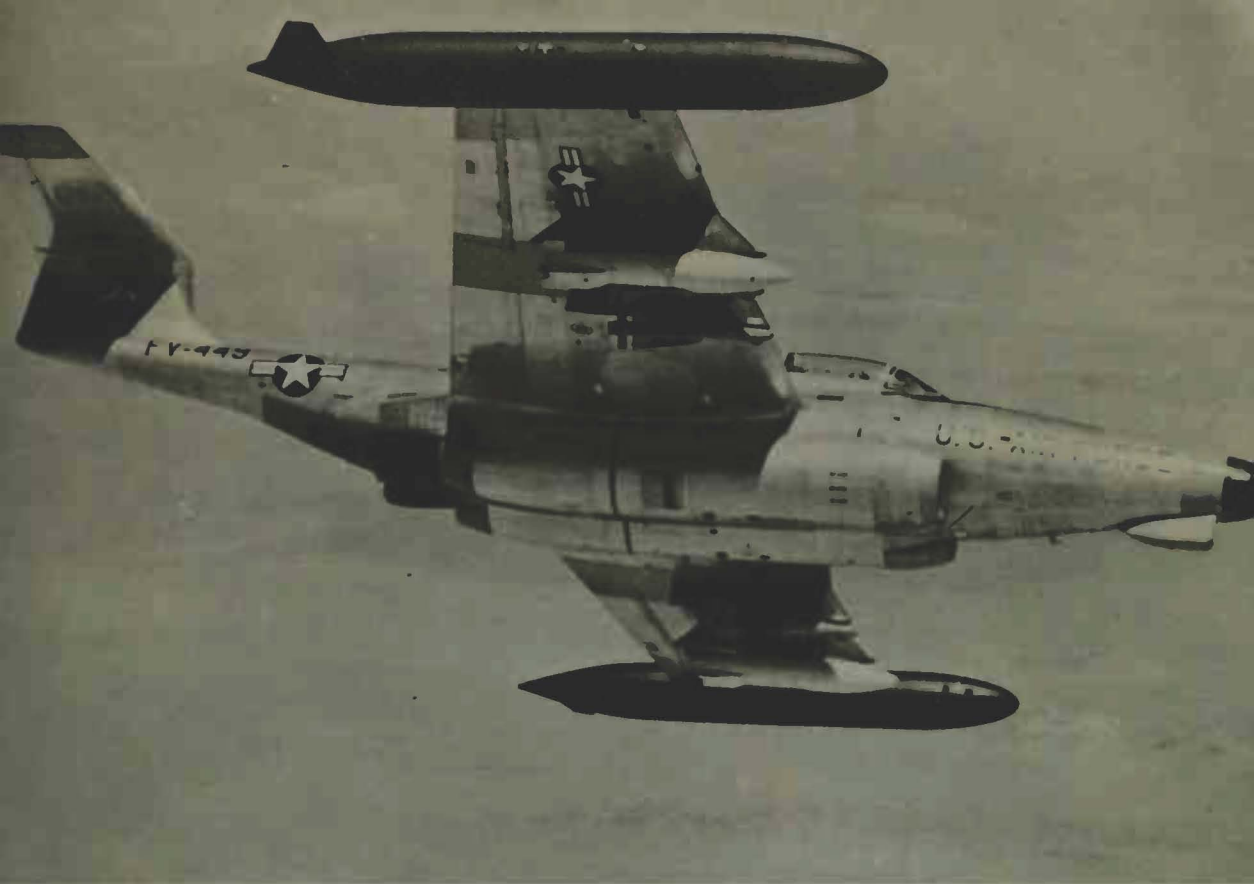
Before it became known as the United States Air Force, our air force had a number of different titles through the years. In 1914 the Aeronautical Division was renamed the



Genie, rocket-powered air-to-air missile carrying a nuclear warhead, is carried under the wing of F-89 jet fighter, and can be stowed in the missile bay of the F-101 and F-106. Some units of the Air Defense Command are already equipped with the weapons.

Aviation Section of the Signal Corps. In 1918 it was separated from the Signal Corps and renamed the Army

Air Service. In 1926 it became the Army Air Corps, and, in 1941, the Army Air Forces.



A U. S. Air Force Northrop F-89J Scorpion with full armament consisting of two white MB-1 Genie nuclear-armed rocket missiles and four Hughes Falcon GAR-2 guided missiles. For purposes of this photo the airplane is armed with the MA-1 test version of the Genie missile.

GENIE (MB-1)

PRIME CONTRACTOR: Douglas •

RANGE: 1.5 miles • **FRAME:**

Manufacturer: Douglas; **Length** (over-all), feet: 8; **Diameter (body)**, feet: 1.25; • **POWERPLANT:**

Manufacturer: Aerojet-General;

Propellants: Solid; **Type and number:** Cast (1)

The Genie was first fired from an aircraft during mid-1957 at the Atomic Energy Commission's Nevada test site during Operation Plumbob. It is part of the weapons inventory of the Air Defense Command, and will be carried by F-89s, F-101s and F-106s.

In 1942 the War Department set up three co-ordinate services: the Ground Forces, the Air Forces, and

the Services of Supply (later Service Forces), each under a commanding general. The commanding general



Matador guided missile, the TM-61C, is readied for launching. An Air Force launch technician operates the hydraulic controls, elevating the tactical missile to a firing position. The new model has an improved guidance system, highly resistant to electronic measures. The Matador flies more than 600 mph at altitudes above 35,000 feet.

MATADOR (TM-61)

PRIME CONTRACTOR: Martin • FRAME: Manufacturer: Martin; Length (over-all), feet: 39.6; Diameter (body), feet: 4.5; Span, feet: 28.7; Weight (gross), pounds: 12,000; Material (major): Aluminum • VELOCITY: 650 plus mph • POWERPLANTS: Booster — Manufacturer: Thiokol; Propellants: Solid; Type and number: Cast JATO (1) Thrust, pounds: 4,600; Sustainer — Manufacturer: Allison; Propellants: JP; Type and number: J-33-A-37 turbojet (1); Thrust, pounds: 4,600

The Matador was the Air Force's first operational missile, made its first flight in 1950, and has been in quantity production for a number of years. Like the Mace, the Matador is under the operational control of the Tactical Air Command. The missile is launched from a special trailer platform by rocket booster. Matador has been deployed overseas since 1954. Units are stationed in Germany, Taiwan, and Korea.

Matador pilotless bomber raars away from its launcher, leaving a fiery trail. This thundering Matador, powered by an Allison turboprop engine, is in service in Europe. With a powerful blast from its engine and aided by a rocket-assisted take-off bottle, it is fired from the "world's smallest airport," a highly mobile roadable launcher no bigger than the Matador itself. Matador's performance capacities are equal to that of conventional jet fighter planes.





Successful test firings have been made with a new version of the Martin *Matador* tactical missile, known as the TM-61B. The new missile is longer, and carries a larger nose section than the present USAF TM-61B *Matadors*. For tactical missions, the TM-61B will be given an entirely new airborne guidance system.



The Martin TM-76 *Matador*, latest version of the TM-61 presently in operational use overseas, has added a new capability to its primary objective of target destruction. A recovery kit, replacing the section of the missile containing the warhead, has been installed, permitting recovery and reuse of the missile. The *Matador* is controlled in recoverable flight by a radar command system.

of the Air Forces became a member of the Joint and the Combined Chiefs of Staff, along with the Chief of Staff of the Army and the Chief of Naval Operations. The National Security

Act of 1947 made the Air Force a separate service on September 18, 1947, and gave it its permanent name.

The Air Force is the service primarily responsible for preparing

MACE (TM-61)

PRIME CONTRACTOR: Martin • RANGE: Over 650 miles • VELOCITY: Transonic • FRAME: Manufacturer: Martin; Length (over-all), feet: 44.2; Diameter (body), feet: 4.5; Span, feet: 22.9; Weight (gross), pounds: 13,800; Material (major): Aluminum, magnesium • GUIDANCE: Manufacturer: Goodyear/AC; Type: ATRAN/inertial • POWERPLANTS: Booster — Manufacturer: Thiokol; Propellants: Solid; Types and number: Cast JATO (1); Thrust, pounds: 100,000; Sustainer — Manufacturer: Allison; Propellants: JP; Type and number: J-33-A-41 turbojet (1); Thrust, pounds: 5,200

Martin TM-76 Mace nonrecoverable type missile fired on Air Force Missile Development Center range to check guidance systems for future cross-country flights.



The Mace is an improved version of the Matador with innovations that warrant its classification as an entirely new missile. First launched in early 1959, the Mace is replacing the Matador in Germany.



BOMARC (IM-99)

PRIME CONTRACTOR: Boeing •
 RANGE: 200 to 300 miles • VELOCITY:
 Mach 2.5 plus • FRAME: Manufacturer:
 Boeing; Length, feet: 46.8; Diameter,
 feet: 3; Span, feet: 18.2; Weight,
 pounds: 15,000 • GUIDANCE:
 Manufacturer: Philco; Type:
 Command • POWERPLANTS: Booster —
 Manufacturer: Aerojet General;
 Propellants: LPR; Sustainer —
 Manufacturer: Marquardt; Type
 and number: Two 28" ramjet

Bomarc will be operated by the Air Defense Command from bases where its range capabilities may be fully utilized. The Bomarc IM-99 is known as an area defense weapon as opposed to short-range antiaircraft missiles known as point defense weapons.

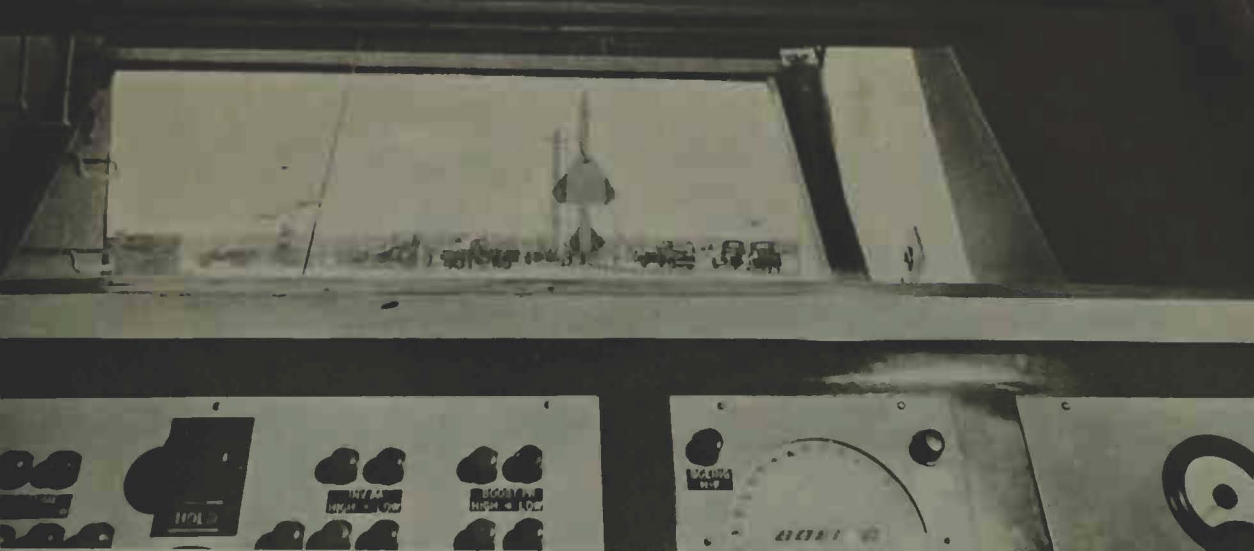
An Air Force Bomarc IM-99 is shown leaving the launching pad, during a test firing of the new interceptor missile at the U. S. Air Force Missile Test Center, Patrick Air Force Base, Florida. The Bomarc is a long-range supersonic ground-to-air interceptor missile for air defense.

forces "to gain and maintain general air supremacy" for our nation at any altitude required for our offensive and defensive operations.

These operations are carried out with electronic warning, communica-

tions and reconnaissance equipment — along with aircraft, missiles and space craft.

Missiles are being, and will continue to be, phased into Air Force combat units as fast as it is opera-



An experimental model of the Boeing IM-99 Bomarc missile is seen on its launching pad through a blockhouse port at Air Force Missile Test Center, Patrick AFB, Florida.



Bomarc in upright position in shelter at Cape Canaveral Air Force Base, Florida.

tionally feasible. The Air Force portion of our total expenditures for rocket weapons is more than one and one-half times as much as for the Army and Navy combined.

There is no question that missiles

will eventually take over a major role in our offensive and defensive forces. As far as the Air Force can see today, however, there always will be a requirement for a mixture of manned and unmanned systems. Many of to-



Rascal being launched from a Boeing B-50 Superfortress.

RASCAL (GAM-63)

PRIME CONTRACTOR: Bell • RANGE: 100 miles max. • VELOCITY: Mach 1.5 max. • Frame: Manufacturer: Bell; Length (over-all), feet: 32; Diameter (body), feet: 4; Span, feet: 14 (approx.); Weight (gross), pounds: 13,000; Material (major): Aluminum • GUIDANCE: Manufacturers: Bell, RCA, Texas Instruments; Type: Radar command • POWERPLANT: Manufacturer: Bell; Propellants: Liquid oxygen and alcohol; Type and number: Liquid, vertical-in-line (3); Thrust, pounds: 12,000 @ 4,000

morrow's rockets will be piloted, as will satellites and spaceships to the moon and beyond.

The Air Force, which is primarily

responsible for preparing forces for the nation's airborne *offensive* operations, is also primarily responsible for its airborne *defensive* operations.

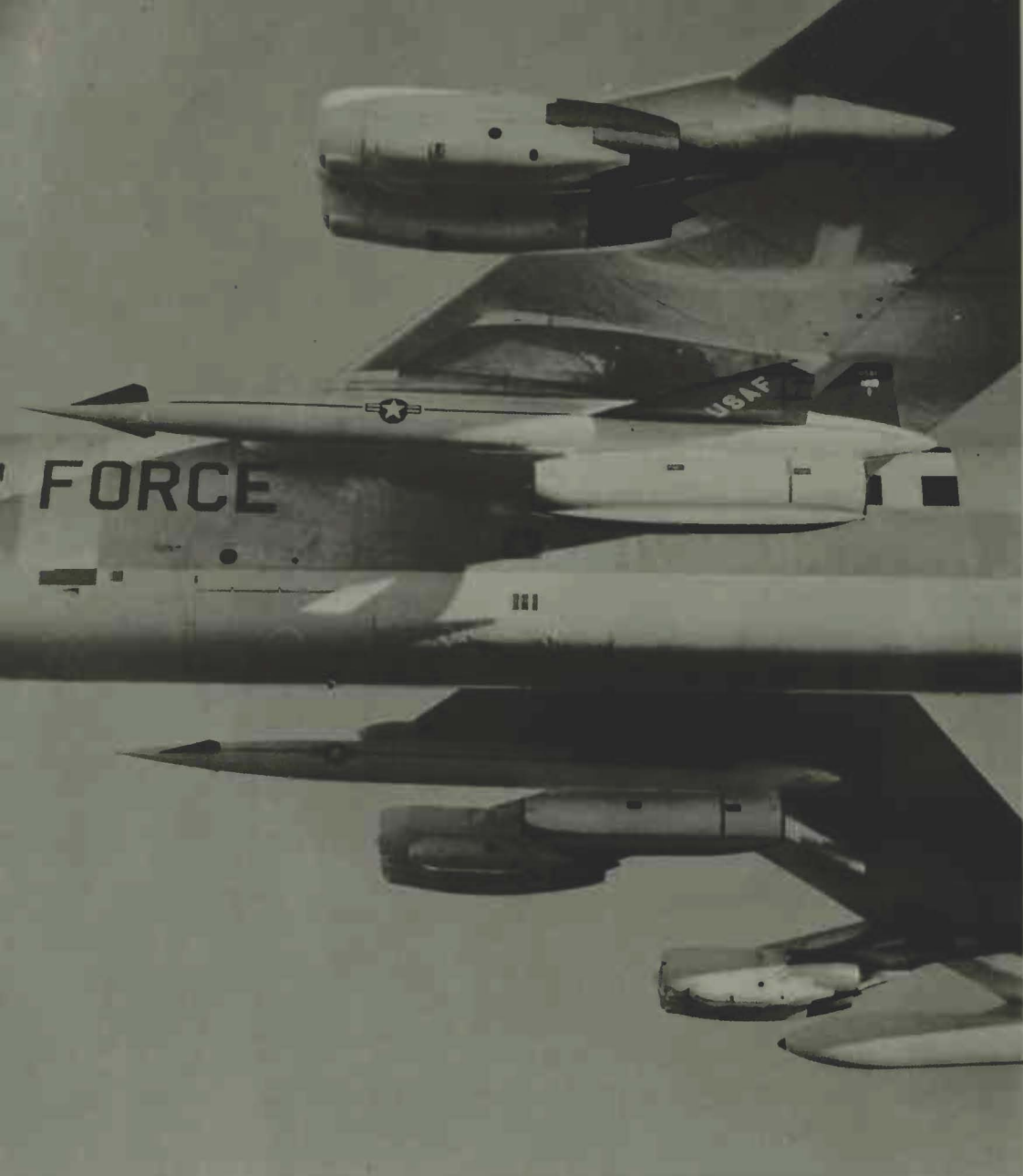


GAM-63 *Rascal* air-to-ground supersonic missile on DUC carrier. The rocket-propelled missile is built by the Bell Aircraft Corp., Buffalo, N. Y.

The Rascal was a supersonic, rocket-powered, air-to-ground guided missile developed and manufactured by Bell Aircraft Company. It was capable of carrying a nuclear warhead and had a range of some 75 miles. Although this missile was extremely accurate and effective, it was overtaken by rapid technical developments in the air-launched missile field, and its cancellation was announced on September 9, 1958.

The Air Force is the service which "shall be organized, trained, and equipped primarily for prompt and sustained offensive and defensive air

operations." "Air" as used in the law does not, of course, limit the operations of air forces to any specific altitude.



From a military standpoint, we cannot stop defending the United States at an altitude level of 125,000, for instance. We accept the need for superiority of our weapon systems

and military forces at any level above the earth's surface if this nation and the Free World are to survive.

The Air Force believes that the United States military air and space



Air Force air-to-ground strategic missile *Hound Dog* is shown aloft as carried by a Boeing B-52 eight-jet bomber of the Strategic Air Command. The B-52 carries two *Hound Dog* missiles, shown inboard nearest the fuselage under each wing. *Hound Dog* takes off from this airborne position and flies onto its selected target, thus extending the bomber's normal range. The missile is built for the Air Force by North American.

HOUND DOG (GAM-77)

PRIME CONTRACTOR:

North American •

RANGE: 500 plus miles

• VELOCITY: Mach 1

plus • FRAME:

Manufacturer: North

American • GUIDANCE:

Manufacturer:

Autonetics; Type:

Inertial • POWERPLANT:

Manufacturer: Pratt &

Whitney; Type and

number: J-52 turbojet

(1) Thrust, pounds:

7,500

The Hound Dog will increase and supplement the destructive power of the long-range bombers of the Strategic Air Command. Hound Dog was first test-fired on a flight of limited range from a B-52 over the Atlantic Missile Range April 23, 1959.

capability must consist of an interacting, indivisibly linked combination of both offensive and defensive forces. These forces must be strong enough offensively to eliminate even-

tually the striking power of the enemy at its source, and strong enough defensively to maintain a high survival rate for all our military forces and for the nation.



The U. S. Air Force *Snark*, first known missile to demonstrate true intercontinental capabilities. On October 31, 1957, a Northrop-built *Snark* "attacked" a target near Ascension Island, 5,000 miles southeast of its launching site at the Air Force Missile Test Center, Cape Canaveral, Florida.

Snark has flown under conditions simulating actual operations and delivered its payload on the target with unprecedented accuracy. The flights have demonstrated the missile's ability to place a nuclear warhead on targets anywhere in the world.



SNARK (SM-62)

PRIME CONTRACTOR: Northrop • RANGE: 5,500 nautical miles • VELOCITY: Mach 0.9 • FRAME: Manufacturer: Northrop; Length (over-all), feet 67.2; Diameter (body), feet: 4.5; Span, feet: 42; Weight (gross), pounds: 59,936; Material (major): Aluminum, magnesium • GUIDANCE: Manufacturer: Northrop; Type: Inertial • POWERPLANTS: Booster — Manufacturer: Aerojet; Propellants Solid; Type and number: Cast JATO (2); Thrust, pounds: 66,000; Sustainer — Manufacturer: Pratt & Whitney; Propellants: Liquid; Type and number: J-57 turbojet (1); Thrust, pounds: 11,000

The progress of the Air Force toward space has been the natural development and extension of speed,

altitude, and range. Recognition of the basic relationship between operations in the earth's atmosphere and in



Snark blasts off from its launching pad at the Air Force Missile Test Center, Cape Canaveral, Florida. The Snark, America's first intercontinental missile, is manufactured by the Northrop Corporation and is powered by an Allison J-71 turbajet engine. The 74-foot missile can deliver a nuclear warhead to a range over 5,000 miles, flying at supersonic speeds at altitudes above 35,000 feet.

Snark is America's first intercontinental missile. It can be launched from the United States and enter a target area from any direction at high or low altitude. In 1958 it was fired on several occasions 5,000 miles down the Atlantic Missile Range, and once it was fired some 1,300 miles and returned to land on the launching site. The first Snark missile squadron was activated in December, 1957, and fired the first production model on April 7, 1959, on a 5,000-mile test flight.

the space above it — the fact that they are an operational entity — has led the Air Force to the use of the

word "aerospace." This term was not developed as a catchword, but rather to identify, in a single word, the con-



Pictured together for the first time are USAF Strategic Air Command missiles *Thor*, *Snark*, and *Jupiter* (left to right), all slated to augment the nation's long-range bomber forces. *Thor* on the left is in the intermediate range (1,500 to 2,000 miles category) as is the Army-developed *Jupiter*. The centerpiece Northrop *Snark* is a 5,500-mile intercontinental weapon.

THOR (WS-315A SM-75)

PRIME CONTRACTOR:

Douglas, Space Technology
Laboratories • RANGE: 1,500
nautical miles • VELOCITY:

10,000 mph • FRAME:

Manufacturer: Douglas;

Length (over-all), feet: 65;

Diameter, feet: 8; Weight

(gross), pounds: 110,000

Material (major): Aluminum

• GUIDANCE: Manufacturer:

AC Spark Plug; Type:

Inertial • POWERPLANT:

Manufacturer: Rocketdyne;

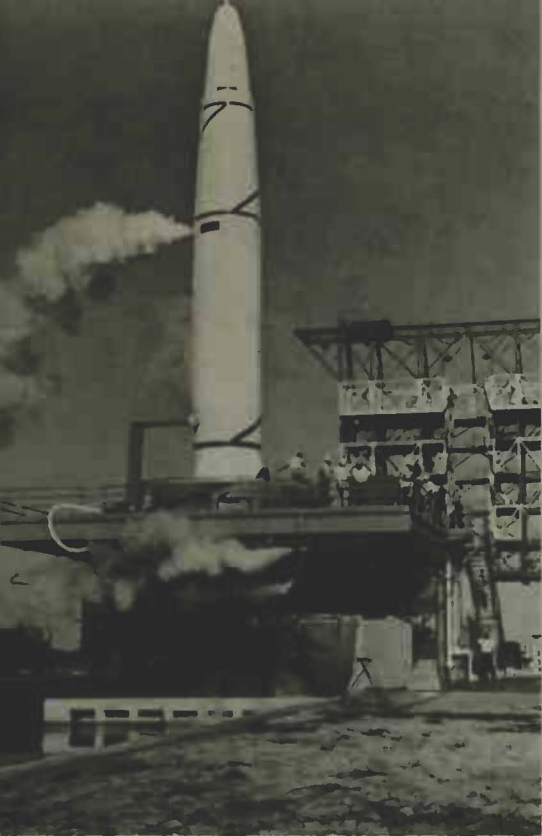
Propellants: Liquid oxygen

and RP-1; Thrust, pounds:

150,000 plus



Thor SM-75 intermediate-range ballistic missile lifts from its launching pad at the Air Force Missile Test Center, Cape Canaveral, Florida. The 1,500-mile-range missile is manufactured with assembly-line production tooling at Douglas Aircraft Company.

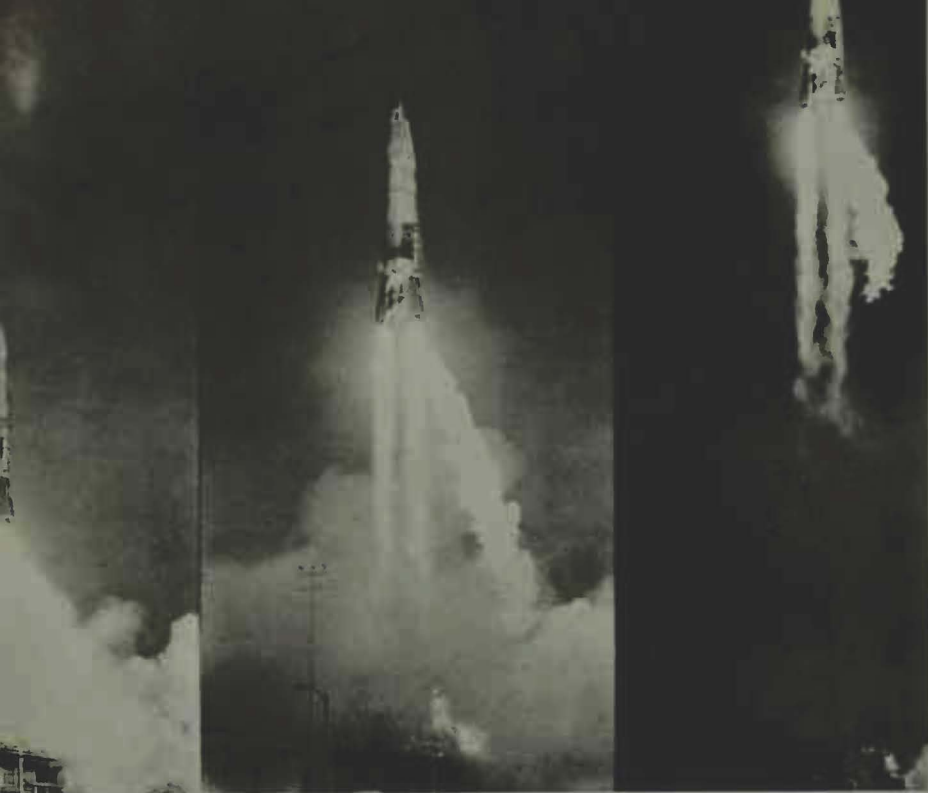


An Air Force Thor is readied for launching at Cape Canaveral, Fla.

Thor, standard Air Force intermediate-range ballistic missile, blasts off from its launching pad at Cape Canaveral, Florida.



America's first intermediate-range ballistic missile. The first Thor missiles to be furnished under an agreement with the United Kingdom were announced by the United Kingdom to have been delivered in early September of 1958. The Thor has been used for the main propulsion system, for several nonmilitary missile experiments, including the United States' historic lunar probe of October 11–13, 1958. The Thor is a single-stage missile capable of being transported by aircraft on a trailer (transporter-erector), which also serves as the missile erecting arm. The Thor was first launched on January 25, 1957, just 13 months from the time the production order was issued.



These sequence photos, first to be released by the U. S. Air Force, record the launching of an *Atlas* intercontinental ballistic missile from Cape Canaveral, Florida, where testing of this country's first ICBM has been conducted. Left, twin incandescent jets from the powerful rocket engines become visible as the *Atlas* climbs higher into the deep blue Florida sky. Center, the huge missile soars skyward, as expendable launcher tubing on pad still burns. Plume of flame spurting from missile base at right is exhaust from fuel system's turbopumps. At right, the *Atlas* is well on its way to successful accomplishment of flight test objectives established for the launching.

tinuous operational field in which the Air Force must function as technological progress permits operations farther and farther away from the earth's surface.

Each of the Armed Services has reasons to operate somewhere in aerospace. Each service's requirements are justified to the extent they enhance the ability to perform its as-



The mighty Atlas, Convair's SM-65, points skyward on its launching pad at Cape Canaveral, Florida. The intercontinental missile is produced in San Diego, California, by Convair-Astronautics, a division of General Dynamics Corporation.



Atlas thunders aloft from its launching pod at the Air Force Missile Test Center. The missile is propelled by twin booster rockets and a main sustainer engine.

ATLAS (SM-65 WS-107A-1)

PRIME CONTRACTOR: Convair

(Astronautics) Div. General Dynamics

Corp. • RANGE: 5,500 nautical miles plus •

VELOCITY: 17,000 mph • FRAME: Stages:

2; Manufacturer: Convair; Length (over-all), feet: 81; Diameter (body), feet: 10;

Weight (gross), pounds: 260,000; Material

(major): Steel • GUIDANCE: Manufacturers:

GE/Burroughs, Arma; Type: Radar-

Doppler Command (later models

all-inertial) • POWERPLANTS: First Stage

(booster) — Manufacturer: Rocketdyne;

Propellants: Liquid oxygen and kerosene;

Type and number: Regenerative liquid

(2); Thrust, pounds: 150,000 each;

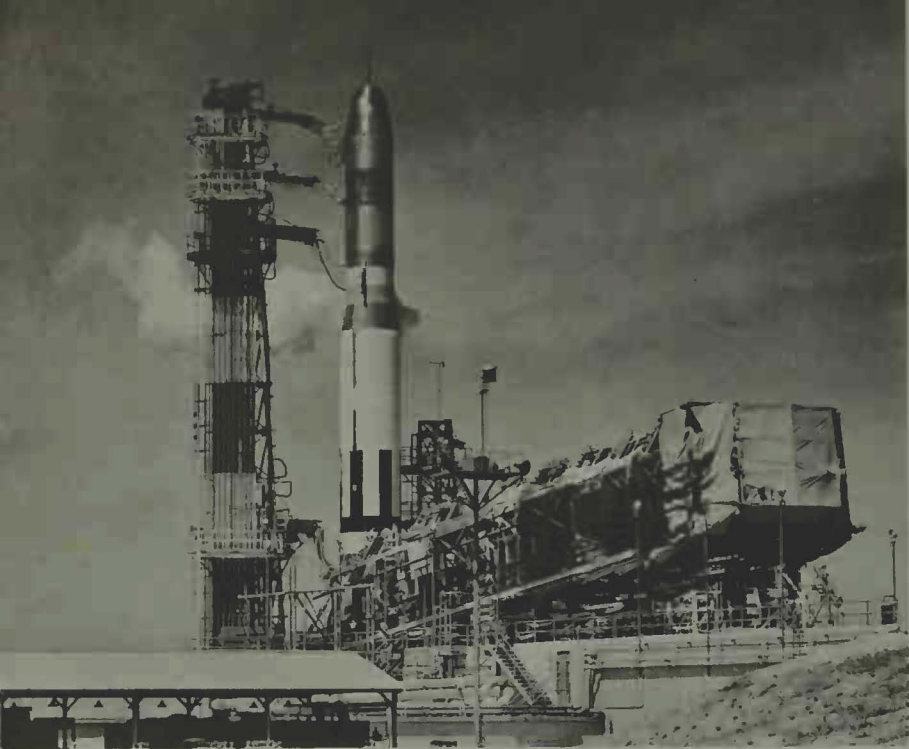
Second Stage — Manufacturer: Rocketdyne;

Propellants: Liquid oxygen and kerosene;

Type and number: Regenerative

liquid (1); Thrust, pounds: 60,000

The Atlas will be America's first intercontinental ballistic missile. The first successful flight using both boosters and sustainer engine took place in August, 1958. The Atlas will be under the operation of the Strategic Air Command. Atlas' two boosters, sustainer, and two vernier rockets are ignited prior to launching. In the first few minutes of flight the booster and skirt are jettisoned. The missile is then accelerated by the sustainer until a velocity of 15,000 mph is reached, and the verniers are then used to trim velocity to the exact degree desired. Nose cone separation occurs after vernier shutdown.



Titan, newest of the Air Force's big ballistic missiles. An intercontinental weapon for the Strategic Air Command, *Titan* has a designed range in the neighborhood of 5,500 miles, a top speed of 15,000 mph. It is being built by the Martin Company and is powered by an Aerojet-General two-stage liquid rocket.

TITAN (SM-68 WS-107A-2)

PRIME CONTRACTOR: Martin • RANGE: 5,500 nautical miles plus • VELOCITY: 15,000 mph • FRAME: Stages: 2; Manufacturer: Martin; Length (over-all), feet: 90; 1st stage length, feet: 54; 2nd stage length, feet: 37 (incl. nose cone); Diameter, feet: 8; Weight (gross), pounds: 220,000; Material (major): Aluminum • GUIDANCE: Manufacturers: Bell Telephone Laboratories, Remington Rand UNIVAC; Type: Initially, radio inertial; later all inertial • POWERPLANTS: First stage (booster) — Manufacturer: Aerojet-General; Propellants: Liquid Oxygen and JP-6; Thrust, pounds: 300,000; Second stage — Manufacturer: Aerojet-General; Propellants: Liquid oxygen and JP-6; Thrust, pounds: 80,000

signed missions — and to the extent they cannot be provided by the service with the primary aerospace mission.

Below are listed major space weapon systems which the Air Force

considers necessary for military space operations of the future. Various of these system requirements are at this time largely in the study and exploration stage. However, their military

Titan breaks for the sky at Cape Canaveral, Florida, in its first test launch February 6, 1959. Successful the first time out, *Titan* still remains in the testing phase of its development. When operational, *Titan* will enter the combat missile inventory of the Strategic Air Command.

The *Titan* was developed as a follow-up to the *Atlas*, which it will follow into operation. The later development has permitted application of knowledge accumulated in the development of both the *Atlas* and *Thor*, including the potential for increased range and greater load-carrying ability. When it becomes operational under the Strategic Air Command, it will be launched from underground bombproof sites. The first of 4 announced *Titan* sites will be on the Lowry Range, southeast of Denver, Colo. Others will be at Ellsworth AFB, S. Dak.; Mountain Home AFB, Idaho; and Larson AFB, Wash.



The Minuteman will be a second-generation ballistic missile, which is expected to be lighter, smaller and simpler than the liquid-fueled ICBMs. It will be stored in underground bombproof silos ready to be fired on a moment's notice. The development of the Minuteman has been accelerated. The over-all program is under the management of the Air Force Ballistic Missile Division of Air Research and Development Command.

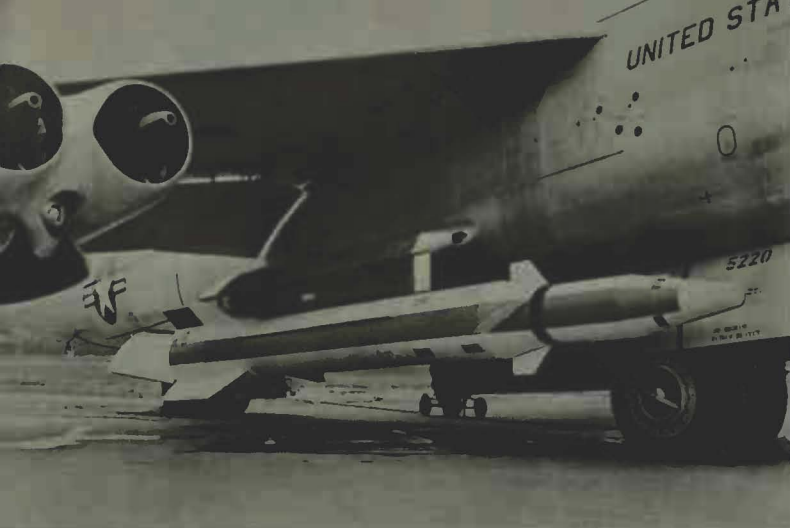
potential is highly apparent today.

Offensive Weapons:

- Advanced Strategic Missile Systems
- Manned Strategic Space System

Defensive Weapons:

- Anti-Missile Defense System
(Early Warning and Extensions)
- Satellite Defense System
- Satellite Inspection System
- Manned Defensive Space System



ALBM

This high-performance missile is intended for use in conjunction with the B-52 and B-58.

ALBM-199B, a two-stage Air Force research and development missile, was fired October 13, 1959, from an Air Force B-47 jet bomber over the Atlantic Missile Range into the vicinity of the earth-orbiting paddle-wheel satellite *Explorer VI*. Intended to demonstrate the feasibility of firing ballistic missiles from aircraft, no attempt was made to intercept or knock down the satellite.



Intended to demonstrate the feasibility of firing ballistic missiles from aircraft, the first flight of ALBM-199B was made to check guidance system accuracy at exit angles approaching the vertical.



Here is the U. S. Air Force's GAM-72 Quail and its mother B-52 bomber. Quail, a Strategic Air Command diversionary or "decoy" missile, is being built for the Air Force by McDonnell Aircraft and has been successfully tested. The new penetration-aid missile is powered by a General Electric J-85 engine.

QUAIL (GAM-72)

PRIME CONTRACTOR: McDonnell •

FRAME: Manufacturer: McDonnell; Length, feet: 13; Wing span, inches: 65 •

POWERPLANT: Manufacturer: General Electric; Type and number: J-85 turbojet (1); Thrust, pounds: 2,000

Intended for penetration of enemy defenses, Quail will be launched from B-47 or B-52 aircraft upon target approach.

Reconnaissance Systems:

Reconnaissance Satellite Weapons System,
and
Infrared Subsystem (Alert System)
Visual Reconnaissance Subsystem
Mapping and Charting Subsystem

Supporting Systems:

Communications Satellite

Environment Observing and Forecasting
System

Space Navigation System

Specialized Test Vehicle

Integrated Ground Acquisition and Tracking
System

Logistic Support Systems

Recoverable Boosters (Prime Movers)

Maintenance and Resupply

Space Transportation System



First pictorial views of the Air Force SM-73 Goose missile, developed for the Air Force by Fairchild Engine and Airplane Corp., Hagerstown, Maryland. The ground-launched diversionary missile is shown in a launch shot at the Missile Test Center in Florida.

Listed in the "penetration-aid" category, Goose was designed to be launched ahead of or in concert with strategic missiles and manned bombers to serve as a diversion or a decoy against enemy air defense systems. However, the program was canceled in 1959.





GOOSE (SM-73)

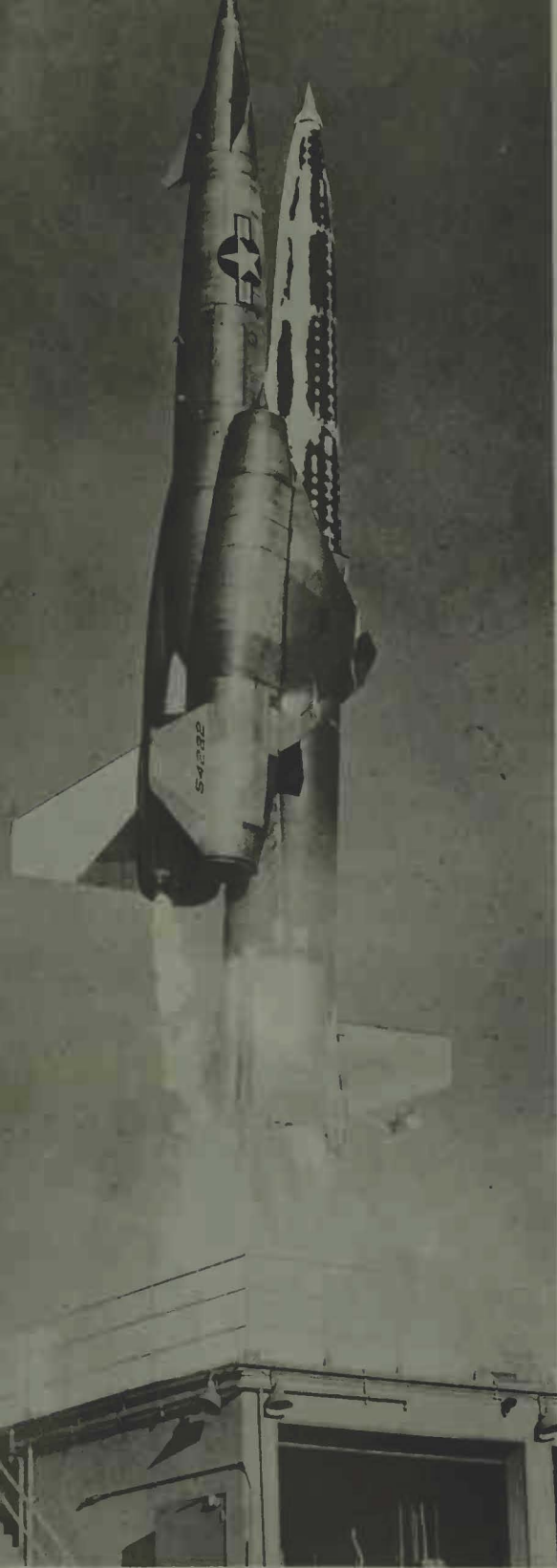
PRIME CONTRACTOR: Fairchild • RANGE: 2,000 miles plus (Ceiling: 50,000 feet plus) • VELOCITY: High subsonic • FRAME: Stages: 2; Length (over-all), feet: 60 (approx.); Diameter (body), feet: 4.5 (approx.); Span, feet: 32 (approx.); Material (major): Plastic • GUIDANCE: Type: Inertial • POWERPLANTS: First stage (booster) — Propellants: Solid; Type and number: JATO (1); Thrust, pounds: 100,000 (approx.); Second stage — Propellants: JP; Type and number: Turbojet (1); Thrust, pounds: 5,000 plus

The Goose was a ground-launched diversionary (decoy) missile under development by Fairchild Aircraft & Engine Company. This small, lightweight missile was to be ground-launched and powered by a jet engine. The cancellation was announced on December 12, 1958.

At the close of World War II, the military potential of missiles was obvious, and the Joint Chiefs of Staff were determined to develop a U. S. missile capability. However, no suitable long-range missile flight testing

facility was available. Therefore, in October, 1946, a Committee on Long Range Proving Ground was appointed to select a suitable test site.

After study of possible locations, Cape Canaveral was selected because



NAVAHO

(No specifications available.)

Navaho research missile being launched at the Missile Test Center in Florida. Instrumented flights of the missiles were part of project RISE, which stands for Research In Supersonic Environment. Project RISE was a responsibility of North American Aviation under its research and development contracts for the Air Force. The primary aim of project RISE was to get design data for the F-108 and B-70 aircraft.

of its isolated location, the nearness of the Banana River Naval Air Station (now Patrick AFB), and the almost unlimited overwater flight potential in a southeasterly direction where strategically located islands offered ideal missile tracking locations.

In July, 1947, the Air Force was

Navaho SM-64 guided missile is shown leaving its launcher.

A long-range, surface-to-surface missile developed by North American Aviation. This air-breathing missile was rocket-launched and had a high load-carrying capability. Research in developing the Navaho provided a great deal of technical information which has been used in later missiles. The cancellation of the Navaho was announced June 11, 1957. The development of the Navaho was initiated originally in 1946.

directed to develop this range and a joint services group began work. Meanwhile, negotiations were started to establish tracking stations on islands in the Bahamas and the West Indies.

By mid-1949 needed legislation was signed by the President establishing the long-range missile proving



Thor IRBM booster lifts *Discoverer* Number 1 off launch pad at Vandenberg Air Force Base, Atlantic Missile Range, California. *Discoverer* Number 1, world's first polar orbit satellite, was launched by the Air Force Ballistic Missile Division for the Advanced Research Projects Agency of the Department of Defense. *Discoverer 1* was successfully put into orbit February 28, 1959.



ground. Construction was started at Cape Canaveral for missile launching and instrumentation facilities. In May, 1950, the Joint Long-Range

Proving Ground became the sole responsibility of the Air Force.

The first missile launching from Cape Canaveral occurred on July 24,

Earth satellite *Discoverer V* with its modified Air Force *Thor* IRBM booster is shown seconds after launch from Vandenberg's AFB. *Discoverer V*, containing a recoverable package, was launched by the Air Force Ballistic Missile Division on August 13, 1959.



1950, when a German V-2 rocket carrying an Army WAC Corporal missile as a second stage roared from its pad. The following month, the Banana

River Naval Air Station was formally dedicated Patrick Air Force Base.

Gradually experimental missile



Discoverer VII is prepared for launch from Vandenberg Air Force Base, California. The Agena satellite vehicle used in Project *Discoverer* is boosted into polar orbit by an intermediate-range ballistic missile.

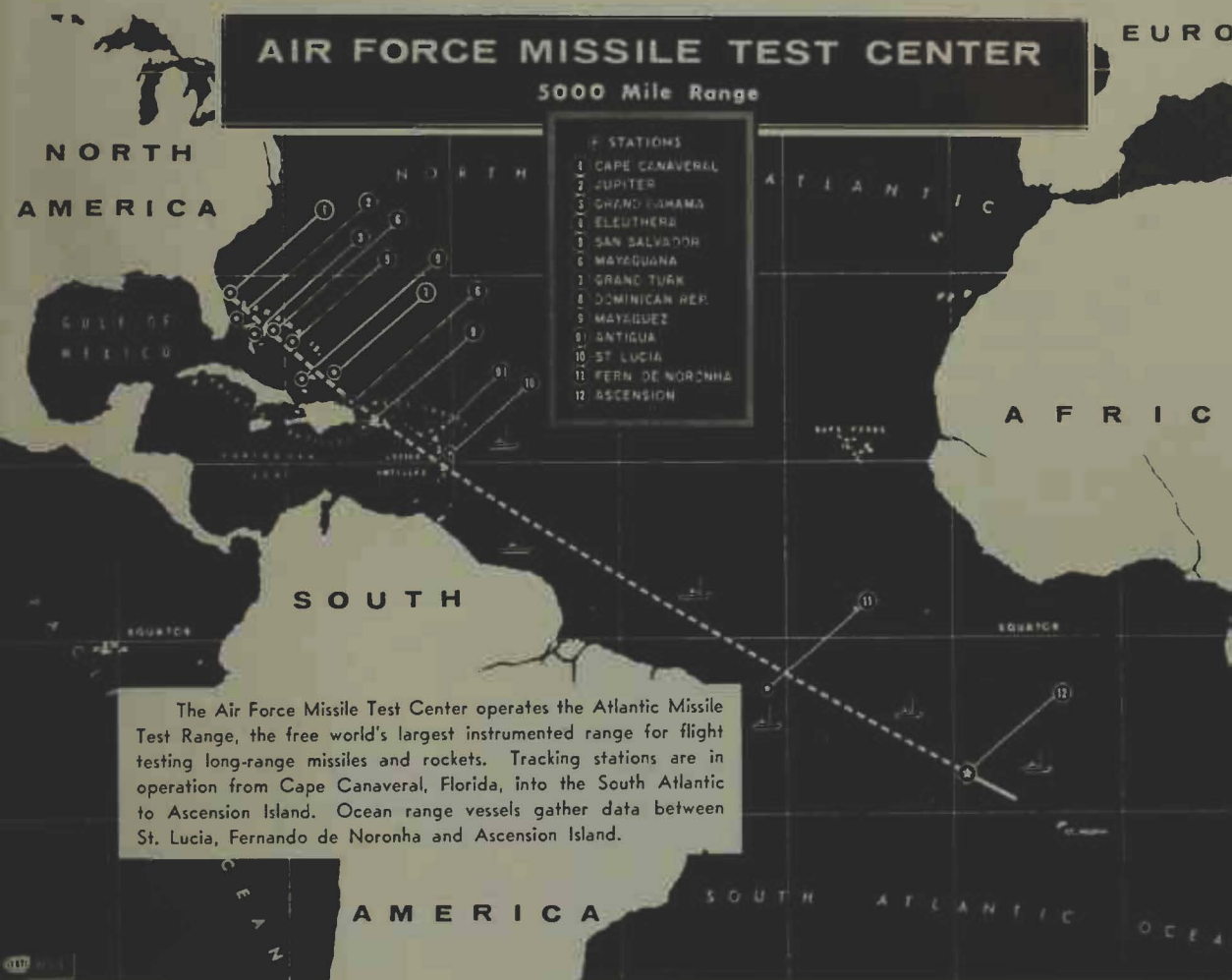
Coughing up its own clouds plus haloed silver lining, an Air Force *Thor-Able II* lights the Florida sky as it takes off to test an advance designed nose cone. The shot shown here occurred February 28, 1959. The first *Able* series consisted of three firings designed to test the basic vehicle. Initial firing in April, 1958, was unsuccessful; the other two, both in July, 1958, resulted in highly successful flights of 5,100 and 5,200 miles. These missions paved the way for Air Force lunar probes, most successful of which occurred on October 11, 1958, when a payload was propelled more than 70,000 miles into space. The *Thor-Able II* series is programed entirely for nose cone design and re-entry tests.



launchings became more frequent. In June, 1951, the first *Matador* was launched. It became the Air Force's first operational surface-to-surface missile. Meanwhile, the Air Force's first missile units were being trained

at the AFMTC (Air Force Missile Test Center).

Construction at downrange missile tracking stations began early in 1951. By 1957, agreements were concluded with Great Britain, the Do-



minican Republic, and Brazil establishing all 12 of today's major tracking stations. In addition, a number of ocean range vessels were modified to serve as floating tracking stations to fill the gaps between St. Lucia Island,

Fernando de Noronha, and Ascension Island. Meanwhile, the Air Force Missile Test Center had been placed under the jurisdiction of the Air Research and Development Command.

In recent years, the AFMTC has

History of Manned Rocket Flight In the United States

X-1

Manufactured by Bell Aircraft and powered by Reaction Motors four-barrel XLR11 rocket engine. First successful rocket-powered flight was made December 9, 1946, by Chalmers H. (Slick) Goodlin, Bell. First supersonic flight was made October 14, 1947, by Captain Charles E. Yeager, USAF.

D-558-II

Manufactured by Douglas Aircraft. Powered by Westinghouse J34 turbojet and RMI rocket engine. First flown February 4, 1948, by John Martin, Douglas. Maximum speed of 1,328 mph was reached by Scott Crossfield, NASA, on November 20, 1953.

XF-91

Manufactured by Republic Aviation. Interceptor fighter with auxiliary rocket power flown successfully in the spring of 1949. Rocket unit powered by Reaction Motors. First combat equipped aircraft to fly faster than the speed of sound, December 9, 1952.

X-1A

Advanced version of X-1. Manufactured by Bell Aircraft and powered by Reaction Motors rocket engine. First powered flight February 21, 1953, by Skip Ziegler. Flown 1,650 miles an hour by Major Charles Yeager, December 12, 1953. Major Arthur (Kit) Murray flew to altitude of 90,000 feet on August 21, 1954.

X-1B

Same as X-1A except especially instrumented for full-scale aerodynamic heating research. First powered flight October 8, 1954, by Major Arthur (Kit) Murray.

X-1E

Modified X-1 with thin wing. First powered flight December 15, 1955, by Joseph A. Walker, NASA.

compiled a spectacular record of "firsts" in the nation's military missile and space programs. Included among them are the first firing of a U. S. satellite, the first full-range

Atlas intercontinental ballistic missile launching, firing *Bomarc* in conjunction with the Air Force *Sage* system, and many more.

If a single accomplishment were



An eerie setting for early morning servicing of the X-15 is provided when chilled helium is pumped into the airplane, causing ground fog. Chilling gas makes it possible to increase fuel load.



Careful ground checkout of all operating equipment, including engines, precedes each flight of the X-15 from Edward's AFB on the California Mojave Desert.

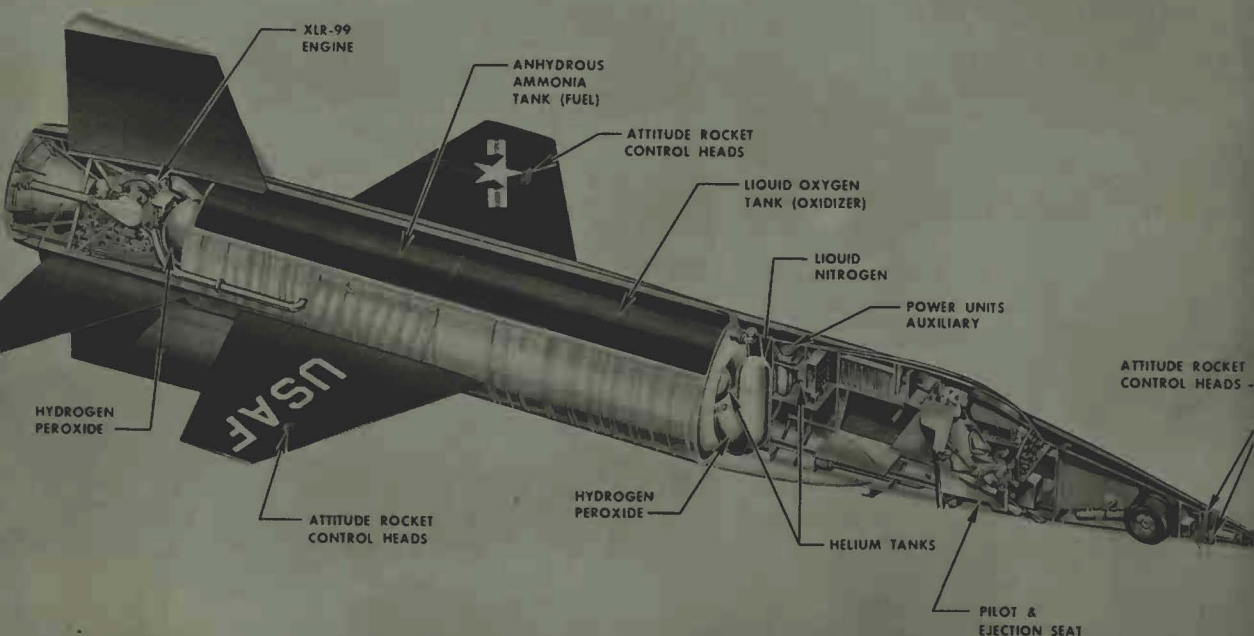
selected to symbolize the AFMTC's unique history, the *Atlas* satellite might be considered the most significant. At 6 P.M. (EST) on December 18, 1958, a 244,000-pound *Atlas* was

launched into orbit from Cape Canaveral. The giant missile achieved a velocity of 17,000 mph at burnout, about 4½ minutes after lift-off. It became the world's largest satellite

X-2

Manufactured by Bell. Powered by Curtiss-Wright rocket engine. First flown April 1953 by Skip Ziegler. Lieutenant Colonel Frank K. (Pete) Everest set world speed record of 1,900 mph on July 23, 1956, and Captain Iven C. Kincheloe set an altitude record of 126,200 feet on September 7, 1956. Captain Milburn Apt was killed in record flight of 2,148 mph on September 27, 1956.

Cutaway view of the rocket-powered X-15.



and achieved an apogee of 928 miles and a perigee of 114.5 miles.

Against this backdrop of spectacular accomplishments, even more important military, satellite and space programs of the Armed Forces and

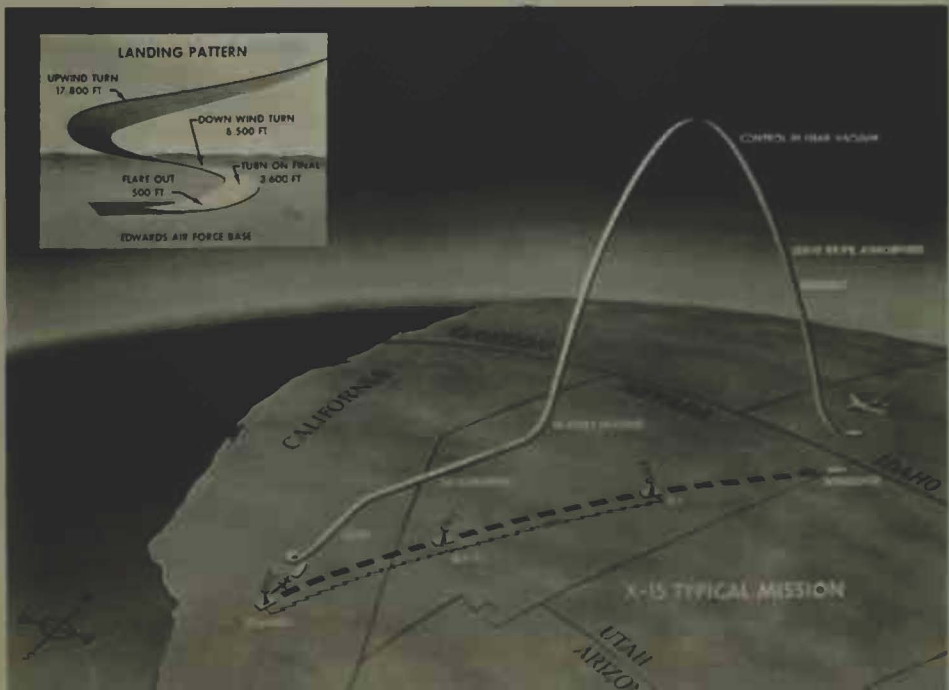
the National Aeronautics and Space Administration are now under way at Cape Canaveral.

In 1959 the Air Force's new missile base at Vandenberg, California, was activated. Also, the Air Force

X-15

Manufactured by North American. Powered by Reaction Motors XLR99 rocket engine delivering more power than two Queen Mary ocean liners. Currently in Research and Development stage. History: April, 1952: Resolution passed by NACA directing laboratories to initiate studies of problem areas likely to be encountered in space flight. May, 1954: NACA team established characteristics of an airplane suitable for exploratory flight studies of aerodynamic heating, stability, control, and physiological problems involved in hypersonic and space flight and the feasibility of building such an airplane. NACA representatives met with the Air Force and Navy development groups to present proposal. December, 1954: Invitations issued to experienced contractors to participate in design competition for the X-15. January, 1955: Formal briefing on specifications. May, 1955: Interested contractors submitted bids. December, 1955: North American Aviation, Inc., designated winner of the competition. Go-ahead given for construction of three X-15's. October, 1956: First Conference Report by the Research Airplane Committee. December, 1956: Development Engineering Inspection Board met. September, 1957: Construction started on X-15. July, 1958: Mating and equipment installation. July 28 and 29, 1958: Second Conference Report by the Research Airplane Committee. October, 1958: Roll-out and delivery to flight test at Edwards Air Force Base. March 10, April 1, April 10, and May 21, 1959: Captive flights at Edwards AFB with test pilot Scott Crossfield at controls. April, 1959: Second X-15 delivered to flight test at Edwards AFB. June 8, 1959: First glide flight and successful landing on dry lake bed at Edwards AFB.

Flight pattern for early X-15 tests.



Dropped from the wing of a B-52, the North American X-15 uses its own rocket power to accelerate to speeds in excess of 3,600 mph. The joint Air Force-NASA-Navy research program provides important data on high-speed flight.



now is building launching sites for long-range missiles in many states, coast-to-coast.

In fact, the Air Force is about to become a Space Force. The dreams of conquering the blue yonder now have become dreams of conquering the in-

finite reaches among the planets and the stars.

Tomorrow's Air Force will be there—in orbit around heavenly bodies millions of miles from the earth. Preparations are being made now....

THE LANGUAGE OF ASTRONAUTICS

(Condensed from Air Force Publication AFP 11-1-4)

acquisition and tracking radar — A radar set which searches for, acquires and tracks an object by means of reflected radio frequency energy from the object, or by means of a radio frequency signal emitted by the object. Continuous position information on the object is provided after original acquisition of the target.

adapter skirt — A flange or extension of a missile stage or section that provides a ready means of fitting another stage or section to it.

additive — A substance added to a propellant to achieve some purpose such as a more even rate of combustion.

after body — (1) A companion body that trails a satellite. (2) An unprotected section or piece of a ballistic missile that re-enters the atmosphere behind the nose cone or other body protected for re-entry.

aiming error — In missilery, an error that results from miscalculation in such matters as longitude or latitude distance, speeds, re-entry deflection, or the like.

air breather — A missile or vehicle propelled by fuel oxidized by intake from the atmosphere.

Air Force Ballistic Missile Division (AFBMD) — A division of Headquarters ARDC located at Inglewood, California. Responsible for research, development and initial operational capability of Air Force Intercontinental and Intermediate Range Ballistic Missiles.

Air Force Flight Test Center (AFFTC) — An ARDC Center at Edwards Air Force Base, California. Conducts flight tests and evaluations on complete Manned Aircraft, Weapon Systems, Aircraft Components, Research Aircraft, Rocket Engines and Parachutes.

Air Force Missile Development Center (AFMDC) — An ARDC Center at Holloman Air Force Base, New Mexico. Conducts research, development, test and evaluation in areas of Guided Missiles, Space Biology and Test Range Instrumentation.

Air Force Missile Test Center (AFMTC) — An ARDC Center at Patrick Air Force Base, Florida. Operates the Atlantic Missile Range for the Department of Defense. Conducts flight tests of aerodynamic and ballistic missiles.

Air Launched Ballistic Missile (ALBM) — A ballistic missile, generally utilizing a solid propellant, which is carried aloft and launched from an aircraft.

aircraft rocket — A rocket-powered missile carried by, and launched from, an aircraft. It may be guided or unguided.

alcohol — Ethyl alcohol (C_2H_5OH) or methyl alcohol (CH_3OH), used with liquid oxygen as a bipropellant. *See* specific impulse. (Ethyl alcohol and liquid oxygen were used in the German V-2.)

Anti-G Suit — A tight flying suit that covers parts of body below the heart and is designed to retard the flow of blood to the lower body in reaction to acceleration or deceleration. An antiblackout suit. Bladders or other devices may be incorporated to inflate and increase bodily constriction as the G force increases.

antisatellite missile — A missile designed to destroy an orbiting satellite.

apogee — The point or position at which a moon or an artificial satellite in its orbit is farthest from its primary.

artificial earth satellite — A man-made earth satellite, as distinguished from the moon. Usually called "earth satellite."

astrionics — The science of adapting electronics to aerospace flight.

astrogation — Navigating in space.

astronaut — One who flies or navigates through space.

astronautics — The art or science of designing, building, or operating space vehicles.

atmospheric braking — The action of atmospheric drag in decelerating a body that is approaching a planet; can be deliberately used, where sufficient atmosphere exists, to lose much of the vehicle velocity before landing.

backout — Reversing the countdown sequence because of the failure of a component in the missile or a hold of unacceptable duration. Most serious task during backout is removal of the propellants from missile tanks. Used in contexts where the countdown has been discontinued.

ballistic missile interceptor — An interceptor, specifically an explosive rocket missile, designed to home upon, and destroy, a ballistic missile in flight. This term is sometimes used as a synonym of "antimissile missile."

ballistic trajectory — The curved portion of a missile trajectory traced after the propulsive force is cut off and the body is acted upon only by gravity, aerodynamic drag, and wind.

biosatellite — A satellite designed to carry an animal or plant, or a satellite that carries an animal or plant.

bird — A figurative name for a missile, earth satellite, or other inanimate object that flies.

blockhouse — A building, usually heavily reinforced to withstand blast and heat, that houses the electronic controls and equipment for preparing and launching a missile, together with auxiliary apparatus.

blowoff — Separation of an instrument section or package from the remainder of the rocket

vehicle by application of explosive force, to retrieve the instruments after they have collected the required information.

boiloff — The vaporization of liquid oxygen as the temperature of the propellant mass rises during exposure to ambient conditions of the missile tank or other containers.

booster — An engine that assists the normal propulsive system of a missile or other vehicle. A booster may be incorporated in the first stage of a missile to give more power for take-off.

brain — Generally refers to the man-made kind — the navigational units or electronic data processing systems.

burnout — The point in time or in the missile trajectory when propellant is exhausted or its flow is cut off, resulting in end of combustion of fuels in the rocket engine.

capsule — A small, sealed, pressurized cabin with an acceptable environment, usually for containing a man or animal for extremely high-altitude flights, orbital space flight, or emergency escape.

captive firing — Test firing of a complete missile where all or any part of the propulsion system is operated at full or partial thrust while the missile is restrained in the test stand.

carrier rocket — A rocket vehicle used to carry something, as in the "carrier rocket" of the first artificial earth satellite.

checkout — A sequence of operational and calibration tests needed to determine the conditions and status of a weapon system.

circuitry — The system of electric or electronic circuits used in a missile system or subsystem.

circular velocity — Critical velocity at which a satellite will move in a circular orbit around its primary. Circular velocity is a special case of orbital velocity and one which is not likely to be obtained in practice due to accuracy of control needed.

circumlunar — Trips or missions in which a vehicle will circle the moon and return to earth.

cislunar space — Space between the earth and the orbit of the moon.

cluster — Two or more engines bound together so as to function as one propulsive unit.

countdown — (1) The step-by-step process leading to missile launching. It is performed in accordance with a pre-designed time schedule, measured in terms of T-Time (T minus time prior to initiation of engine start sequence and T plus time thereafter). (2) Also used to describe the step-by-step process leading to captive tests, battleship tank tests, flight readiness firings and mock firings.

destructor — An explosive or other device for destroying a missile or one of its components intentionally.

downrange — In a direction away from the launch site and along the line of a missile test range.

escape velocity — The speed a body must attain to overcome a gravitational field, such as that of earth, and thus theoretically travel on to infinity. The velocity of escape at the earth's surface is 36,700 feet per second. A practical manned space craft would travel the atmosphere at a lower velocity and accelerate to escape velocity beyond in order to avoid unacceptably rapid initial acceleration and high skin temperature from aerodynamic heating.

exotic fuel — Unusual fuel combinations for aircraft and rocket use with the purpose of attaining far greater thrust.

fallback area — At certain missile sites, an area to which technicians and others fall back once the missile is readied for firing.

flame bucket — An opening built into the pads of some rockets into which the hot gases of the rocket pour as thrust is built up. The flame bucket is directly under the rocket positioned for launch. One of its sides turns inward to form the flame deflector; the opposite side is open.

gantry — Crane-type structure, with platforms on different levels, used to erect, assemble,

and service large missiles; may be placed directly over the launching site and rolled away just before firing. Short for "gantry crane" or "gantry scaffold."

gimbaled motor — A rocket motor mounted on a gimbal, i.e., on a contrivance having two mutually perpendicular axes of rotation, so as to obtain pitching and yawing correction moments.

go-no-go — Of a missile launch: So controlled at the end of the countdown as to permit an instantaneous change in decision on whether to launch or not to launch.

ground support equipment — All ground equipment that is part of the complete weapon system and that must be furnished to ensure complete support of the weapon system. Included are all implements or devices required to inspect, test, adjust, calibrate, assemble, disassemble, transport, safeguard, record, store, actuate, service, launch, and otherwise support and maintain the functional operating status of a weapon system, subsystem, end item, or component.

hardened (hard base) — Made hard, as with concrete or earth, to withstand overpressure of nuclear attack or other blast, e.g., Hard Base, Hard Structure.

hypergolic propellant — A rocket propellant that ignites spontaneously upon contact with an oxidizer.

launch pad — A concrete or other hard surface area on which a missile launcher is positioned.

liquid oxygen — Oxygen supercooled and kept under pressure so that its physical state is liquid. Used as an oxidizer in a liquid-fuel rocket.

lunar orbit — The orbit of a body placed in orbit about the moon.

multi-stage rocket — A rocket having two or more thrust-producing units, each used for a different stage of the rocket's flight.

orbit — The path described by a celestial body in its revolutions around another body.

perigee — The point at which a moon or an artificial satellite in its orbit is closest to its primary.

probe — A thing used to explore, examine, and test the nature of something, especially a test sphere, earth satellite, or other instrumented vehicle used to penetrate outer space and made to report back information on conditions encountered; specifically an instrumented vehicle that moves close to, around, or upon a spatial body, and reports back to the earth, by telemetry or by other means, such information about the body under surveillance as is obtained from the particular instruments in use.

recovery — The act of retrieving a portion of a launched missile or satellite which has survived re-entry.

re-entry — The return of a ballistic missile or other object into the sensible atmosphere.

re-entry nose cone — A nose cone designed especially for re-entry, consisting of one or more chambers protected by an outer shield.

separation — The event which occurs when a full-stage, half-stage, warhead, or re-entry vehicle is separated from the remainder of the vehicle.

silo — A missile shelter that consists of a hardened vertical hole in the ground with facilities either for lifting the missile to a launch position, or for the direct launch from the shelter.

skirt fog — The cloud of steam and water that surrounds the engines of a missile being launched from a wet emplacement.

sloshing — The back-and-forth splashing of a liquid fuel in its tank, creating problems of stability and control in the vehicle.

specific impulse — A means of determining rocket performance. It is equivalent to the effective exhaust velocity divided by gravity, expressed in pounds per second.

spin stabilized — Directional stability of a projectile obtained by the action of gyroscopic forces which result from spinning of the body about its axis of symmetry.

static firing — The firing of a rocket motor or engine in a hold-down position to measure thrust and accomplish other tests.

target drone — An unmanned aircraft or a missile used as a target for testing interception equipment and procedures.

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