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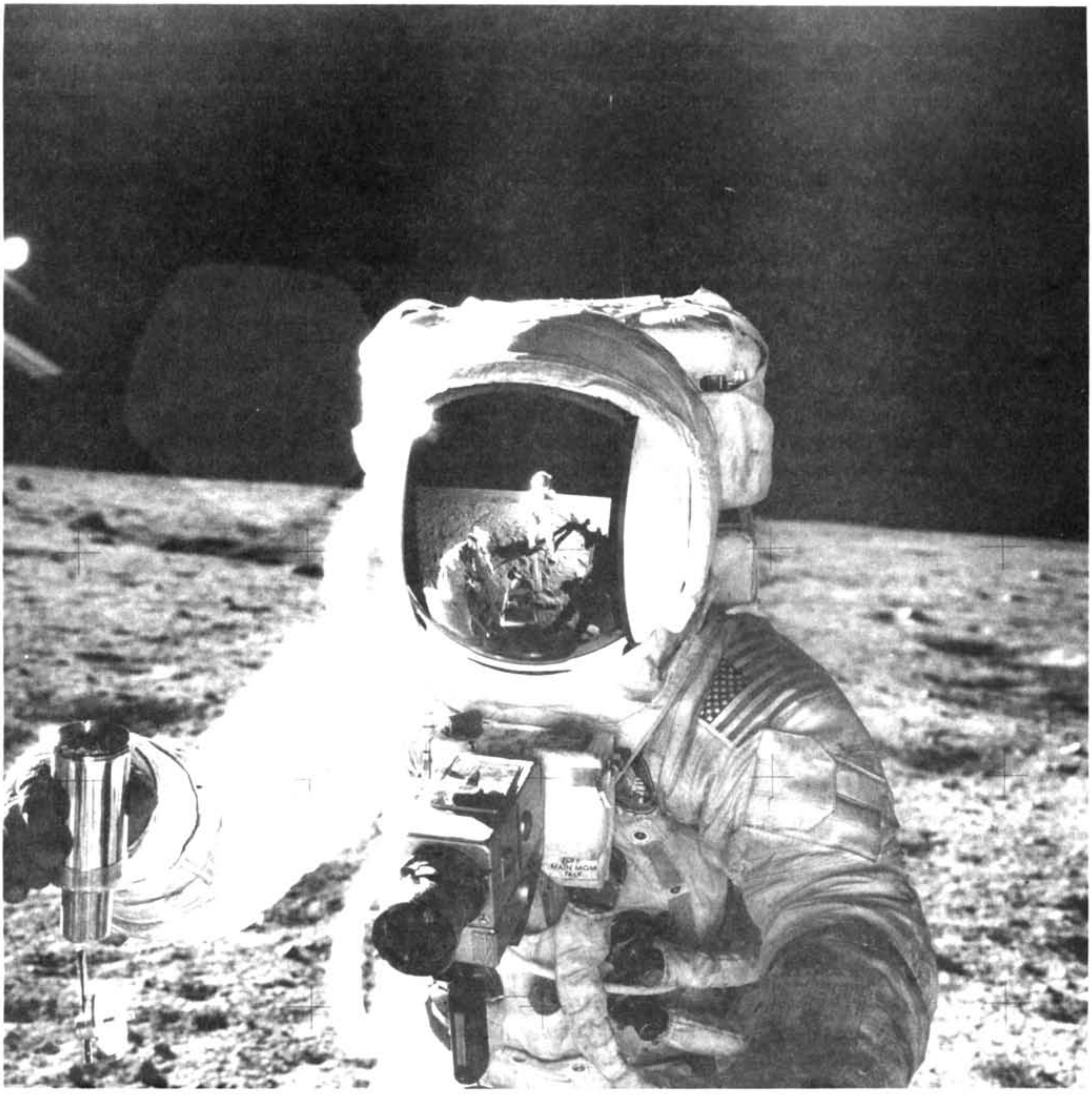
From Sand to Moondust

...a narrative of Cape Canaveral, then and now

From Sand to Moondust



...a narrative of Cape Canaveral, from discovery to moon shot

Introduction

Mankind in the past few years has set sail on one of its greatest ventures—exploration of outer space. Man has long dreamed of a trip to the Moon and to other planets. Through manned space flight, he has been able to cast off his mental and physical anchors to earth and translate his dreams into reality.

A spectacular series of space accomplishments fired people's imaginations and focused their attention on one of the most famous geographical locations in the world—Cape Canaveral. The purpose of this narrative is to tell the story of this historical location from the protohistoric period to the modern-day Moonwalks.

The narrative has been prepared in two separate parts. Part I is a compilation of historical material; Part II is a recap of particular points of interest, past and present, located at Cape Canaveral.

We have no illusions that Part I is a comprehensive or definitive work of the history of Cape Canaveral. It would take volumes to properly reconstruct the historical events of this area. Additionally, perhaps we are still too close to these events to have the perspective necessary to objectively write such a history. Instead, our purpose in Part I has been to create an interest in the many wonders recently accomplished at the Cape—events so numerous that even the participants have been unable to grasp the import of it all. In all probability, the lay reader has, through television and other media, vicariously experienced some of the highlights, but has missed many of the details, which are no less significant. Our intention has been to encourage the reader's interest so that he will wish to pursue a detailed study and appreciation of the many accomplishments, past and present, that have occurred here.

In Part I we have attempted to confine the narrative to factual data. However, a history of the Cape cannot ignore the broad social and political context of events. We hope the reader will understand why we have digressed, at times, in this direction.

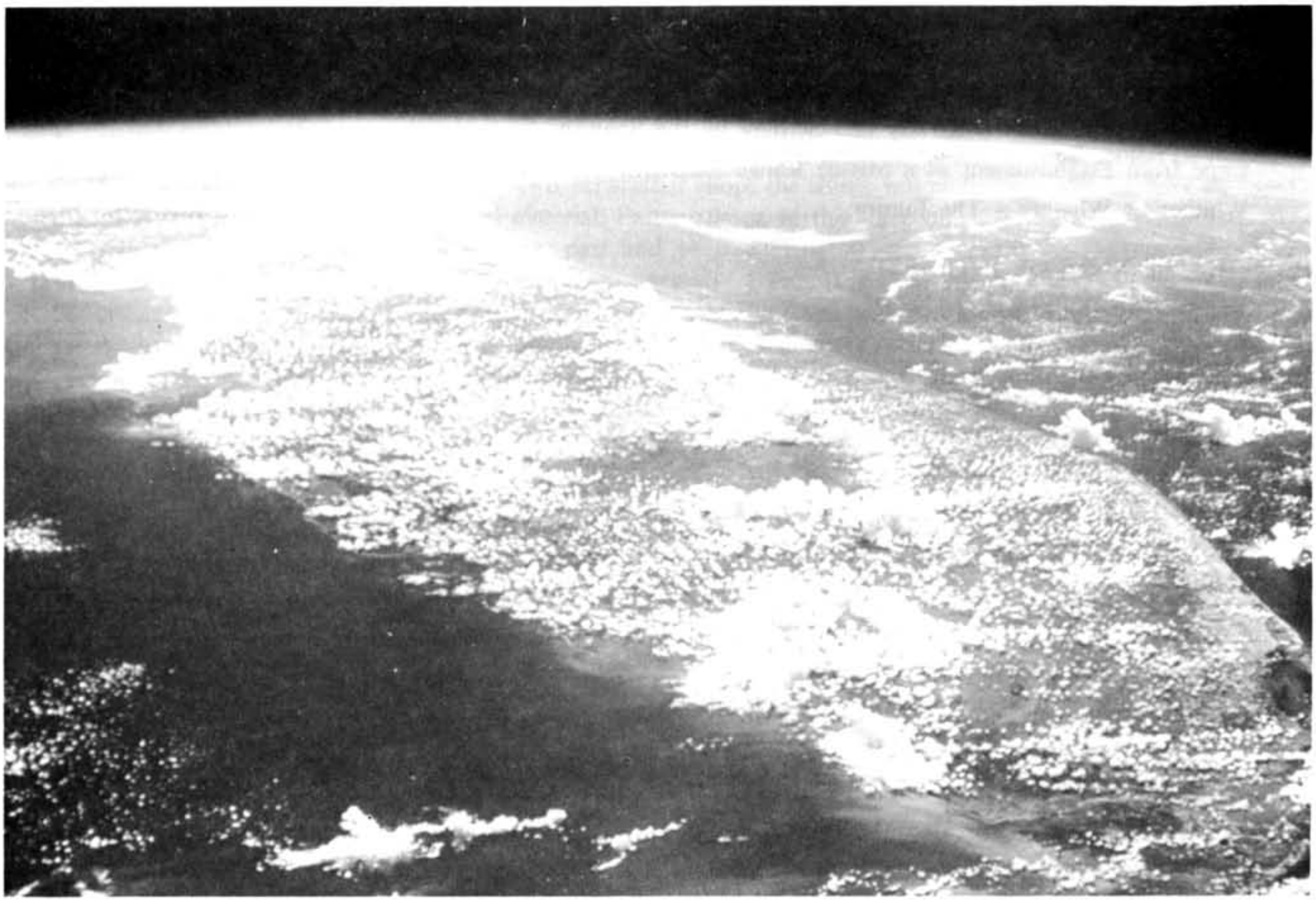
Part II is a narrative of the major points of interest at the Cape and is primarily limited to the missile and space booster vehicles and their installations. The objective in Part II has been to provide a guide whereby an individual, with the aid of a Cape map, might take his own guided tour of the Cape, at his own pace.

CREDITS AND ACKNOWLEDGMENTS

This book, for the most part, is a compilation of official materials released by the United States Air Force, the National Aeronautics and Space Administration, and industrial contractors supporting these agencies. The originators of this book, the Air Force and Pan American World Airways, Inc. (now Pan Am World Services, Inc.), gratefully acknowledge the cooperation and assistance of Mr. Homer Cato, well-known historian-archaeologist of Micco, Florida, and the Real Eight Corporation of Melbourne, Florida. Mr. Cato was invaluable in supplying source material and photographs pertaining to Florida's aboriginal Indians. By generously granting a personal interview, he provided the medium for a greater understanding and appreciation of protohistoric Florida. The staff of the Real Eight Corporation, particularly Colonel H. A. Cannon (ret.), Mrs. Faye Dicks, Mr. Robert F. Marx, and Mrs. Elva McArdle, cheerfully assisted the writer in gathering source material and photographs of Spanish treasure shipwrecked along the Florida coastline. The photographs credited to both of these sources—Mr. Cato and the Real Eight Corporation—cannot be reproduced without the express approval of their owners.

Appreciation is also extended to the organization and individuals—too numerous to mention here—who generously contributed source material and other assistance in the preparation of this book. Without exception, these people, the majority of whom are space workers, enthusiastically cooperated with the author. By their actions, we are reminded once again that the space spectaculars originating from the Cape have not been the product of machines and technology, but of its people—the men and women of Cape Canaveral, a unique breed of individuals.

Contents



Astronauts' view of Florida, looking north.

PART I
Histories

History of Cape Canaveral from Discovery and Settling by the Spanish

Sift the sands of Cape Canaveral and you sift the sands of time. The complexity of the present, with the excitement surrounding manned flights to the moon and other space spectaculars, overshadows the almost forgotten past—a past rich in Indian and New World lore, replete with aborigines, pirates, shipwrecks and buried treasure, and hardy pioneers.

Pre-Spanish Period

It is difficult to reconstruct the development of culture during prehistoric or preliterary Florida. Due to the relatively recent works of archaeologists and anthropologists, it is possible, however, to reconstruct from physical remains some of the history of the successive Indian migrations and levels of culture developed in Florida.

It is believed the Florida Indians numbered about 25,000 at the end of the fifteenth century.[1] Prior to that, Indians of varying levels of development but with cultural habits dictated by coastal and marsh life roamed up and down the Florida Coast.

During the earliest migrations into northern Florida, approximately 10,000 years ago, the Indians were almost exclusively hunters, were occasionally cannibals, and used skins for clothing and bone and sinews for tools and ornaments. As time passed, the first suggestions of villages began to appear. The Indians began to depend upon seafood, supplemented by nuts and edible roots. Large refuse mounds several feet thick, called middens, contained coquina, whelk, and clam shells, as well as other Indian artifacts.[2]

Typical Indian artifacts found in areas around the Cape. (Photo credit: Mr. H. Cato and M. L. Skinner)

Several middens, found along the St. Johns River, mark the sites where these Indians settled. A soft chalky or St. Johns paste appeared and pottery-making began. This pottery was dispersed all over the Florida peninsula. Shards have been found not only in the St. Johns area and along the East coast but on the Gulf coast at the base of many of the old saltwater shell heaps and from sites that have been dredged up and are at present under water.[3]

Historians claim that two major groups of Indians occupied the Cape Canaveral area. The Ais (pronounced Ah-ees, and sometimes spelled Ays, Aye, and Is) occupied the coastal and Indian River region from Cape Canaveral to the St. Lucie River and inland twenty to thirty miles. The Timucuans, a much larger group, occupied an area from Cape Canaveral to Georgia. These Indians were aboriginal and should not be confused with the Seminoles, who did not enter Florida until early in the eighteenth century.[4]

The Ais were nonagricultural and lived principally on seafood, coco plums, palm berries, cabbage palm, and sea grapes. At the time of the Spanish invasion into the New World, they added Spanish knives and hatchets to their basic bow and arrow technology.[5]

The Timucuans subsisted by hunting, fishing and agriculture, and they stored winter and emergency rations in a central granary. Here, as elsewhere, the Europeans found the Indians unwilling to part with their surplus.[6]

These Indians reportedly had few religious or burial rites even after the Spanish attempts to Christianize them. However, it is interesting to note the findings uncovered by a local archaeologist, which show that the Indians had incorporated the idea of the Christian cross, often arranging the remains in a cross-like shape when burying their own or others.[7] From this it cannot be interpreted that they had become Christianized; many of the skeletons were minus heads and other parts of the body, indicating that the Indians were still cannibalistic. It can be safely said, however, that these Indians lavished attention on the dead and believed in life after death, for artifacts, such as shards of pottery, jewelry and shell dippers, were carefully placed alongside the dead in the burial mounds.[8]

In the two and a half centuries following Ponce de Leon's visit in 1513, most of these aboriginal Indians disappeared. They fell victims to epidemics, primarily of European origin, to warfare among themselves and with the white man, and to slave expeditions.[9] The survivors, if any, migrated out of the area, never to be seen again.

Spanish Period

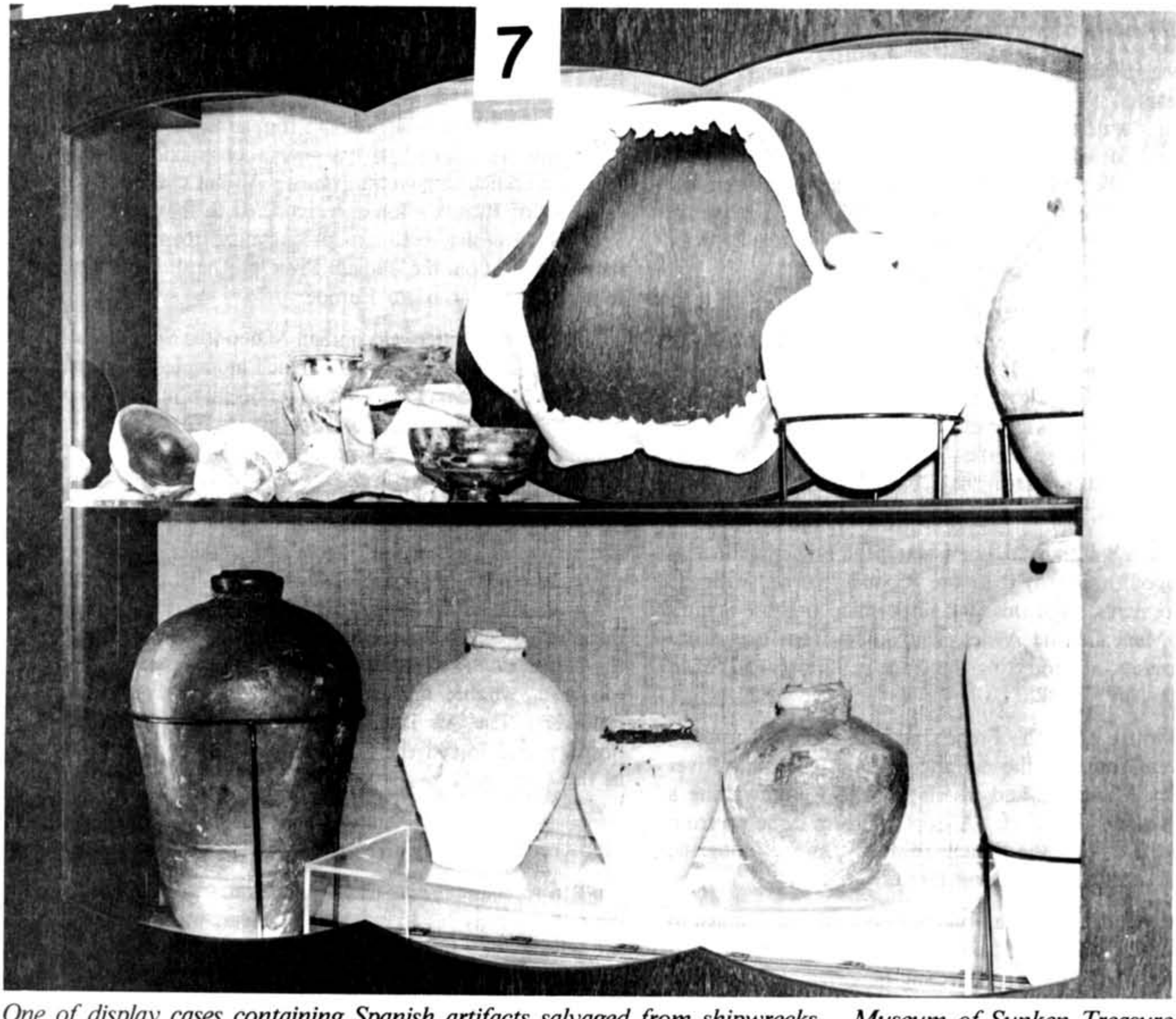
From the time of the marsh-dwelling Indians to the adventurers of France and Spain, continuing even to the present, the sea has drawn explorers to Florida and to the Cape.

The principal motive which led to the discovery of the New World was the shortage of precious metals which were needed to meet Europe's expanding mercantile trade. The Spanish were certain that if they sailed westward they would reach Marco Polo's Zipangu (Japan) and there they could obtain the gold and silver needed. However, as it happened, it was not the precious metals from Zipangu that were obtained but those from the mines of Peru and Mexico.[10]

The Spanish were dependent upon the New World treasures discovered by Columbus in the Indies, and Cortez, who conquered Mexico in 1519. Any delay in the arrival of the treasure from these two areas damaged Spanish credit and caused great concern in all the major financial centers of Europe, as the New World treasure provided nearly 95 percent of the metals on which the European monetary systems were based. Spain, although the leading power in Europe at that time, was totally dependent on other European nations for manufactured goods, both for export and domestic use, thus contributing to the total European economy.[11]

The discovery of Florida by the white man was one of the results of the expansion of the New World at the end of the fifteenth century. In 1513 Florida was officially discovered by Ponce de Leon. His second landing along the coast was below Cabo de Canaveral (Cape Canaveral) where hostile Indians forced a retreat to the Spanish ships. These landings on the Florida coast were to replenish water and wood supplies and to meet the aborigines for the purpose of finding treasure.

Florida was a colorful land, but Ponce de Leon was searching for gold and glory, not flora and fauna. He sailed down the coast to Los Martires (the Florida Keys) and



One of display cases containing Spanish artifacts salvaged from shipwrecks – Museum of Sunken Treasure. (Photo credit: Real Eight Co., Inc.)

Tortugas, meeting at every landing hostile Indians whose appearance gave no indication of wealth and who did not offer to lead him to hidden treasure or magic fountains.[12]

Although Ponce de Leon failed in his search for gold and silver, he recognized the value of the Bahama Channel as an exit from the Gulf of Mexico. The waterway soon became the main route for not only the treasure fleets but all other ships returning from the Caribbean and Mexican ports on their way to Spain.

Credit for discovering Florida goes to Juan Ponce de Leon because his voyage was under official Spanish auspices. However, there is evidence of prior discovery. For example, it is certain that slave hunters came to Florida from Spanish settlements prior to Ponce de Leon's 1513 expedition. This would explain the hostility of the Indians when he and his successors landed on the coasts of Florida. Also, three maps that are representative of Florida appeared before 1513—the Albert Cantino map of 1502 and two other maps of 1508 and 1511.[13]

Meanwhile, several other Spanish adventurers visited the Florida east coast to explore and to trade with the Indians. Among these were Hernando de Soto, who, according to legend, also visited the Cape. However, because of the hostility of the Indians and the poorness of the land, Florida was generally left alone by the Spanish as long as no other nation threatened their waterway from the New World to Spain.

The French came to the Cape next, victims of a shipwreck. In 1562, in an effort to establish French claims in the Americas, a Frenchman, Jean Ribault, was sent on an expedition. He discovered the St. Johns River and established a colony at Fort Caroline. Ribault then went back to France to gather help in protecting this claim. In 1565 he returned to the colony with about 600 reinforcements.[14]

Spanish authorities knew about the French settlement and hoped to destroy it before Ribault returned with the reinforcements. For this task King Philip II chose Spain's Pedro Menendez de Aviles, who knew from experience the necessity of protecting the trade route between Spain and the New World.[15]

Shortly after the French arrived at Fort Caroline, they went south to the entrance of the St. Johns River to attack Menendez and his ships, who were awaiting a favorable tide and wind. A tropical storm came up from the north, driving the French ships southward along the Florida coast and wrecking them.[16]

Menendez, unaware of the extent of the damage to the French, marched overland and destroyed Fort Caroline. King Philip II, rejecting his original decision to leave the Florida coast unsettled, ordered the Spanish to conquer, govern and colonize the lands discovered, and to Christianize the natives.[17] Menendez, after ousting the French at Fort Caroline and at Matanzas Inlet, planted settlements at strategic places. Priests were taken along to try to convert the Indians. By Royal decree, if the Indians were summoned to embrace the Christian faith and refused, they might then be enslaved.

It is interesting to note what the Spanish officially thought of the Indians. Don Fray Juan Cabezas Altamirano, Bishop of Cuba, visited Florida and accordingly reported:

> "Cicero never beheld such men as are most of the people of Florida. They are so barbarous that what is usually accepted and customary does not obtain. Especially savage are those of the coast, who worship neither the sun, nor the moon, nor anything. They go about naked like beasts, in the woods, eating wild fruits and raw shellfish, for they do not even know how to use fire."[18]

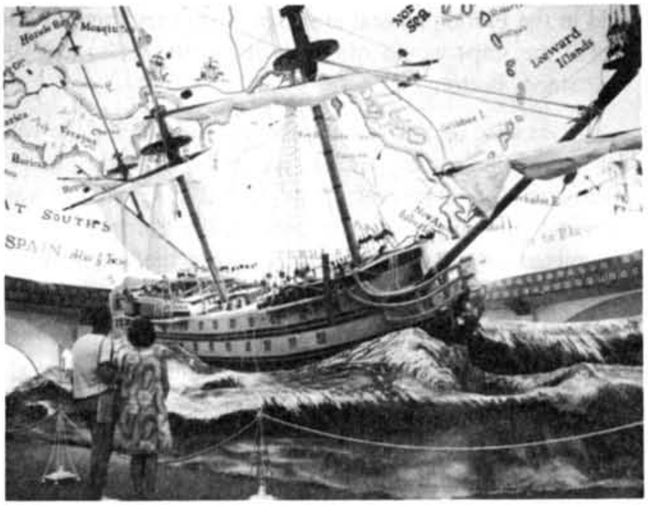
Menendez received word that some 170 stragglers from Ribault's forces were on the coast to the south, and sent men by land and sea to the vicinity of Cape Canaveral. The Frenchmen, having built a small fort at Cape Francois—their name for Cape Canaveral—were constructing a vessel from the French shipwreck, *Trinity*. All but twenty of the survivors of Ribault's forces surrendered to the Spanish.[19] Records show that both groups continued to a large Ais Indian village on the Indian River.[20] The French were subsequently returned to Europe.

After a punitive raid on San Mateo (the Spanish had renamed Fort Caroline),[21] the French attempted no other settlements of Spanish Florida until late in the next century. They had not lost interest in the region, but confined their actions to privateering and pirate raids.

The history of settlements and attempts by the Spaniards to establish permanent forts for the protection and refuge of shipwrecked sailors and soldiers dates from this time (1565). Menendez established a blockhouse at the north end of the Indian River. His men then worked their way down to the southern part of the river, learning the nature of the Indians, and obtaining a description of the land, wildlife and climate. Their stay was brief, however. The Ais Indians remained relentless in their hostility and forced the Spanish to abandon their forts in the Cape area.[22]

Shipwrecks

In recent years the Cape Canaveral area has become famous not only for its space spectaculars but also as the site where gold and other valuables have been salvaged from shipwrecks dating back to the Spanish period. The voyage to the New World was indeed a hazardous undertaking, with shipwrecks being the greatest danger.



48-ft scale model of Hampton Court, largest of a fleet of 12 ships. (Photo credit: Real Eight Co., Inc.)

Gold and silver coins retrieved from 1715 Spanish fleet wrecks. (Photo credit: Real Eight Co., Inc.)

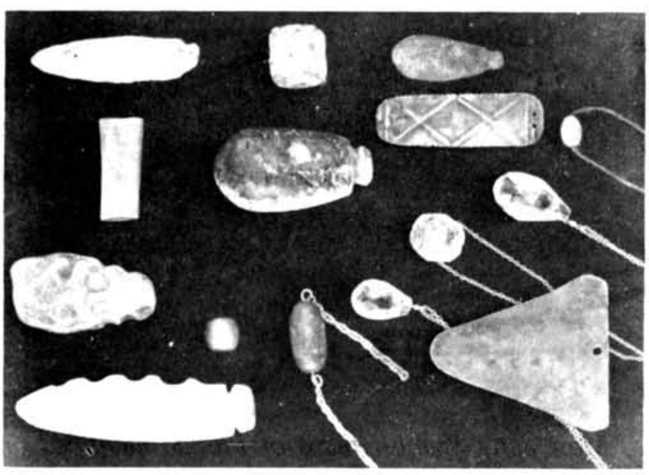
Early sixteenth-century map showing Cape Canaveral. Most early Spanish maps of Florida identified only two places — Los Martires (Florida Keys) and Cabo de Canaveral (Cape Canaveral).

After Ponce de Leon's discovery of the Florida east coast, almost all ships returning to Spain from the New World used the Bahama Channel. Havana was the only Indies port in which nearly every ship stopped in returning from the Indies, Mexico, and as far away as Manila, en route back to Spain. Once the Florida coast was sighted a northerly course was taken. Because the Bahama Channel is no wider than 50 miles at any point, the ships would attempt to steer up the middle of the Channel. Generally, the sailors stayed within view of the coast until sighting Cape Canaveral, where they would change course and head for Bermuda, then to the Azores and on to Spain.[23]

For three centuries, slightly over 5 percent of the ships in the Indies navigations were lost, with the majority of wrecks, for some reason, occurring in the Caribbean. The losses were due to weather conditions; to the construction of the ships, which were often topheavy and therefore easily capsized; and to privateers and corsairs. However, the majority of the shipwrecks were the result of incompetent navigation.[24]

Navigation was a definite problem for the Spanish. The average navigator depended on dead reckoning. For example, they had no means of determining longitude until the nineteenth century and, in addition, lacked other instruments needed for navigation. The problem was complicated further by inaccurate maps and charts of Florida (most sixteenth-century charts identified only two places, the Florida Keys and Cape Canaveral); and by the shortage of navigators. This is one of the reasons why the ships traveled in convoys: there were not enough navigators for each ship to have its own.[25]

As a result of the above, the Spanish used unusual methods in sailing between Havana and Spain. Instead of attempting to steer a course between the dangerous reefs and shoals of the Florida coastline, they would steer directly for the reefs since, at that time, navigation dictated sighting as many known points as possible to establish a ship's true position.[26] Naturally when storms occurred, as they often did in the Florida coastal areas, or when they traveled after dark, the ships would often go up on the reefs, wrecking the ship's bottoms.



Indian artifacts. (Photo credit: Mr. H. Cato)

Because of the vast number of shipwrecks, the value of the treasure carried, and the navigation methods used (it is estimated that 99 percent of the ships lost occurred in water shallow enough for divers to reach), the European powers attempted salvaging operations to recover the lost treasure.[27]

Even before Columbus "rediscovered" the New World in 1492, diving was practiced by many of the aborigines, mainly as a means of obtaining food, but also to obtain pearls and other valuables. In salvaging the ships and in their search for pearls, the Spanish mercilessly utilized this diving ability—first with the cannibalistic Carib Indian, then the Lucayan Indian. By the middle of the sixteenth century, these Indians were virtually extinct. The Spanish had already learned that the Indians of Florida were also good divers but because of their hostility they were not used. The Spanish, instead, began to use Negro slaves from Africa in their diving and salvaging efforts.[28]

Although no known pearl deposits exist today in Florida waters, there are several accounts from the sixteenth century which state that the Florida Indians dived for pearl oysters along the east coast of Florida. Documents dated as early as 1544 state that the east coast Indians were also diving on and recovering the vast amounts of shipwrecked treasure lost along the coastline.[29] This could account for the treasure recovered from Indian burial mounds found in the Cape area and for the recorded accounts of the wealth of the aborigine Indian, particularly the Ais.

The wealth of these aborigine Indians is heavily documented. For example, the Spanish in *Barcia's Chronology* describe the Indians of the west coast of Florida in this way:

> "For all the men and women, in their dances, wore strips of gold and silver hanging from their necks and middles; some having so many they could not move....had no further information as to their having mines, but rather imagined the greater part of this wealth came from the frequent shipwrecks along the ill-fated coast, and that the rest was acquired through barter and trade with the neighboring caciques."[30]

As further stated in Barcia's account, the cacique (chief) of Carlos (the Calusa tribe located on the west coast) considered the cacique of Oathxacua (the chief in the Cape area, probably an Ais) "his most devoted friend, who lived five days' march from the province of Carlos."[31] The two tribes bartered and traded, further explaining the wealth o: these Indians.

Archaeologists have recovered many artifacts from Indian burial mounds in areas near Cape Canaveral. Artifacts include pieces of eight, jewelry, hair pins, parts of skeletons, piercing instruments, etc. (Photo credit: Mr. H. Cato and M. L. Skinner)

Robert F. Marx in his list of shipwrecks (see note 10) further demonstrates not only the wealth of the Ais Indians and how it was obtained, but verifies that these Indians resided in the Cape area. Examples are: "Year 1551—Nao, San Nicholas . . . was wrecked near Ais, and the Indians recovered a great deal of what it carried."[32] "Year 1554—The ship . . . sank near Ais, richly ladened with gold and silver, and the Indians of the King of Ais recovered a great deal from the wreck."[33] "Year 1556—Indians of the King of Ais are reported to have recovered over a million in pesos in bars of gold and silver and many precious pieces of jewelry made by the Indians of Mexico, near Cape Canaveral. . . ."[34]

The diving ability and wealth of these Indians probably further accounts for their demise. Thoughout this period, it is well documented that the Ais and other coastal tribes came into frequent conflict with the Spanish who were shipwrecked and/or attempting to salvage lost treasure and, in the process, massacred the Spanish and, in turn, no doubt were massacred.

For almost three centuries after the Spaniards discovered the Cape, civilized man virtually ignored its presence except as a sailing landmark.

Nineteenth Century to Present

Among the histories of the fifty states, Florida's is the longest and certainly one of the most colorful, stretching back through four centuries and five varying national cultures which have shared in its development. Although St. Augustine was the first colony established in the United States, Florida, particularly the east coast, remained relatively undeveloped until the nineteenth century.

During the first half of the nineteenth century a settler, Douglas Dummitt, began an industry that was destined to make the Indian River section known throughout the world. The industry he established was a citrus grove—parent of the famed Indian River brand of citrus.

In 1807 Douglas D. Dummitt is said to have smelled the orange blossoms growing on sour orange trees on Merritt Island as he sailed up the coast to his father's new sugar cane plantation. At the age of 23 he returned, establishing a home on what later became known as Dummitt Grove. In 1828, by using Indian dugout canoes made from cypress logs, which were poled up the Indian River by Negro slaves, young Dummitt was shipping his first fruit commercially.[35]

The site Dummitt had selected for his orange grove was on Merritt Island, between the Cape and the mainland, with the warm tidal waters of the Indian River on one side and of the Banana River on the other. The Indian River is actually a salt water tidal lagoon, about 2 miles wide in most places and 120 miles long, running between the Florida mainland and the Atlantic barrier beaches.[36]

The orange industry actually began with the Spanish. Columbus, under orders, carried with him the seeds of the first citrus trees to reach the New World. In all likelihood, Ponce de Leon, Hernando de Soto and other Spanish explorers introduced oranges to the mainland during their Florida discoveries. Each sailor bound for the New World was required by Spanish law to carry one hundred orange seeds with him. The citrus were then planted in remote places for medical reasons. Indians, carrying them away from the Spanish colony, inadvertently scattered seeds in the Florida wilderness, and sour oranges began to grow wild.[37]

When Dummitt died in 1872, his orange grove became the property of an Italian "nobelman," the Duc Di Castellucia. The Duke cleared and developed the estate and built a very large and unusual home, which became known in the area as Villa Castellucia, or the "Duke's Castle."[38]

The Villa was unusual for many reasons. It was composed of twenty octagonal-shaped rooms—the owner believing that this shape would enable it to withstand the force of gales and winds. The lumber for the Duke's immense dwelling was obtained from driftwood when a ship went aground near Daytona Beach, with ship beams serving as corner uprights and as siding for the two narrow spiral staircases. But the most unusual aspect of the Castle was the result of marital problems. Always seeking unique solutions to the mundane, the Duke built a partition through the middle of the house. On one side the Duchess lived with her servants, while the Duke lived peacefully—so we assume—on the other.[39]

The "Castle" was carefully preserved over the years, and was later moved from its original site on Merritt Island to Titusville by the local Historical Society. It was destroyed by fire in December 1967.[40]

In March 1844, shortly before the close of the Seminole War and at the height of Dummitt's citrus activity, the territory now known as Brevard was called St. Lucie. In 1855 the boundaries and name of the county were changed once again and it received its present name—Brevard.[41]

The Cape area still remained relatively untouched by civilization. At that time it was not just a great undertaking to travel from the coast into the interior, but all travel and communication along the Indian River was difficult and limited. There were no road or railways and the river and ocean were the only ties with the outside world. Travel was adapted to the mood of the winds and water—when the winds blew the early settlers traveled. When it ceased, the travelers paused also.

In the 1880s a regular line of steamer traffic was inaugurated on the Indian River from the upper St. Johns River. A semi-weekly line of steamers went north from Sanford. This began a period of improvement and prosperity and was the beginning of tourist travel on the river. By the mid-1880s the population numbered but a few families.[42]

Next came the railway. By February 1893, Flagler's first train rolled into Titusville (formerly called Sand Point), Cocoa and Rockledge. By June 1893 the railway extended to Eau Gallie.[43]

With the advent of transportation, the area surrounding the Cape began to grow. Titusville, located at the head of the Indian River and destined to become the County seat, was founded by Colonel Titus, a soldier of fortune who sold supplies to the Confederate Army during the Civil War. Titusville became a flourishing port as early as the 1880s when a wooden-tracked railroad, powered by mules, carried goods as far inland as Sanford.[44]

Other towns included Cocoa (first named Indian River City), which was settled in 1881 when the first house was built. Rockledge, first spelled Rock Ledge and established in 1873, was the oldest winter resort on the east coast of Florida, and was named for the ledges of coquina rock that jutted out along the Indian River.[45]

Merritt Island was first settled in 1868. The primary economy of the island was based on cattle, pineapple, sugar cane and citrus. The settlers traded with the Indians who came to the Island by boat since the other settlements, including Sand Point, could only be reached by sailboat.[46]

The first bridge across the Banana River from Merritt Island was completed in 1923. Prior to that time the only access was by boat. In 1925, Cocoa Beach was incorporated as a town.[47]

One of the oldest settled areas was the Cape itself, however. In 1843, it was selected as the site for a lighthouse. The lighthouse seen today is not the original construction, but one that was built in 1868. In 1894, after the sea began to threaten its foundation, the new construction was moved inland 1½ miles to its present site. (See lighthouse narrative, page 64.)

Some early pioneers, in addition to the lighthouse keepers and their families, inhabited the Cape but, generally speaking, it was relatively untouched by civilization. The very isolation that made the pioneer lighthouse keeper's life such a lonely one was a major factor influencing the U. S. Government in its selection of Cape Canaveral as a missile site.

History of Cape from Establishment as a Missile Range

It is estimated that about 530 million people watching television saw Neil Armstrong's televised image and heard his voice describe the event as he took "one small step for a man, one giant leap for mankind" on 20 July 1969. A Saturn rocket, gleaming in the early morning light and waiting to carry astronauts to the moon, is a far cry from the first missile fired from Cape Canaveral.

The distinction of the first firing from the now world-famous Cape goes to the Bumper, a captured German V-2 rocket with a WAC-Corporal second stage. This rocket, fired on 24 July 1950 under almost primitive conditions, was fueled directly from tank trucks. An old Army tank was used as the blockhouse controlling the launch.

For the full impact of the history of the Cape, however, it is necessary to go back beyond this first launching.

Following World War II, government officials realized that space would of necessity play an important part in the future safety of the United States. A joint committee, composed of military and civilian government leaders, was formed in 1946 to select a site for a long-range proving ground. Sites in California, Georgia and Texas were also considered, but a 15,000-acre site along Florida's east central coast was selected.

Cape Canaveral was chosen for a variety of reasons: it was isolated, therefore ideal for security and developmental purposes; it was economically advantageous—the government already owned portions of the Cape—and since it was relatively uninhabited and undeveloped, development could occur at minimal cost.

Beyond the many advantages offered by Cape Canaveral itself, the over-water flight range potential was also an important determining factor—long-range missile flights were possible over an area that was relatively free from major world shipping lanes and any groups of inhabited land masses. Islands of the West Indies and South Atlantic offered ideal locations for the permanent stations needed to track missile flights and record vital performance information.

On 1 October 1949, the Joint Long Range Proving Ground was activated, later known as the Air Force Eastern Test Range (AFETR). Managerial responsibility was given to the Air Force. In 1950 construction of missile launching pads began, construction which was to change the almost isolated peninsula to a multimillion-dollar investment.

On 1 August 1950, the onetime Banana River Naval Air Station was renamed Patrick Air Force Base in honor of the Army Air Corps' first chief, Major General Mason M. Patrick.

In November 1963, the name Cape Canaveral was officially changed to Cape Kennedy, in honor of President John F. Kennedy, but was later restored to its historic name by popular demand.

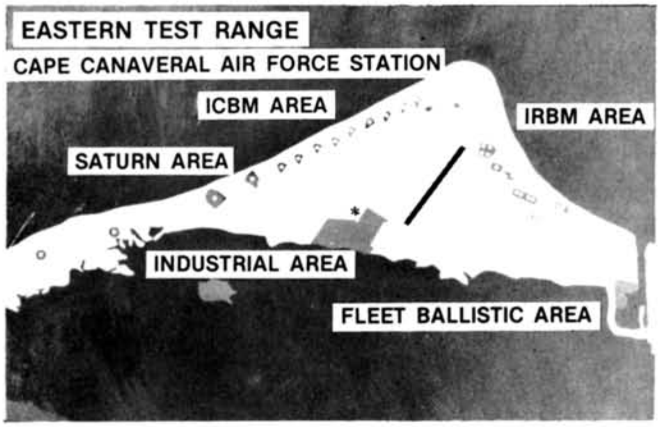
The AFETR was in essence a vast missile testing "laboratory," supporting tests for the Air Force, Army, Navy, NASA, and some international users such as the United Kingdom. This "laboratory" included the administrative headquarters at Patrick AFB; the launch site located at Cape Canaveral Air Force Station (15 miles north of Patrick); and the downrange tracking facilities, an area extending 10,000 miles down the Atlantic into the Indian Ocean.*

The island tracking stations of ESMC are Grand Bahama, Grand Turk, Antigua and Ascension. From these sites radar and optical devices track the vehicle while telemetry equipment records vital information of the flight performance.

Station 1 of this huge 10,000-mile "laboratory" is the Cape. Within the Cape boundaries are complete assembly and launch facilities for ballistic missiles and space launch vehicles, storage and dispersing stations for fuels and oxidizers, and a landing strip for airlift of rocket

**In 1979, AFETR became one of the major elements of the Eastern Space and Missile Center (ESMC). Other units of ESMC were the USAF Hospital, Patrick AFB; the 6550 Air Base Group; and the 6555 Aerospace Test Group.*

stages, spacecraft and other aerospace hardware. At the southern edge of the Cape is a deep-water port where large missile components are delivered, tracking ships are berthed and serviced, and operations are conducted in support of missile-launching submarines.



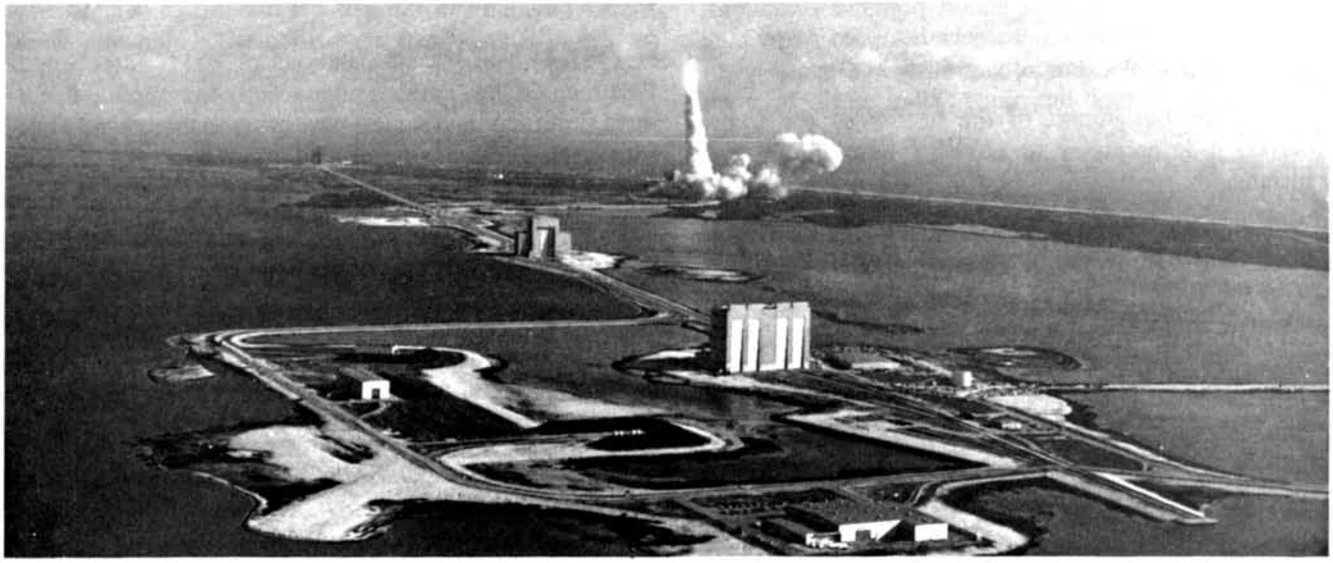
Aerial view of Cape areas.

The Cape is divided into three firing zones. The tip of the peninsula has been used for testing tactical missiles and small experimental rockets, such as weather rockets. The medium-sized ballistic missiles (Redstone, Minuteman, Pershing, Polaris/Poseidon, Thor and Blue Scout) were launched along the southeastern shore. It was from a launching pad in this area that the first U. S. man in space—Astronaut Shepard—made his initial journey.

The northeastern shore, called ICBM Road, is the avenue of the giant ballistic missiles, later converted for manned and unmanned space explorations. Here are the Atlas ramps (Complexes 11, 12, 13 and 14); the Titan towers that fold back (Complexes 15, 16, 19 and 20); the Atlas-Centaur gantries (Complexes 36A and 36B); and those that were used for the Saturn I and IB trials (Complexes 34 and 37). These massive structures, standing as high as 320 feet and weighing as much as 6,800 tons, are among the largest in the world.

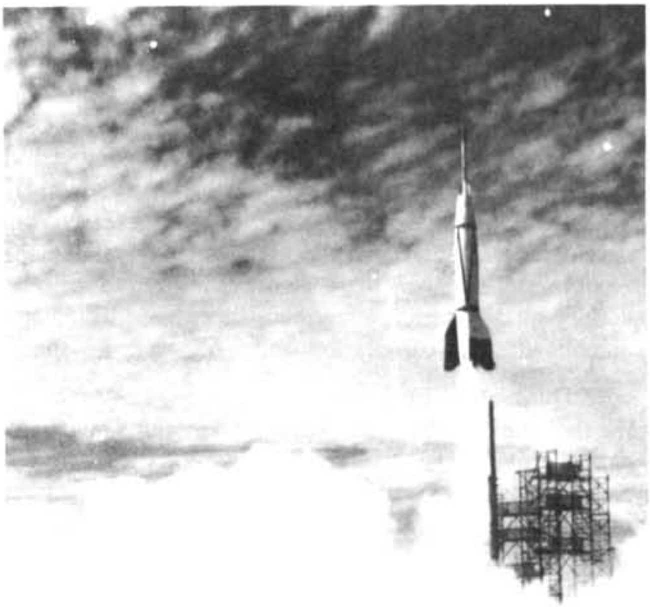
They are, however, overshadowed by the even larger installation—Apollo Complexes 39A and 39B and Titan III Complexes 40 and 41. Few people realize that these huge complexes and their installation are not part of the original 15,000-acre Cape Canaveral area. The Apollo Saturn V Launch Pads 39A and 39B are located on an area referred to as the Florida coastal strip; the Vehicle Assembly Building (VAB) and other installations used in support of the Apollo program are located on Merritt Island. Titan III installations, such as the Vertical Integration Building (VIB) and the Solid Motor Assembly Building (SMAB), are located on areas that were dredged and filled in, constituting "islands" in the river. The Titan III Pads 40 and 41, however, are located in two different locations—Pad 40 is located on the Cape, Pad 41 is located on the Florida coastal strip.

ICBM row.

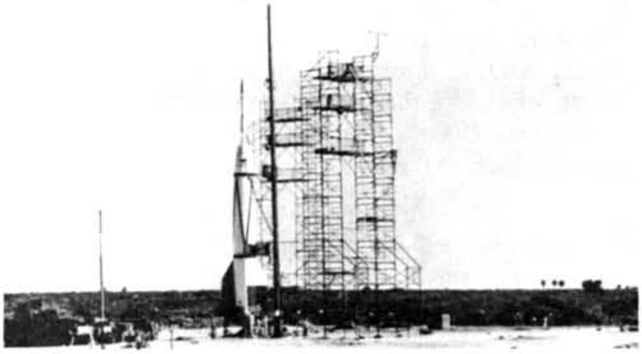


Titan IIIC lift-off. Titan III facilities were built on land dredged from the Banana River.

V–2 arriving at Patrick AFB from White Sands Proving Ground—1950.



Lift–off of first missile launched from Cape (Bumper 8), 24 July 1950.



Bumper 8 consisted of two stages—a sleek V–2 captured from the Germans, topped with a U. S. Army WAC–Corporal.

Panoramic view of Cape following Bumper lift–off.

History of Missile Testing

To adequately understand the history of the Cape within the past few decades, it is necessary to consider the mood and temperament of the nation (and world) during various time periods following World War II. These "moods" were reflected in the research and development (R&D) work accomplished at the Cape, accomplishments which were to occur in four primary development phases: winged missiles, ballistic missiles, unmanned space exploration and manned space flight.

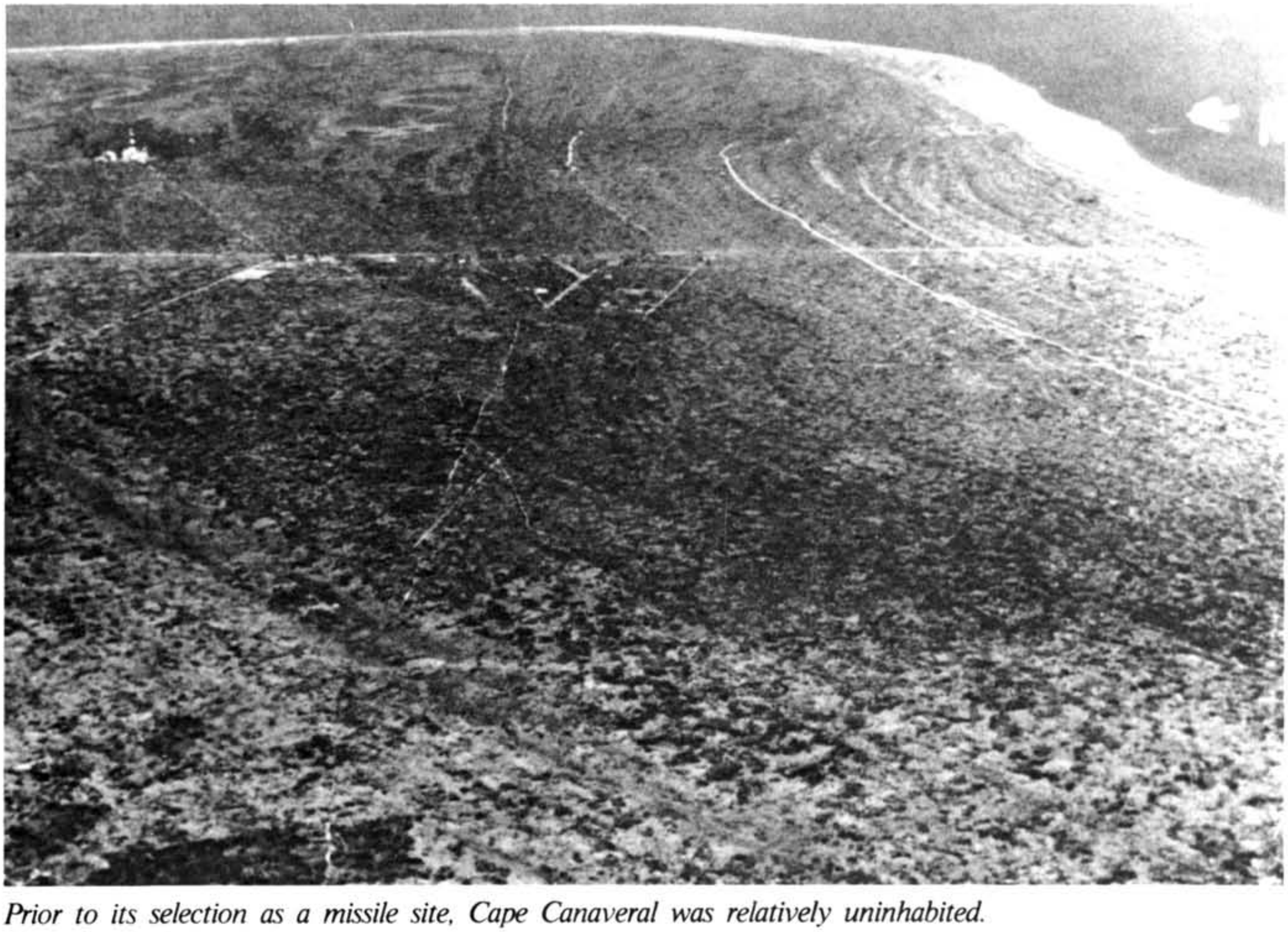
During the years immediately following World War II the nations of the world were understandably apprehensive. The United States and Russia were participating in a weapons race. In the United States, some military and congressional leaders felt that at least until 1965 manned bombers, supplemented by air-breathing guided missiles evolving from the German V-1, should be the principal American "deterrent force." (Air-breathing guided missiles is a term that simply means any pilotless flying aircraft.) During these early postwar years much of our space development effort was directed toward this goal.

Winged Missiles

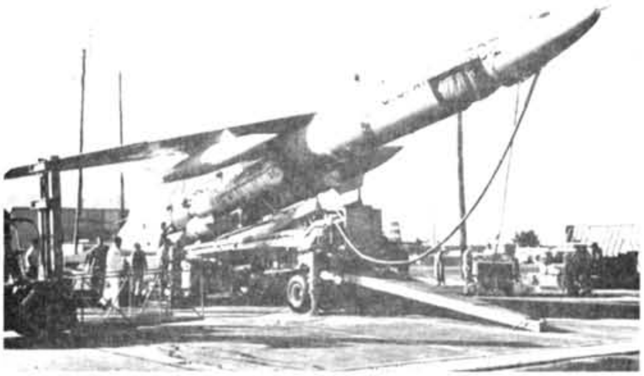
The earliest research and development vehicles flown on the ETR were "winged" or "cruise" missiles. Early launchings from 1950 through 1952 were to test these craft, which were basically pilotless bombers. Developed for air-to-air, air-to-surface, surface-to-surface interception uses as well as tactical surface-to-surface use, these aerodynamic cruise missiles flew in the atmosphere and required air to support combustion in their engines. They were literally captives of the atmosphere.

Although not the first vehicle to be flown on the Cape—the Bumper has that distinction—the tactical Matador missile was the first Air Force missile program to become operational after being flight-tested from the Cape. The initial flight on 20 June 1951 served as a training ground for the downrange station on Grand Bahama Island, which, for the first time, successfully tracked and recorded launch data. On 7 December 1951, the first all-military launch of the Matador was performed at the Cape.

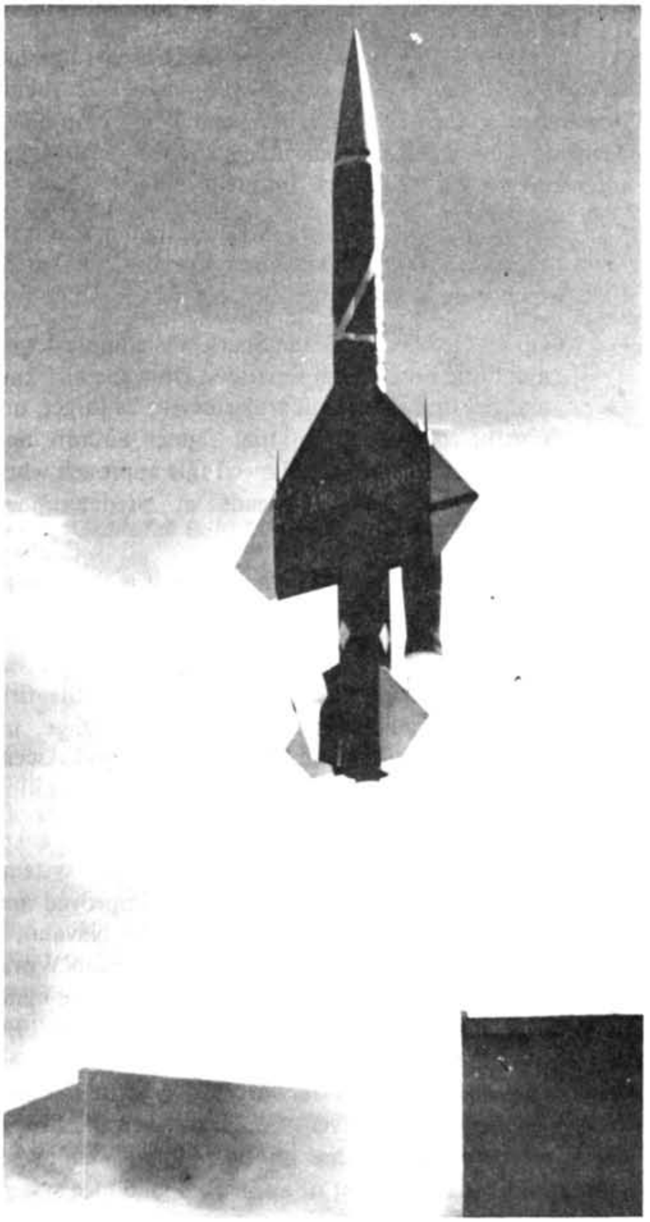
The surface-to-surface Matador, having a range of 600 nautical miles, was programmed to dive vertically to its target and was therefore exposed to both ground fire



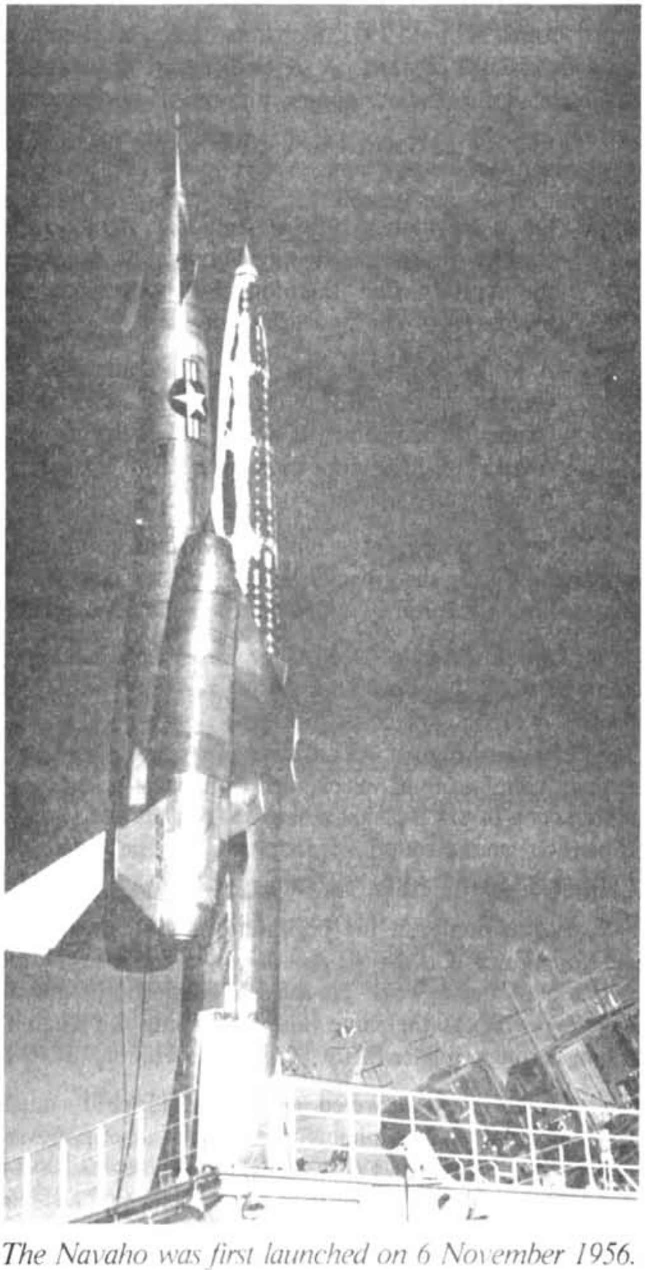
Prior to its selection as a missile site, Cape Canaveral was relatively uninhabited.



The Snark surface-to-surface missile was first launched on 29 August 1952.



The Bomarc was first launched on 10 September 1952.



The Navaho was first launched on 6 November 1956.

The delta-winged Bull Goose was an air-breathing decoy missile.

and attacking aircraft. This vulnerability was corrected with the development of the Snark's ballistic warhead.

Snark—the first and only genuinely long-range intercontinental U. S. winged missile—made 97 flights downrange between 29 August 1952 and 5 December 1960. Many of these flights were unsuccessful—the Atlantic was often referred to as "Snark infested waters."

The Snark, resembling a sleek jet fighter and having a range of 5,000 nautical miles, scored a number of firsts which were implemented in later missile programs:

- On 26 October 1955, the Snark was equipped with a ballistic nose which separated from the airframe and fell in a supersonic trajectory to its target, unobstructed by conventional fighter aircraft and ground fire. (ICBMs followed this approach when releasing nuclear warheads at predetermined altitudes.)
- On 26 November 1955, the Snark was the first to use a stellar guidance system (one which picks out certain celestial bodies for navigational aids).
- On 31 October 1957, the Snark made the first 5,000-mile guided missile flight downrange, initiating tracking operations at Antigua and Ascension stations as well as the use of instrumentation ships.

Other Air Force pilotless winged missile systems tested at the Cape included the Mace, an improved and long-range version of the Matador; and the Navaho, a long-range, two-stage vehicle based on a German World War II concept of a skip-glide bomber. The Mace made 44 research and development flights between October 1959 and July 1963. The Air Force Navaho made 26 flights between August 1955 and January 1959, when the program was terminated. Even though it was cancelled as a project before it became an operational weapon, it pioneered the development of an inertial guidance system and large rocket engines.

The first defensive missile weapon system flown on the ETR was the pilotless interceptor, Bomarc. This long-range missile cruised at 2,200 mph and was designed to intercept and destroy enemy aircraft before they reached the borders of the United States. First test fired by the Air Force in September 1952, the 47-foot-long Bomarc did not have to be fired in a straight line to its target, since its on-board radar "homed in" or "locked" onto elusive targets.

Offensive missile systems were also test fired from the Cape: the air-launched winged missile, Hound Dog, and the air-launched ballistic missile, Skybolt. During the short-lived Skybolt program, six inertially guided GAM-87A missiles were launched and flight tested from B-52 bombers. This program was cancelled on 31 December 1962.

Another missile in this same category was the Bull Goose. In the event of a nuclear war, this delta-winged missile was designed to confuse enemy ground and air defenses by making them think this was the attacking aircraft. This decoy missile, first fired in March 1957, was air-breathing and operated at subsonic speeds. Even though considered a successful research and development missile, the program was cancelled a year after the inaugural flight. The technological climate of the country was changing, and with it the type of testing done at the Cape. The age of the winged missiles was superseded by a family of long-range vehicles—the ballistic missiles.

Concurrency

It is necessary to digress at this point to understand why ballistic missile development proceeded as it did. One term is pertinent—concurrency.

From 1947 until 1951, the United States did not have an active ICBM project. A series of events beginning in 1949 altered our cautious approach to missile development:

- In 1949 the Soviet Union exploded her first atomic device.
- On 1 November 1952 at Eniwetok Atoll in the Pacific, the Atomic Energy Commission detonated the world's first thermonuclear explosion, the harbinger of the hydrogen bomb.
- Also in late 1952, the "Teapot Committee"—composed of nuclear and missile scientists—concluded that shortly it would be possible to build smaller, lighter and more powerful hydrogen-fusion warheads.

These developments, combined with the atmosphere prevailing during the advanced stages of the "cold war," initiated our concurrency approach to missile development.

Translated simply, concurrency means the simultaneous completion of all necessary actions to produce and display several weapon systems. The management task was complex—involving parallel advances in research, design and testing; manufacture of vehicles and components; design and construction of test facilities; testing components and systems; expansion and creation of industrial facilities; and the building of launch sites.

For example, at the beginning of 1956 the job of developing one ICBM—the Atlas—was complicated by the decision to begin work on the IRBMs—Thor, Jupiter, Polaris—while at the same time developing the Titan I, a longer range, higher thrust "second generation" ICBM.

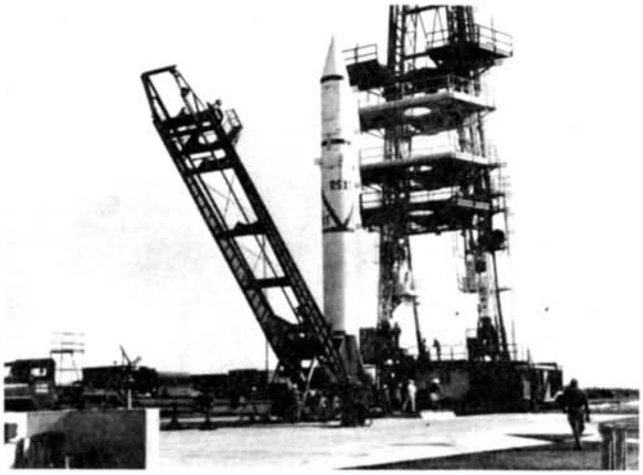
Concurrency answered an immediate need—much was accomplished in a minimum amount of time; however, it soon became obvious that mission guidelines had to be established. In November 1956 the Secretary of Defense issued his "roles and missions" memorandum, confirming Air Force operational deployment of ICBMs, assigning ship-based IRBMs to the Navy, and restricting Army operations to weapons with ranges of 200 miles or less.

Ballistic Missiles

In the mid-1950s the United States began to fly long-range ballistic missiles at the Cape. Divided into two basic categories they were: the intermediate-range ballistic missile (IRBM) with a range up to 1,500 nautical miles (Thor, Jupiter, Redstone), and the intercontinental ballistic missile (ICBM) with a range of 5,000 nautical miles (Atlas, Titan and Minuteman).

These ballistic missiles differ from the cruise or winged missiles: they fly like an artillery shell in a long arc from launch stand to target in minutes, and they fly out of the atmosphere through space and carry their own oxidizer.

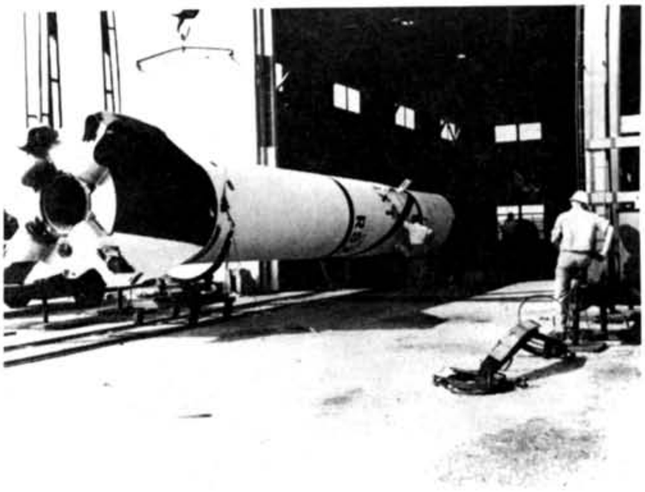
On 20 August 1953, the Army's 200-mile-range bombardment rocket, Redstone, was the first ballistic missile launched from the Cape. This rocket had a modified Navaho booster engine; was a direct descendent of the German V-2; burned alcohol and liquid oxygen; produced about 75,000 pounds of thrust; and was nearly 70 feet long and slightly under 6 feet in diameter.



Army's Redstone was the first ballistic missile launched from Cape Canaveral.

During the next five years, 37 Redstones were fired to test structure, engine performance, guidance and control, tracking and telemetry. It was the forerunner to the Army's Jupiter C and Jupiter IRBM, and was used as a space booster for other programs including the Mercury suborbital manned space flights.

The Redstone was the first large ballistic missile to be employed in the field by U. S. troops, and was by necessity a mobile system—meaning it had to be moved to a new location within a short period of time so that the firing battery could not be pinpointed by the enemy.



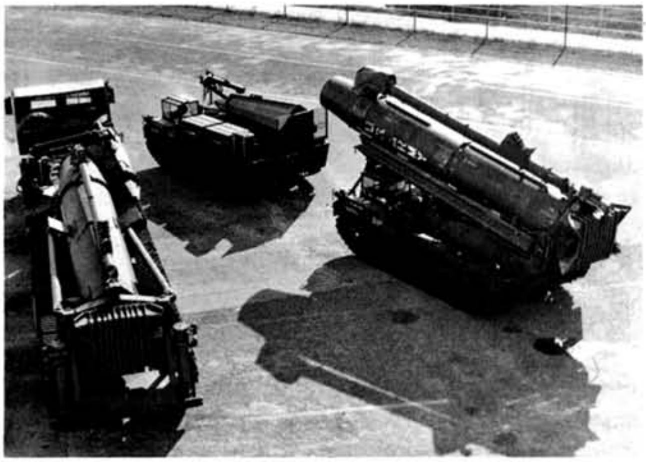
The Redstone being moved to temporary assembly building.

In 1958 the Redstone was placed in the NATO defense. In the mid-1960s it was replaced by the Pershing.

On 25 February 1960, the U. S. Army launched the first Pershing, a solid-propellant, two-stage, inertially guided missile with a selective range up to several hundred miles. After 56 firings from the Cape, the research and development phase was completed with the final firing on 24 April 1963.

The Pershing, a rugged missile designed for use by the Army is 34 feet tall and weighs 10,000 pounds. Its solid-propellant system provides high reliability and short reaction time. Rolling along the ground on a transporter-erector-launcher, the Pershing is accompanied by three other vehicles—communications, power-programmer, and warhead—enabling the missile to be moved quickly to an unprepared site, erected and fired in a matter of minutes.

Pershing was first launched on 25 February 1960.



Pershing's improved transporter-erector-launcher replaced the Redstone in Europe.

At the present time the Pershing is transported to the Cape for checkout at Hangar N. Placed on ships docked at Port Canaveral, they are shipped to Europe where German troops are being trained in support of the NATO Alliance.

Intermediate-Range Ballistic Missiles (IRBM)

In 1955 the DOD studied the need for an interim operational ballistic missile prior to the completion of the Atlas research and development ICBM program. Concluding that an IRBM with a 1,500-nautical-mile range could be developed in a relatively short time to meet deterrent requirements, approval was granted in late 1955 to the Army and Navy for the Jupiter program (in 1956 the Navy portion was redirected to the Polaris); and to the Air Force for the Thor program.

The initial Thor flight test was conducted from Cape Canaveral 13 months later (25 January 1957). Its first full success was achieved on its fifth flight test. The Thor went on to score a creditable record during 48 research and development launches on the ETR. It was declared operational after its seventeenth research and development flight, and in December 1958 the first of four squadrons was activated in England. It stood guard in England until 1963 when the Atlas and Titan ICBMs were deployed to assume defense of the United States. It is no longer in service as a weapon system.

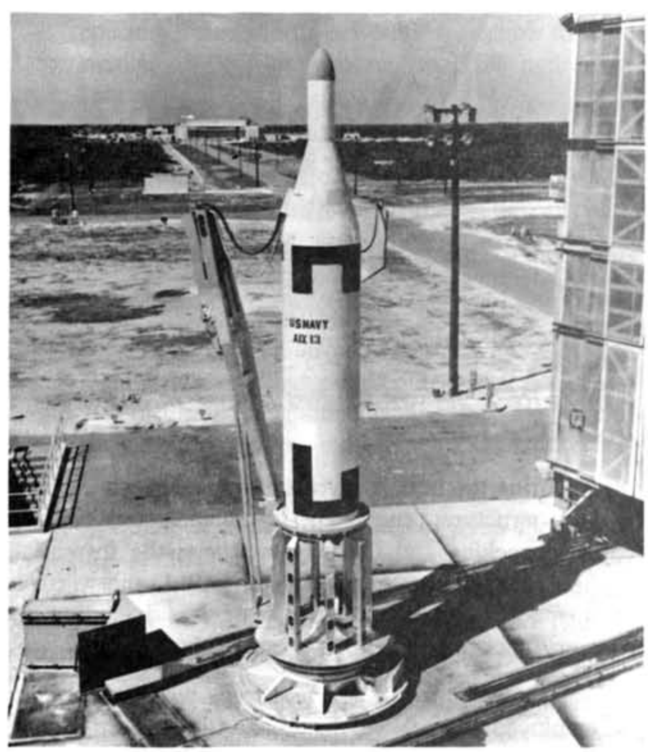
Early in 1956 the Army Ballistic Missile Agency at Huntsville, Alabama modified some of its medium-range Redstones in order to extend the studies of reentry thermodynamics. As modified, the Redstone became a multistage vehicle called the Jupiter C (for Composite Reentry Test Vehicle). Meanwhile the Air Force conducted its own investigation of reentry using a special multistage test rocket called the X-17, manufactured by Lockheed.

The Army's Jupiter was a contemporary of the Thor and, although developed by the Army, was assigned to the Air Force for operational deployment. The 58-feet tall, 110,000-pound missile (shorter but wider than the Thor) made a total of 65 research and development crew training and space launches between 14 March 1956 and 22 January 1963.

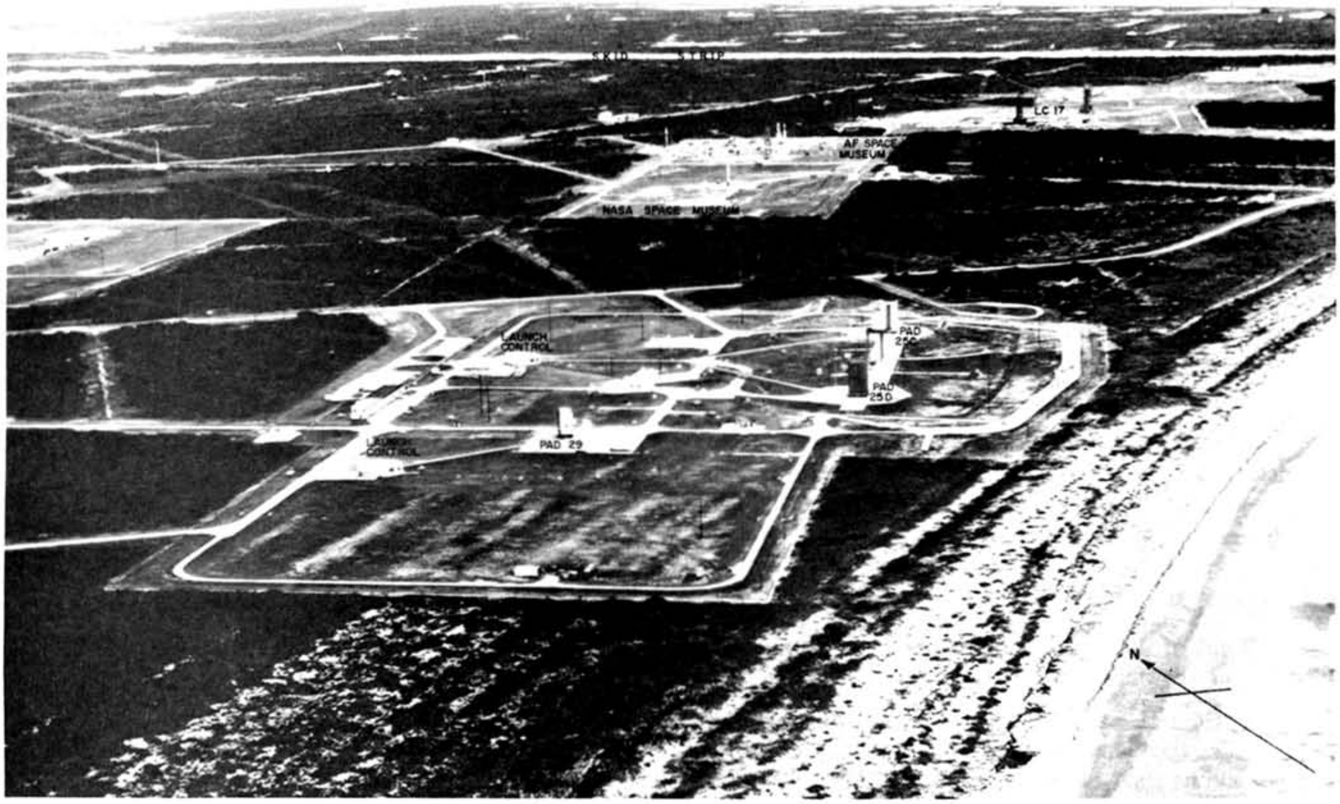
Wishing to convert the Army's Jupiter for use on submarines, the Navy took part in the early development work at the Redstone Arsenal. It was soon learned, however, that the maintenance problems involved with a liquid-fueled missile such as the Jupiter would prevent its use aboard a submerged submarine. The Navy abandoned the Jupiter program and in December 1956 began developing the solid-fueled IRBM Polaris.

The first version of the two-stage solid-propellant Polaris, the A-1, was fired in 1958. Of the several hundred Polaris launchings, roughly half have been research and development missiles from land pads; the other half have been crew-training firings from submarines submerged offshore.

The Navy land complex, located on the Cape near the Port, includes launch pads and blockhouses, missile assembly and checkout facilities, and administrative buildings. In addition, a Navy pier and associated facilities located at the Port are maintained for submarines and surface ship use in support of the three versions of the Polaris (A-1, A-2 and A-3) and the C-3 version of the Poseidon.



The Polaris fleet ballistic missile was first fired from a Cape launch pad on 13 April 1957.



Launch Complexes 25 and 29 are the land-based launch sites for the Navy Polaris program.

Intercontinental Ballistic Missiles (ICBM)

Atlas

Atlas was originally developed by the Air Force as the nation's first operational ICBM. This first ICBM had a hectic on-again-off-again career but became not only the first operational ICBM but went on to become the major large-boost vehicle for manned and unmanned space missions in the first decade of the space age.

As far back as 1945 the Air Force invited proposals for an ICBM with a range of 5,000 nautical miles. The following year the Air Force awarded a contract to Convair for a study that led to the MX-774 missile, a sort of Americanized V-2, called HIROC. Funding for this program was discontinued in 1947, then resumed on a minimal basis during the Korean War. In January 1951 Convair was awarded a new contract for Project MX-1593, renamed Atlas. Yet again, funding was conservative. Full-scale development was finally implemented in January 1955. The missile's design called for a 1½-stage configuration with three engines (one sustainer and two boosters) ignited prior to liftoff and the two booster engines jettisoned during flight.

The initial Atlas flight test was conducted from the Cape on 11 June 1957. The first complete success came on the third research and development flight. At peak there were a total of 129 Atlas D, E and F missiles operational at complexes arrayed across the United States. With the advent of the Titan II and Minuteman silo launch capability, the Atlas ICBM force was phased out in 1964–65.

Prelaunch of Atlas ABRES missile.

Titan

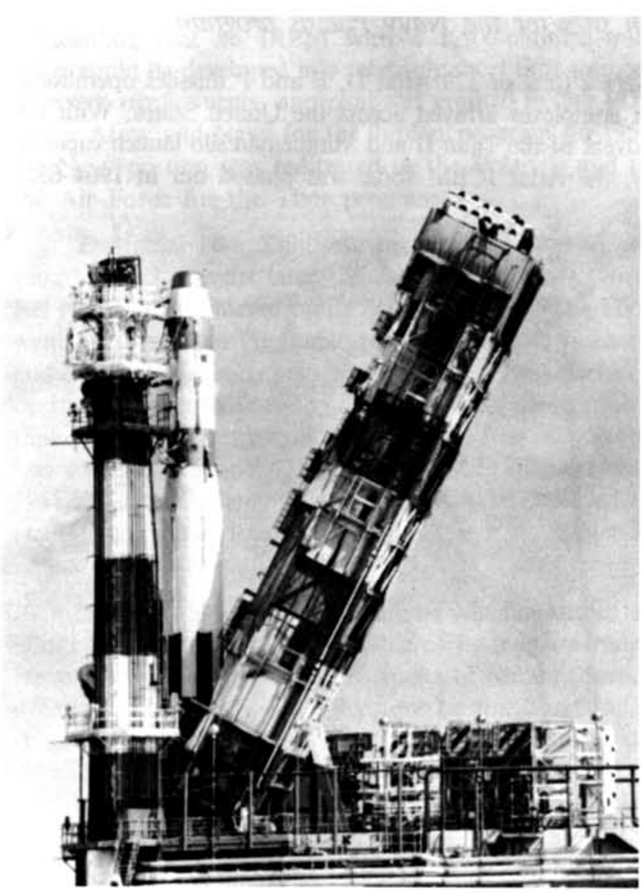
A Strategic Missiles Evaluation Committee recommendation that the United States develop a follow-on ICBM to the Atlas led to the initiation of the development of the two-stage Titan I in 1955. The Air Force was assigned the Titan development program.

The first of 47 Titan I flight tests was successfully conducted on 6 February 1959 from Cape Canaveral. The first of six Titan I squadrons was declared operational by the Strategic Air Command in April 1962. The subsequent development of the Titan II and Minuteman caused the Titan I squadrons to be phased out early in 1965.

Titan II development was initiated in June 1960. Major configuration modifications to the Titan I design included use of storable, hypergolic liquid propellants, an increase in first-stage thrust from 300,000 to 430,000 pounds and second-stage thrust from 80,000 to 100,000 pounds, a switch from radio to inertial guidance, and the utilization of silo launch.

A total of 35 Titan II flight tests was conducted, the first on 16 March 1962.

The Titan II was declared operational in December 1963. Today there are a total of six operational squadrons (two squadrons each dispersed throughout three bases).



Titan II was first launched on 16 March 1962.

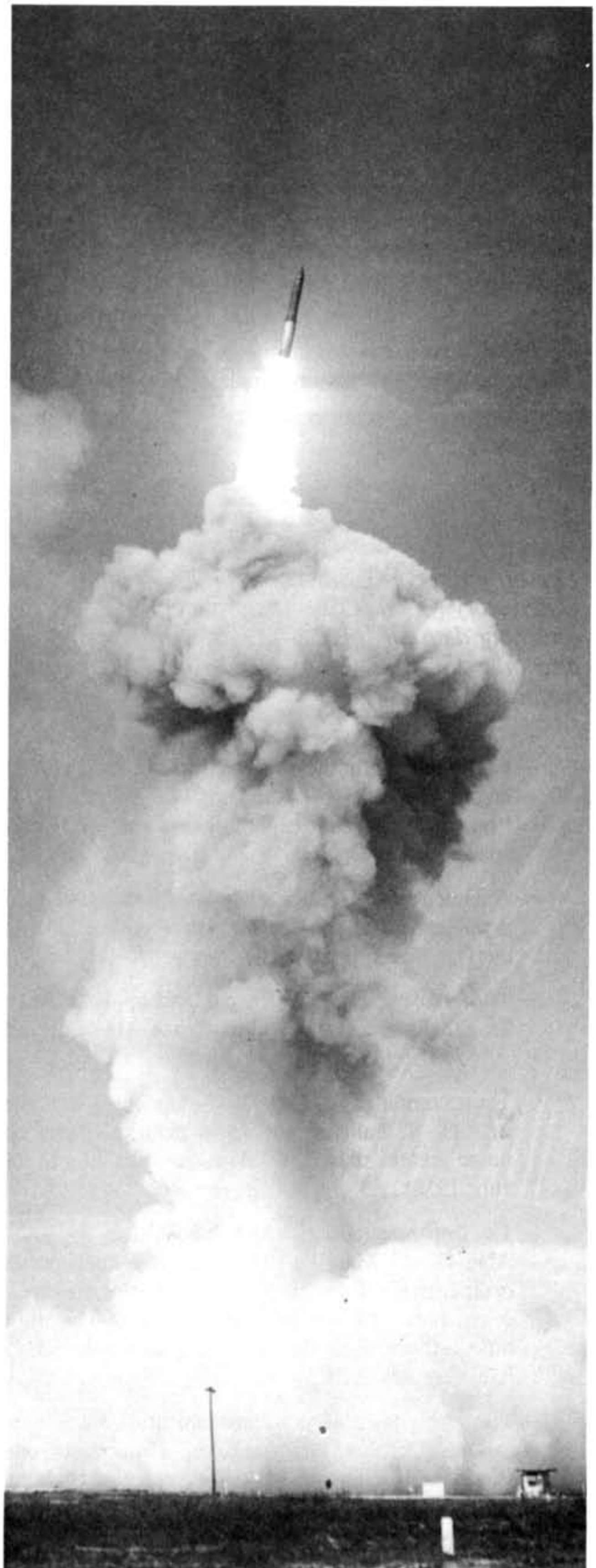
Minuteman

The majority of the weapon systems under development in the early missile programs used liquid propellants. The storage life of liquid propellants is not limitless, however, because highly corrosive substances are involved. From time to time various safeguards have to be taken, such as defueling, rinsing, etc. In short, liquid propellants have a far shorter storage time than solid propellants which can be stored for years. It was therefore advantageous to develop an ICBM using a solid propellant.

Most solid-propellant grains are cast with either a star-shape or circular cavity running the length of the case. The star grain, shown here, provides the greater burning surface, therefore the greater thrust. It can also be given a profile that decreases thrust near the end of burning time.

In early 1958 the Air Force was told to proceed with the research and development of a three-stage, solid-propellant ICBM—the Minuteman. Deriving its name from the Minuteman of the American War of Independence, it was first test fired on the Eastern Test Range on 1 February 1961. Developed in three phases—Minuteman I, II and III—it was declared operational, with the final Minuteman test fired from the Cape in December 1970.

With a range of 6,300 nautical miles, the Minuteman has a reaction time of less than a minute and requires a target selection time of only ten seconds. Launched from underground silos, it has an all-inertial guidance system and its speed exceeds 15,000 mph.



Successful launch of Minuteman III.

Space Exploration

When the early missiles were fired from Cape Canaveral, few people realized that man would orbit the Earth, or that within a few short years man would not only circle the Earth but fly to the Moon, land and return. America's attention was dramatically directed to the importance of space exploration, however, on 4 October 1957, when Russia's Sputnik I lumbered into space.

Amid the excitement and breast-beating that followed in the wake of Sputnik I, little is remembered except that America's first Earth satellite was the world's third artificial satellite. Obviously nothing can be done to change our historical position as the second nation to enter space. We were ready and had the capability, but lacked the necessary funds and "go ahead" to proceed.

America's first orbiting satellite, Explorer I, was launched on 31 January 1958, just three months after Sputnik's space venture. This first satellite, weighing 30 pounds, was orbited by the Army Juno 1. Juno 1 was basically a Jupiter C with the addition of a fourth solid-propellant stage. The first-stage Redstone's tankage had been lengthened to hold more fuel and oxidizer, thus extending the burning time of the engine.

Explorer I, launched just 84 days after project go-ahead, is in a sense both father and child to the American space program. Timewise, it is the progenitor of a succession of space probes. In another sense, Explorer I represents a child—the firstborn, unsophisticated offspring of a robust rocket technology.

Explorer I was only the beginning, however. Since those early confusing days of the U. S. space program, five space launch vehicle "families" evolved—Scout, Thor, Atlas, Titan, and Saturn—capable of efficiently and reliably meeting present and near-future launch requirements.

Scout

The four-stage Scout (later to be increased to five stages) was the first U. S. all-solid-propellant launch vehicle. Used by both NASA and the Air Force, the initial Scout configuration was revised periodically to meet suborbital and satellite launch missions.

Combined, the nominal four-stage Scout is 72 feet long, with a first-stage diameter of 40 inches, tapering to a third-stage diameter of 31 inches. The vehicle weighs 39,600 pounds and generates a total thrust of 185,000 pounds.

In 1959 NASA let a contract to Chance Vought to design and build a small and relatively simple four-stage rocket. This rocket, named the Scout, had to be inexpensive and capable of carrying scientific payloads to great heights, or of putting those payloads into low or medium orbits. The Scout was intended to replace, in missions such as these, the enormous and expensive rockets then in use. A prime requirement was total reliability of operation—the principal reason why all of the Scout's stages were solid-propellant.

Scout development dramatically demonstrated the coordinating role of the various services. The Algol first stage was taken from a Navy Polaris test vehicle; the Castor second stage was derived from the Army Sergeant rocket; and the third and fourth stages (Antares and Altair) were versions of the third stage of the Navy Vanguard.

Work on a DOD vehicle based on the NASA Scout development program was also initiated in 1959 and assigned to the Air Force, with launchings from both the Eastern Test Range and the Satellite and Missile Test Evaluation Center (SAMTEC). Four configurations originally were conceived for use on the ETR, three for suborbital missions (first attempted with a Blue Scout, Jr. on 21 September 1960), and one for orbital missions (initially attempted in April 1962). However, the Blue Scout vehicle finally was used solely for satellite launch missions.

Blue Scout operations at the Cape were a complete Air Force Blue Suit effort. "Blue Suit" means that the vehicle was received by the Air Force at the ETR in a "box," and was assembled, checked out, and the payload attached by an Air Force unit. The Air Force "Blue Suiters" did all the preflight testing, countdown, launch, telemetry data monitoring, data receipt and flight evaluation for the Blue Scout at the ETR.

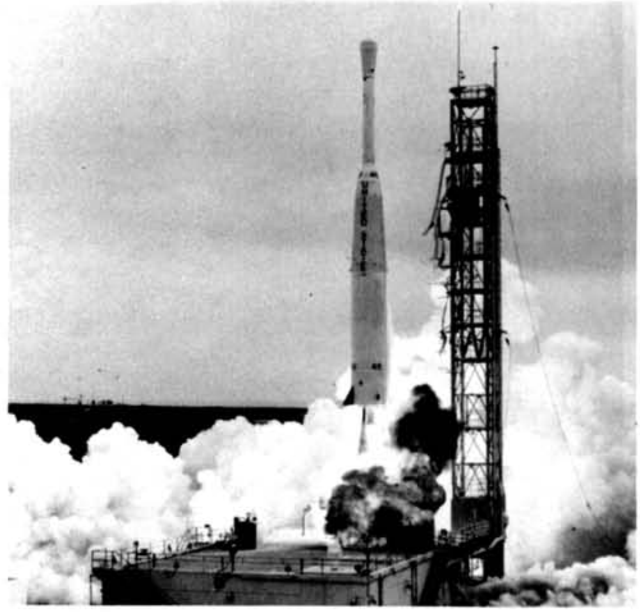
In 1961 the Air Force Blue Suit Unit launched six Blue Scout I and II space boosters from the ETR—one of which carried an experimental Mercury payload. The last Air Force Blue Scout was fired at the Cape in 1965.

NASA's Scout continued to be used at Wallops Island, Virginia, and at the Cape in support of NASA's Explorer program, and in support of international cooperative programs with France (the FR-1), Italy (the San Marco program), and with the European Space Research Organization (ESRO).

Thor/Delta

With the Thor space vehicle, we enter the realm of great accomplishments. Although this missile was developed as an intermediate-range military weapon, its main importance lies in the services it has rendered to science. Used as a ballistic missile as well as a space booster, it has been involved in a number of firsts:

- Thor was the first double-programmed system—production including missile and booster with long-range as well as space capabilities. (This choice was made even before the vehicle was declared operational as a military weapon.)
- A Thor Ablestar (22 June 1960) placed two satellites in orbit simultaneously.
- Thor launched the first passive communications satellite, Echo I (12 August 1960).
- The Thor Delta space system launched the world's first international satellite (Ariel S-51).



Lift-off of Thor-Delta carrying an Orbiting Solar Observatory (OSO). OSOs study sun and solar activity, returning data on solar X-ray and gamma rays and also on solar flare activity (explosions on the sun's surface).

- Combined with the Agena B, Thor boosted an engine capable of restarting in space. This "on/off/on again" capability was another first in space.
- A Thor Agena B successfully launched and orbited a payload, and the capsule was recovered in the air (12 November 1961).
- Thor Able I dispatched a payload approximately 78,000 nautical miles into space (11 October 1958)—the first deep space probe.
- Thor, combined with a second-stage Able, was the first U. S. ballistic missile to achieve a surface range greater than 5,000 nautical miles (9 and 23 July 1958).
- The instrumentation package launched by the Thor Able IV (11 March 1960) achieved a heliocentric orbit between Earth and Venus, transmitting data over a record distance of 22,500,000 statute miles—the longest direct radio transmission man had ever achieved.
- Thor Ablestar placed a communication satellite in orbit (4 October 1960), relaying a message from President Eisenhower to the Secretary of State at the United Nations.

Apart from some minor modifications resulting from experience in flight, the Thor first stage has remained essentially the same as that of the originial missile.

Space booster versions of the Thor include:

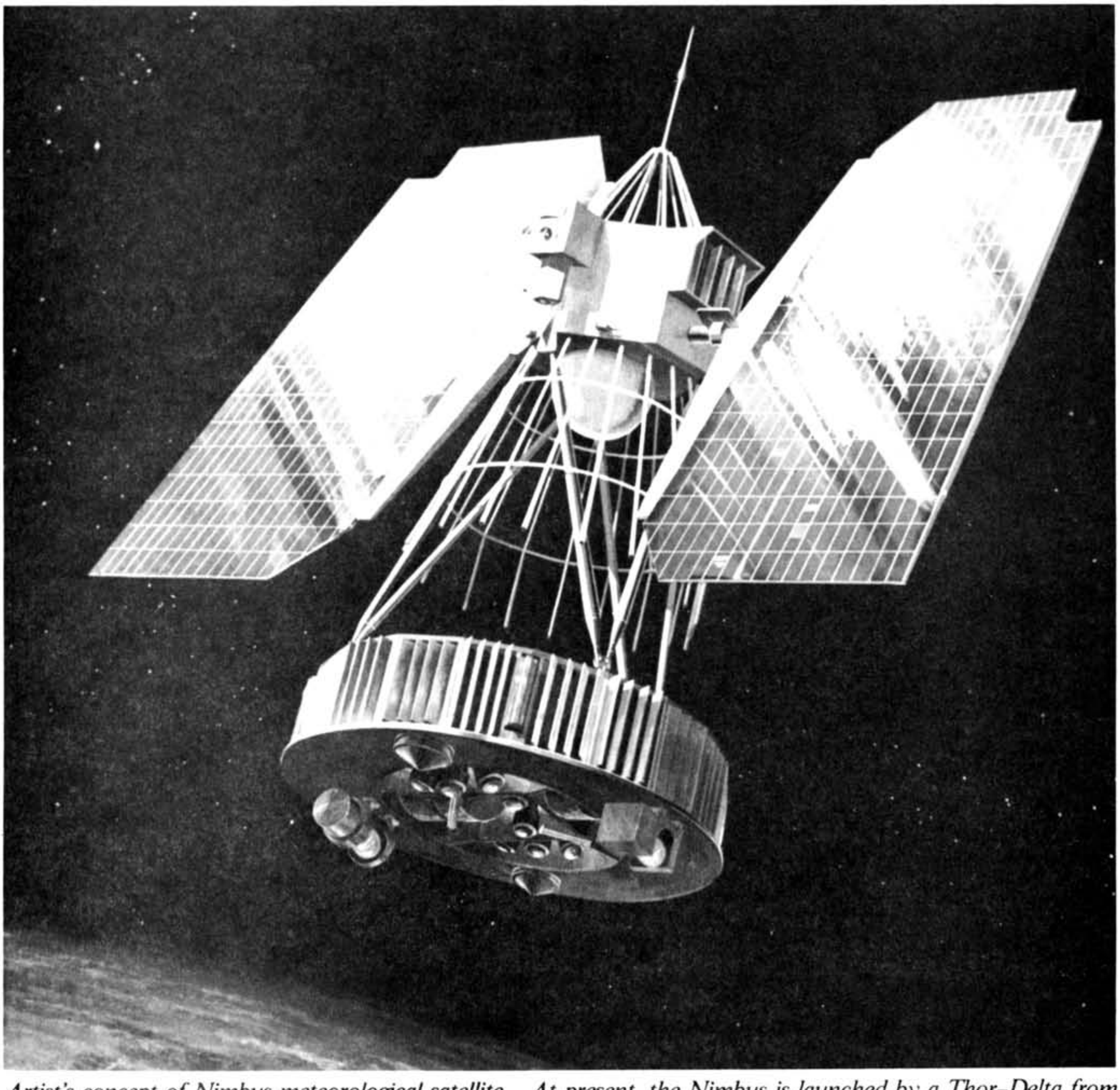
— Thor Ablestar, a two-stage version used by the Navy (the Transit navigational satellite) and by the Air Force (ANNA, a geodetic mapping satellite). It is no longer used.

— Thor Able, a two-stage vehicle used to test experimental nose cone materials intended for the Atlas and Titan, and a three-stage version for lunar satellites and deep space probes. It is no longer used.

— Thor-Agena, a two-stage vehicle used to launch Discoverer satellites for the Air Force.

— Thor-Delta, a three-stage vehicle and its numerous derivatives used by NASA for launching a variety of satellites. It has been continuously improved, first by utilization of more powerful upper stages (Improved Delta), then by the addition of solid-propellant boosters at the base of the missile (Thrust Augmented Delta), and by the lengthening of the tanks of the Thor, making it fully cylindrical (Long Tank Thor).

There have been numerous uprated versions of Delta in a "building block" progression. Later versions of Delta employed nine strap-on solid motors as well as improved-performance upper stages to achieve the greater



Artist's concept of Nimbus meteorological satellite. At present, the Nimbus is launched by a Thor-Delta from the Satellite and Missile Test Evaluation Center (SAMTEC).

capability needed to orbit advanced scientific and meteorological satellites.

By March 1971, 72 Delta spacecraft had been launched from the Eastern Test Range.

This three-stage Delta launched the NATO-B communications satellite on 2 February 1971.

Atlas Space Booster

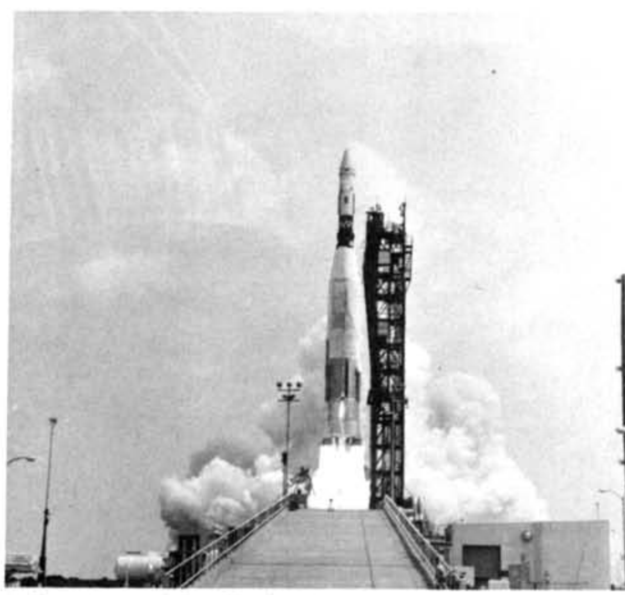
The United States named the first of its huge ICBMs after the giant Atlas, who was condemned by the Greek god Zeus to carry the skies on his shoulders. Atlas set the fashion for satellites of more than 100 tons in weight and thrust.

Just as the Thor rocket acts as first stage for the low-powered American satellite-launchers, so the Atlas plays a comparable role for the medium launch vehicles. Essentially, it is employed as a space booster with upper stages such as Agena or Centaur, but it can be used alone, as it was when it launched the Mercury capsules and the Agena Target Docking Adaptor (ATDA) target used by Gemini astronauts.

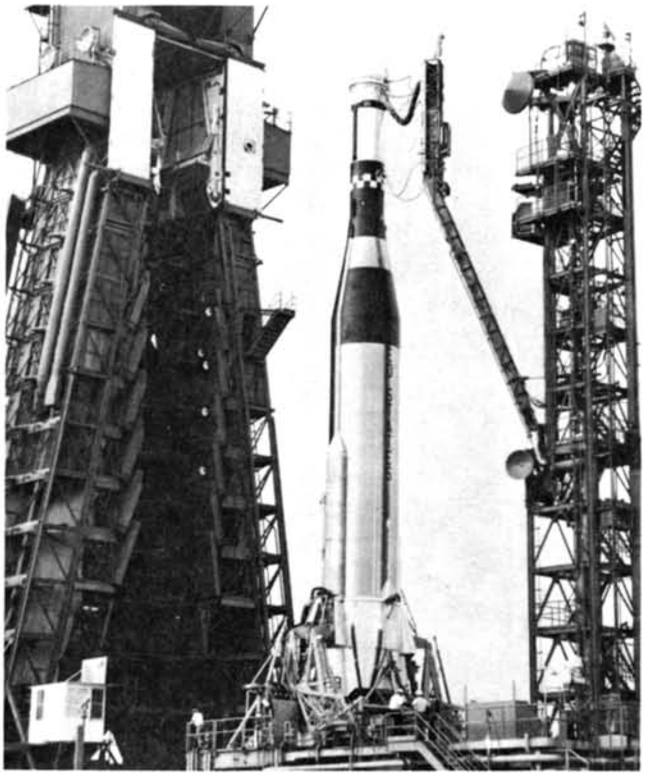
The Atlas demonstrated its versatility as a space launch vehicle early in the U. S. space program. On 18 December 1958, an entire Atlas vehicle was placed in orbit as a space vehicle—Project Score. President Eisenhower's Christmas message to the world was relayed from the orbiting vehicle. Atlas 10D, known as "Big Joe," was used to successfully launch an unmanned Mercury test capsule on 9 September 1959. The two-stage Able configuration developed under the Thor program was coupled with the Atlas for a series of lunar missions in 1959-60. Later, American astronauts were put in orbit by a modified Atlas "D" vehicle. An Atlas "F" launched a monkey through the Van Allen radiation belts which ring the earth.

Atlas-Agena

The Atlas-Agena launch vehicle, a two-stage booster which includes a modified Atlas first stage and an Agena second stage, has been used to launch the Ranger moon-probe spacecraft and the Mariner interplanetary spacecraft used for the Venus, and Mars flyby missions. In addition, the Atlas-Agena has been used as the Gemini target vehicle, and as the space booster for the Orbiting Astronomical Observatory (OAO), Lunar Orbiter, Vela



Atlas-Agena lift-off of a Gemini target vehicle. Target vehicles were an essential part of the rendezvous and docking missions of the manned Gemini program.



Mariner 5 payload atop an Atlas-Agena D at Complex 12. The Mariner made a 2,480-mile flyby of Venus, then continued in solar orbit.

Hotel and other space programs. It is still in use today for classified Air Force programs.

Agena A, originally intended for use with the Atlas but first employed with the Thor, was mated with the Atlas and initially used to launch Midas 1 in February 1960. After four launches the Atlas-Agena A configuration was retied in favor of the Atlas-Agena B in July 1961. In addition to USAF's Midas and Samos programs and classified payloads, the Atlas-Agena B also has been used by NASA to launch Mariner, Orbiting Geophysical Observatory (OGO), and Ranger spacecraft.

The original Atlas-Agena D configuration, weighing 280,000 pounds and standing 104 feet high with payload, was introduced in July 1963, and was employed for classified DOD missions and to launch dual Vela satellites. NASA spacecraft launched by the Atlas-Agena D include Appliation Technology Satellite (ATS), Gemini target vehicles, Lunar Orbiter, Mariner, OAO, and Ranger.

In 1967 the basic Atlas was lengthened 117 inches for use with the Agena, increasing booster and sustainer engine thrust to a total of 394,000 pounds. This elongated Atlas (SLV-3A)-Agena D combination was able to orbit 7,950 pounds, and to launch 1,450 pounds on a lunar mission and 980 pounds on a planetary mission.

The present Atlas-Agena was uprated to a combined thrust of 410,000 pounds and was 119 feet tall.

Atlas-Centaur

The Atlas-Centaur is the most sophisticated of the U. S. space vehicles developed from the original military weapon missiles. The secret of its performance is in its second stage, the new liquid hydrogen-fueled Centaur. Combined with the Atlas, the Centaur is capable of carrying heavier payloads than the Atlas-Agena combination.

Development of the Centaur second stage was initiated in 1958. It was the first of a new generation of space vehicles to pioneer the use of liquid hydrogen for space flight, and was to have a bearing on other NASA projects, such as upper stages of the Saturn. It was also the first U. S. space vehicle with a digital computer as part of its guidance system.

Numerous difficulties were encountered in the development of the Atlas-Centaur program, primarily because of the propellant. Liquid hydrogen is superior to previous or conventional rocket propellants because of its high energy yield compared to its weight. It provides approximately 40 percent more energy per pound of propellant than conventional kerosene-type rocket fuels. Liquid hydrogen is colorless, odorless, and lightweight—only one-fourteenth as heavy as water. To remain in a liquid state, hydrogen must be maintained at minus 423 degrees F. If "warmed" above that temperature, it vaporizes to gas. Before hydrogen could become practical as a fuel, an entire new technology had to be established.

Lift-off of Atlas-Centaur with Surveyor spacecraft, Complex 36B. The Surveyor landed on the moon and returned 19,000 photos plus soil analysis data in support of the Apollo Moon-landing program.

The original Atlas-Centaur weighed 300,000 pounds when launched and was 10 feet in diameter and 107 feet tall. A new elongated Atlas version (SLV-3C), lengthened 51 inches for use with the Centaur, was used beginning in 1967. This new configuration featured a total thrust of 394,000 pounds, capable of orbiting 11,500 pounds, and carried 2,900 pounds on a lunar mission and 2,200 pounds on a planetary mission. The Atlas-Centaur configuration featured a total thrust of 410,000 pounds and varied in height from 117 feet to 132 feet, depending on space mission and payload.

The first Atlas-Centaur orbital flight test was attempted late in 1963. Centaur was declared operational on 11 August 1965. Its first operational mission successfully launched Surveyor 1 in May 1966. The Centaur's restart capability was operationally employed for the first time to launch Surveyor 3 from a parking orbit into a lunar trajectory.

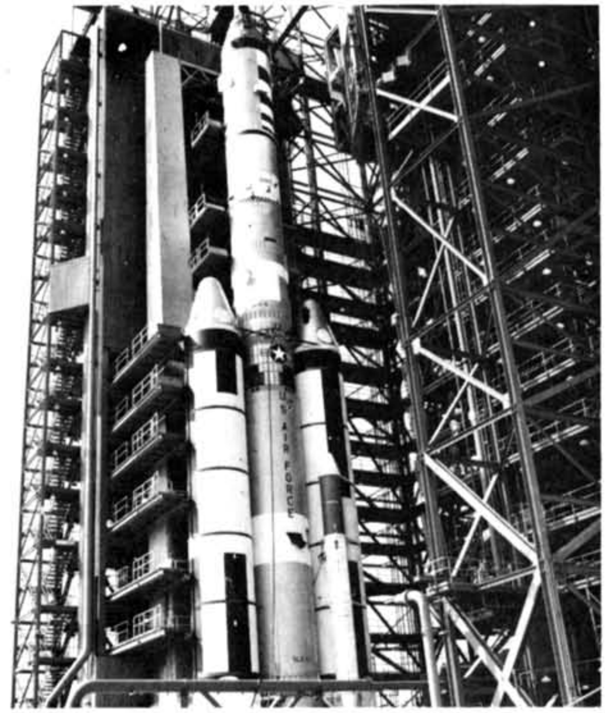
Atlas-Centaur has also been used as the space booster for OAO, ATS, Mariner and Intelsat programs.

Titan IIIA on mobile launch platform with Solid Motor Assembly Building (SMAB) in background. The launch platform is powered along the dual-track rail system by two parallel-controlled 110-ton diesel locomotives.

Titan III Space Booster

The Titan "family's" role in space exploration includes Titan III's space exploration (covered here) and Titan II's contribution to the manned spacecraft program (covered later).

Titan III was the second DOD launch vehicle to be developed from the outset as a space launch system. (The ill-fated Vanguard was the first.) Late in 1962 development of the Titan III was begun. Seventeen Titan III research and development flights were originally scheduled with two basic configurations developed for launch from Cape Canaveral—Titan IIIA and Titan IIIC.



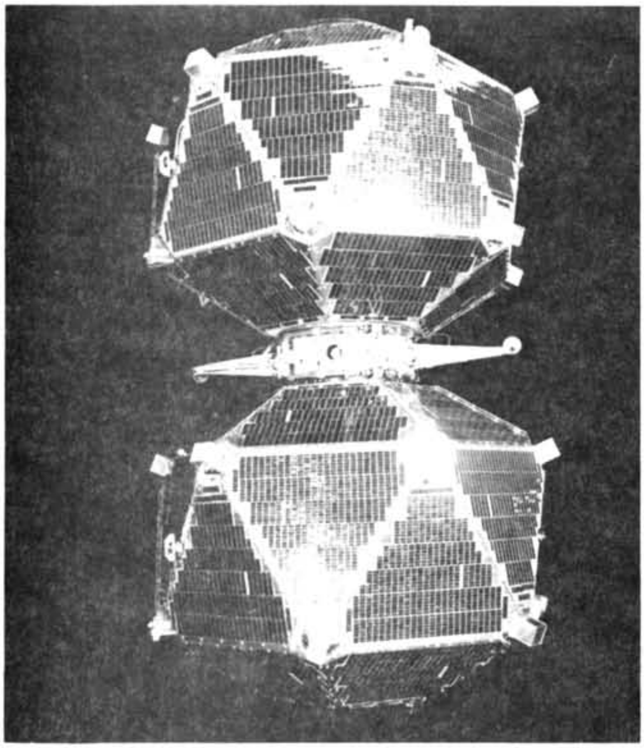
Titan IIIC at Complex 40. This 127-foot-tall vehicle was originally intended for use as the space booster for the Manned Orbiting Laboratory (MOL) program, which was later cancelled.

Titan IIIA (SLV-5A) was the first vehicle in the Titan III series to be developed, and is a modified Titan II with a Transtage third stage added. The Titan IIIA stands 124 feet tall and can orbit 6,200 pounds.

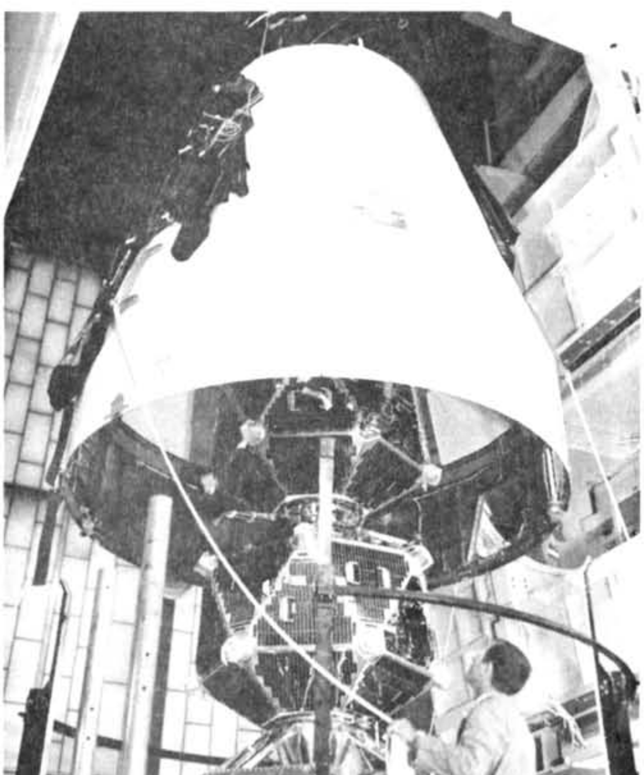
Titan IIIA was initially flight tested from Cape Canaveral on 1 September 1964; its dummy payload failed to reach orbit, but most flight objectives were met. Three more Titan IIIA missions were then successfully conducted in the next eight months, with the Transtage fired three times on one flight and four times on another and three Lincoln Laboratory payloads orbited. A scheduled fifth Titan IIIA flight was cancelled as all research and development objectives had been met and the program was ready to progress to Titan IIIC.

The Titan IIIC (SLV-5C) consists of the Titan IIIA plus a strap-on solid propellant booster (Stage 0). This "zero" stage utilizes two 120-inch, five-segement motors with a total thrust of 2,400,000 pounds. First-stage thrust is increased to 474,000 pounds. The vehicle is 127 feet tall, weighs 1.4 million pounds, and can orbit 25,100 pounds.

The initial Titan IIIC flight test was conducted on 18 June 1965 and a 21,000-pound inert payload was



Velas, launched by Titan IIIC, are Earth-oriented nuclear test detection satellites.



Fairing installation of Titan IIIC satellite. On 9 February 1969, Titan IIIC placed in orbit the largest comsat to that time—a 1,600-pound Tacsatcom. This two-story-tall satellite orbited 22,300 miles above the Pacific.

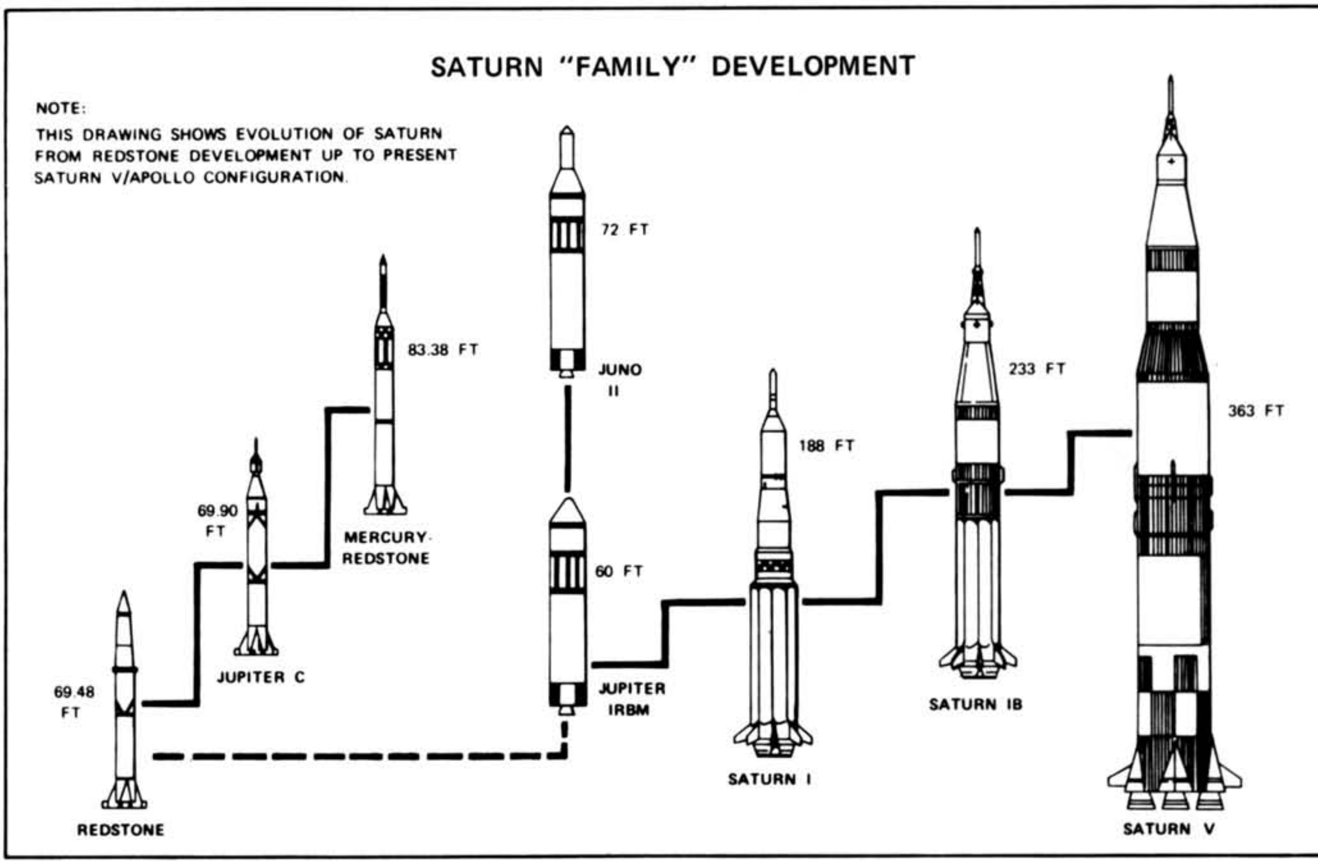
successfully orbited. All subsequent launches—a total of fifteen through mid-1971—carried functional payloads including multiple IDCSP communication satellites, advanced Vela nuclear detection satellites and ERS, GGTS, LCS, LES, DODGE, Oscar and OV satellites plus an unmanned Gemini B capsule ejected in a reentry test.

Saturn

Approximately nine years and ten months after the launch of the Explorer, Saturn V rumbled off the pad, carrying into orbit the weight of almost 10,000 of the 30-pound Explorer Is. Saturn V towers nearly 300 feet higher than the Jupiter C and produces 7.5 million pounds of thrust, nearly 90 times that of the Jupiter C. Yet these two vehicles are closely related. Saturn V was developed under the supervision of the same team—although greatly expanded—that built the Jupiter C which placed the first satellite into orbit. The technology used to develop the Explorer I is basically the same as that used on the Saturn V, only more sophisticated and highly developed.

The Saturn program grew out of studies initiated at the Army's Redstone Arsenal for a powerful rocket using existing components wherever possible. These conditions led to a "cluster rocket." By adapting the propellant tanks of Redstone and Jupiter missiles and using H-1 motors developed from those used on Jupiter and Thor, a final-stage booster developing a thrust of 680 tons was envisaged. Initially termed the Juno 5 Project, it was

Pioneer and Explorer satellites, launched by the Juno II shown here, have been used for a series of solar atmospheric and solar physics probes.



renamed Saturn early in 1959. In November 1959 technical direction of the Saturn program was transferred to NASA.

A detailed description of the development process leading to the Saturn "family" of vehicles is best expressed by the above drawing.

Manned Space Missions

The manned space program has progressed in three phases—Projects Mercury, Gemini and Apollo—all occurring at the Cape.

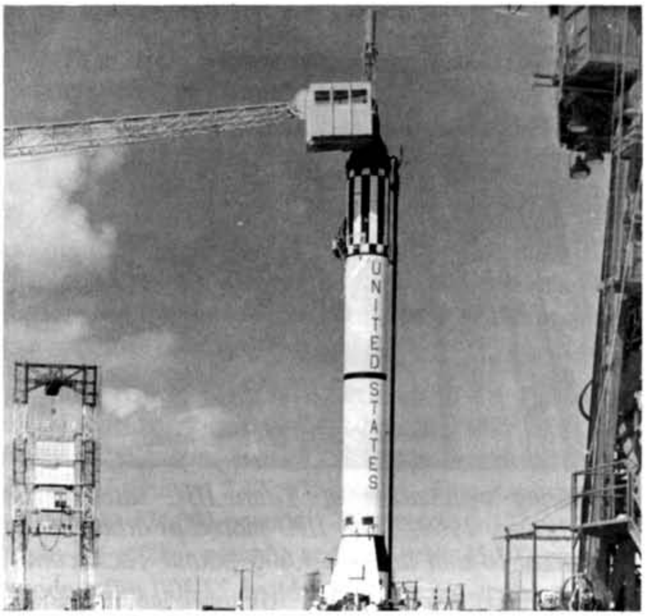
Mercury

Project Mercury—named after the Olympian messenger Mercury, son of the Greek god Zeus and grandson of Atlas—was to become the focal point for the Free World's first manned journey into space—the first step on a ladder leading to the Moon, perhaps beyond.

Project Mercury was designed to demonstrate that man could withstand the high accelerations of a rocket launching, a prolonged period of weightlessness, and then a period of high deceleration during reentry.

Staged in two acts, the Mercury Project was to include two ballistic, parabolic one-man flights into space (suborbital), followed by four orbital manned missions. Two space boosters were to be combined with the Mercury capsule: the first, a modified Redstone, was to be used for the suborbital portion; the second, the Atlas-Mercury combination, was to be used for the orbital missions.

The suborbital phase began when Ham, a chimpanzee, was launched on 31 January 1961, several months prior to the first manned suborbital flight.

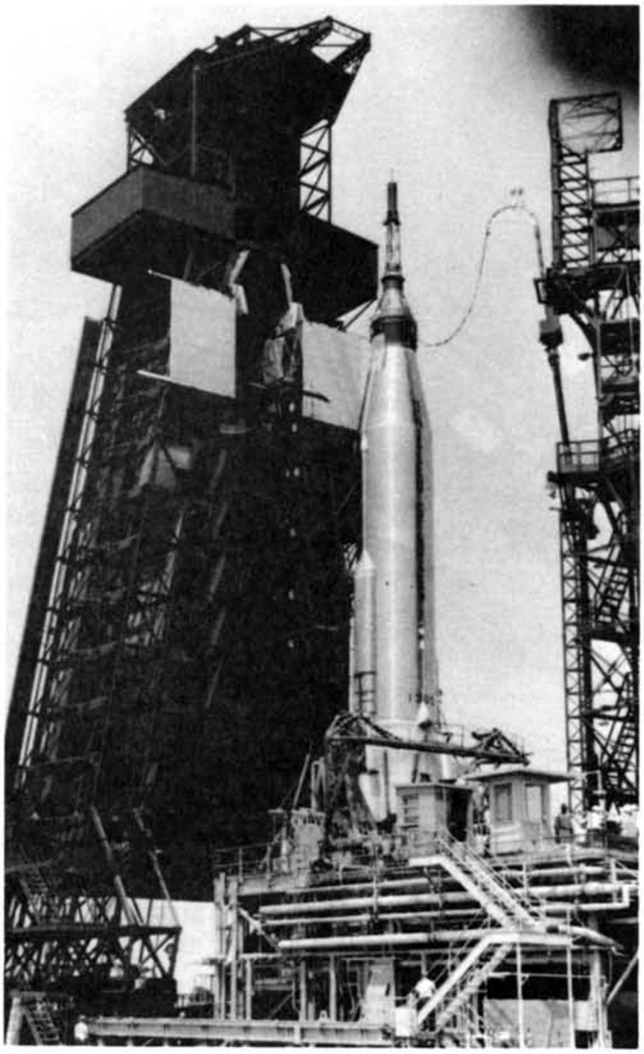


Mercury-Redstone.

Primates were used to test the safety of the Mercury capsule/Redstone launch vehicle configuration prior to its use in the manned flights.

Modified Redstone missiles were used to send Astronauts Alan Shepard (first U. S. man in space) and Virgil Grissom on separate suborbital space flights on 5 May 1961 and 21 July 1961, respectively. Because of the success of these flights, a scheduled third manned suborbital mission was cancelled as unnecessary. The two manned missions concluded the Mercury-Redstone phase of Project Mercury.

After five unmanned suborbital and orbital flights in 1960-61, including the Mercury-Atlas 5 flight of the chimpanzee Enos, the Mercury-Atlas manned orbital space flight effort was successfully initiated with John Glenn's Mercury-Atlas 6 three-orbit mission on 20 February 1962. After four manned Mercury-Atlas orbital missions, the program was successfully concluded 15 months later with Mercury-Atlas 9, Gordon Cooper's 22-orbit flight.



Mercury-Atlas.

Project Mercury lasted 55 months, from authorization through Astronaut Cooper's one-day mission. Largely because of Project Mercury, which fostered Project Apollo and fathered Project Gemini, mankind seemed ready for the next step in manned space exploration.

Gemini

Late in 1961, NASA initiated the follow-on to the Mercury program—Project Gemini—the second step toward Apollo. Project Gemini was publicly announced on 3 January 1962. It had been determined that if Project Apollo was to employ a concept called lunar orbital rendezvous (LOR), to land men on the Moon and recover them, then space rendezvous and docking, of necessity, had to be perfected. Mercury had served far more than its original purpose, but it could hardly meet the maneuverability requirement of space rendezvous and docking. Gemini was thus designed to serve this function.

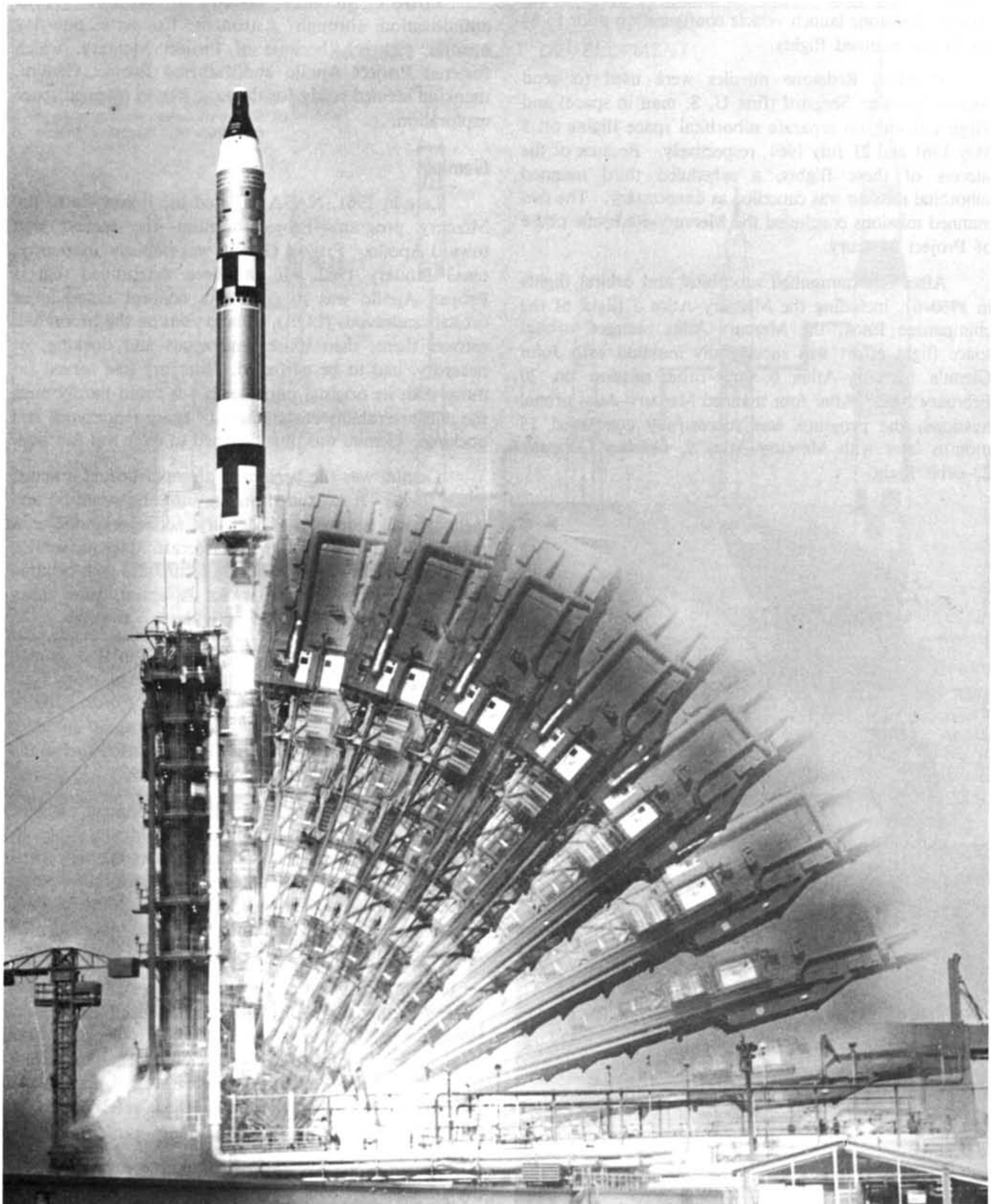
Gemini was the beginning of sophisticated manned space flight. It expanded and refined the scientific and technological endeavors of Mercury, adding a second crew member and a maneuverable spacecraft. New objectives included rendezvous and docking techniques with orbiting spacecraft, extravehicular walks in space, plus other scientific and extravehicular activities.

A decision was made to use the Titan II to launch the two-man spacecraft, with the task of man-rating (safe for man) the vehicle assigned to the Air Force. Major Titan II configuration changes included a radio guidance system, redundant electrical and flight control systems, and a malfunction detection system.

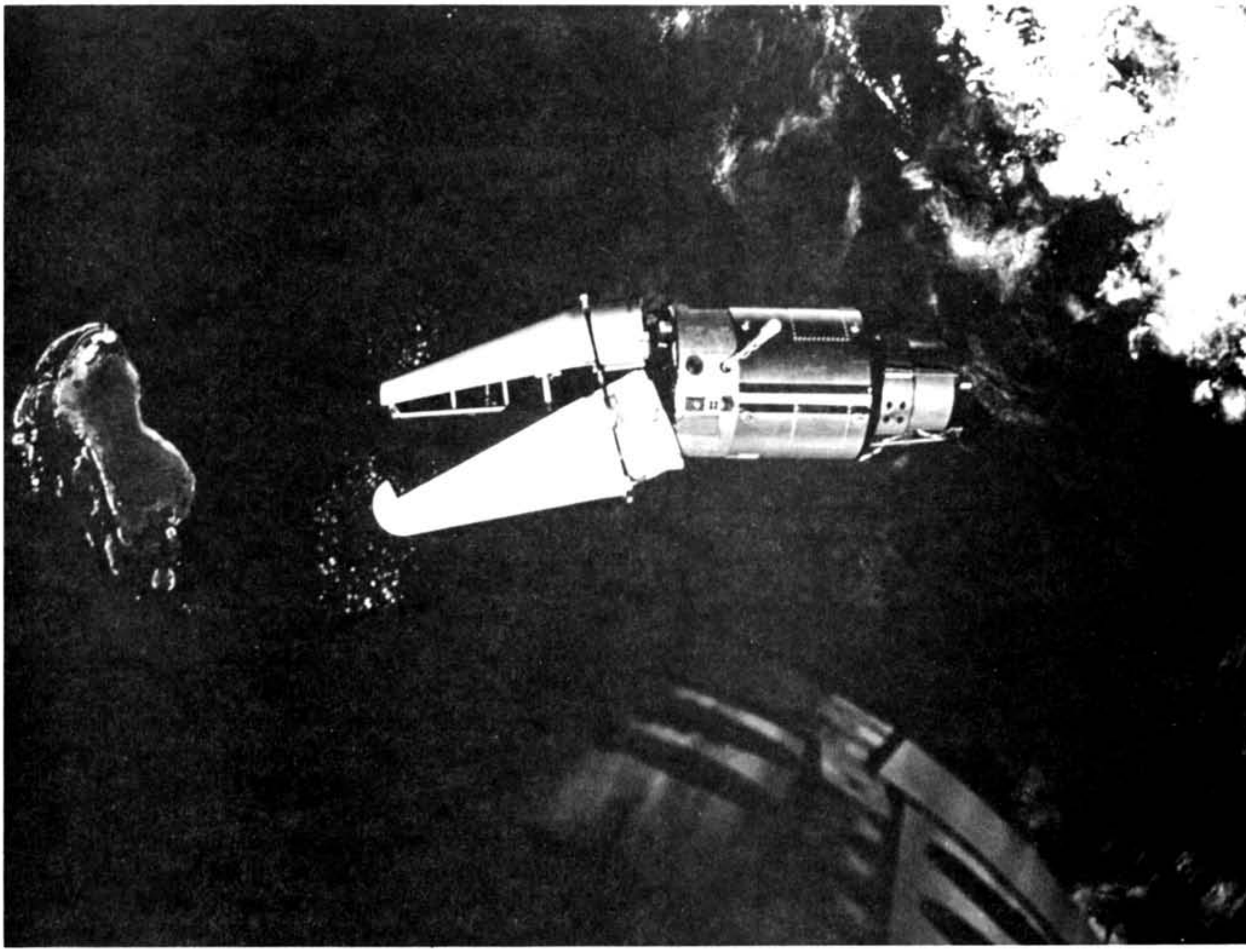
The Gemini spacecraft, with development assigned to NASA, looked much like the familiar Mercury capsule, except for its doubled size and its countersunk viewports. It was a far more sophisticated vehicle than the Mercury spacecraft, however, with modular components easily accessible, a real, if limited, orbital maneuvering capability, and ejection seats instead of an escape pylon.

Titan II debuted as a space launch vehicle on 8 April 1964, with the launch of the unmanned Gemini 1. Gemini manned flights began in March 1965 with Gemini 3, and concluded 20 months later with Gemini 12. In all, ten 2-man launches occurred, successfully placing 20 astronauts in orbit and returning them safely to Earth.

With the successful conclusion of the Gemini objectives, our nation seemed committed to send men to the Moon—just 350 years after Galileo first turned a telescope toward Earth's natural satellite.



Special-effect photo of Gemini-Titan 10.



GT-9 and GT-10 over Venezuela.

Apollo

Why the Moon? Mariner II, in its magnificient survey of Venus in December 1962, interpreted Venus to be one destination in planetary space that might as well be forgotten as a target for manned landings. Mars remained a mystery, but so also was the Earth's Moon.

Space scientists were already committed for the Moon, however, when on 25 May 1961, President Kennedy said in a special message to Congress:

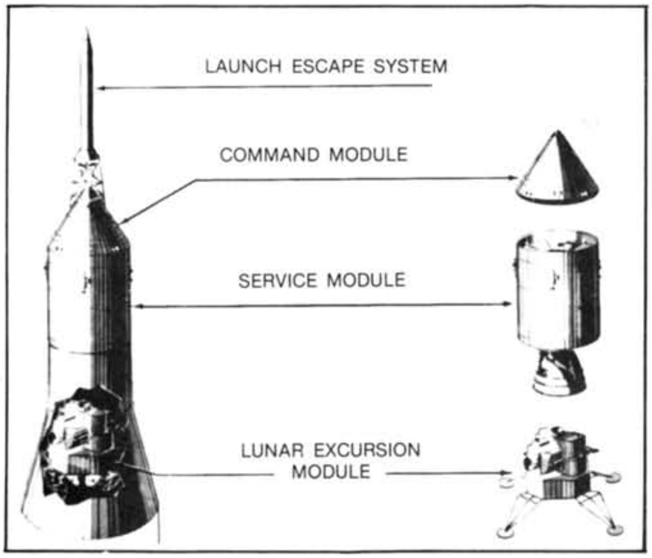
> "I believe this nation should commit itself to achieving the goal before this decade is out, of landing a man on the Moon and returning him safely to the Earth. No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish."

On 9 January 1962, the public got its first view of drawings of Apollo when NASA announced that the Saturn C-5 would be the Moon Program rocket. The Saturn was described as being as tall as a 27-story building and generating 7.5 million pounds of thrust in its first stage, which would make it 20 times more powerful than the Atlas. The Saturn was to have the capacity to send 45 tons of spacecraft toward the Moon and to place 120 tons in low-Earth orbit.

Briefly, the objective of the Apollo Moon-landing program was to send a three-man spacecraft to the Moon and into orbit around it, land two astronauts on the Moon while the third continued in orbit, return the two Moon explorers to the orbiting spacecraft, and return all three safely to Earth.

To accomplish these objectives the Apollo missions were divided into two categories: Earth orbital and lunar. The flight testing proceeded in the following manner: orbital—unmanned and manned flights; lunar—manned lunar orbital and lunar landing flights. This sequence was necessary to test spacecraft launch vehicles, equipment and procedures, and crew operations to ensure the safe landing and return of the astronauts.

Many significant events have occurred during the Apollo flight testing. Some of the highlights follow.



Artist's concept of Saturn V/Apollo launch escape system.

Apollo 15 lift-off (26 July 1971), carrying Astronauts David R. Scott, Alfred M. Worden and James R. Irwin to the Moon.

The first flight test of the Saturn V occurred with the launch of Apollo 4 (9 November 1967), which successfully demonstrated the spaceworthiness both of the Saturn V booster and the CSM. Apollos 4, 5 and 6 were part of the Earth-orbital phase of the program.

The first manned Apollo flight (Apollo 7) occurred on 26 September 1968, when three astronauts were put in Earth-orbit by a Saturn IB. Apollo 8 (21 December 1968) accomplished several firsts: astronauts were launched for the first time by the Saturn V, and the first lunar orbits occurred.

Apollo 11 signaled the success of man's first lunar landing. Launched in July 1969, Apollo 11's crew returned to Earth just 98 months after the establishment of a manned lunar landing as a national goal.

Whither or Whether— The Future

Where does it all end? Predictions for the future become so nebulous as to be of little value.

Today, America's space program is entering a transition period. Until the launch of the Saturn V the means to enter space had been given the most attention. Now that we have the necessary operational space hardware, attention is turning toward exploration and investigation in depth, and the exploitation of new scientific knowledge in practical application.

Our present investigation and plans indicate a growing interest in the possibilities of higher frequencies for communication satellites. Progress in laser technology provides excellent potential in communication applications. Nuclear rockets provide significant increase in space propulsion versatility, a necessity in future space programs involving heavier payloads. We are also in the midst of a computer revolution which will undoubtedly give us a new order of data processing equipment—smaller, lighter, and cheaper—with infinite potential for influencing satellite design and function. New sources of power in space—enabling us to break away from the solar cell—can make future satellite development a whole new game.

Future space exploration - whither or whether? This seems to be the question confronting us today. Should we continue to succeed in the complete range of possibilities in the multifaceted space program—in all the exciting programs in Earth orbit, such as communications, meteorology, and Earth resources, and in extended lunar and planetary exploration? Yet how can we justify spending billions exploring the Moon and the planets of our solar system when there are so many pressing social problems here on Earth—unemployment, social inequality, and pollution, to name a few.

Hundreds of years from now, historians will look back on all this as one small episode in the history of man. Yet space exploration has not been merely one episode, rather it has been many episodes, many people, many days of inspiration, frustration and elation, resulting from the dreams, vision, foresight and personal contributions of many from all walks of life, representing many nationalities. Space discoveries are indeed the result of the concerted efforts of Twentieth-Century Man.

PART II
Points of Interest

Air Force Space Museum

The Air Force Space Museum is located at Complex 26, Cape Canaveral. Its mission is to preserve for the public the hardware and spirit of United States' rocketry by maintaining and displaying the finest collection of old and modern missiles, rockets and related space equipment.

The museum was first opened at historic Launch Complex 26, Cape Canaveral. The museum grounds now include Complexes 5/6 where the first two U. S. manned suborbital space flights by Astronauts Shepard and Grissom originated, and Pads 26A and 26B. The first U. S. satellite, Explorer I, was launched from Pad 26B.

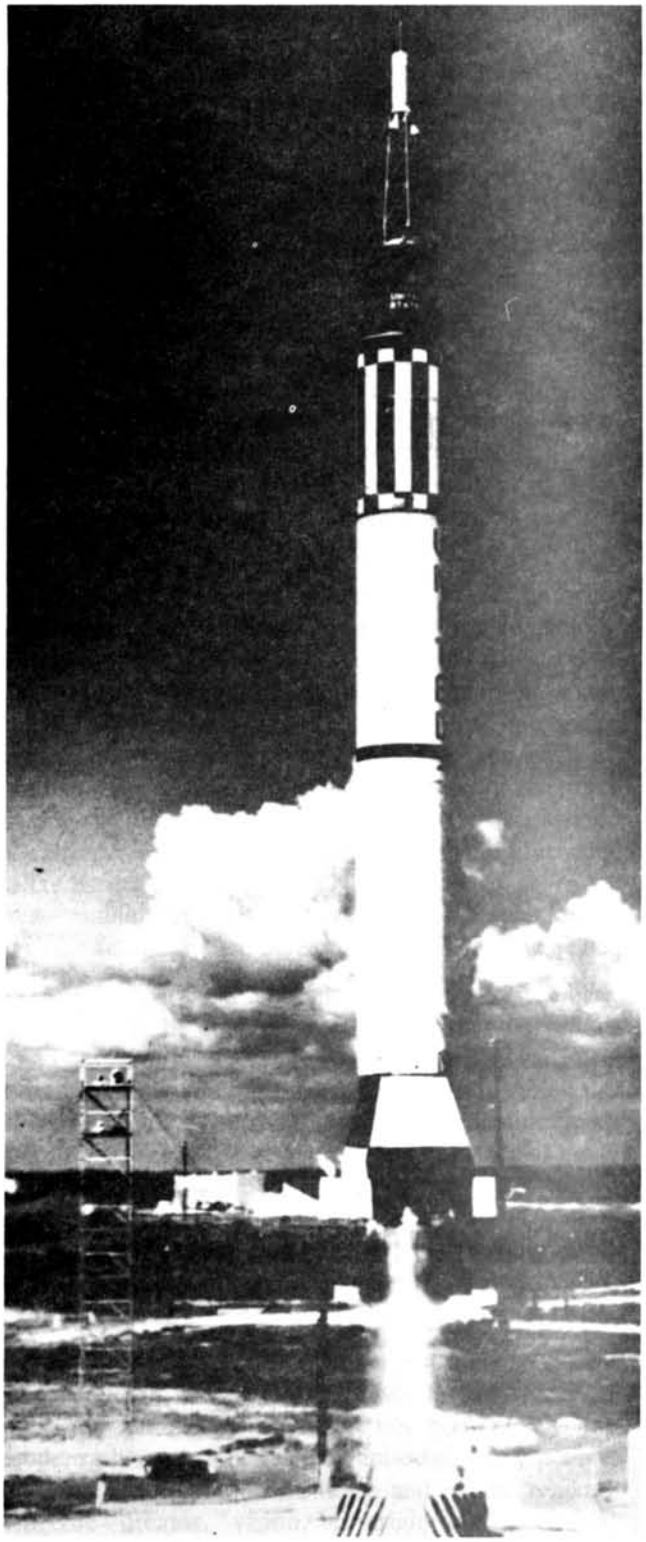
The museum complex was the site of many other important launches including several satellites, the primates Ham, Gordo, Able and Baker, and other Redstone, Juno and Jupiter flights. Jupiter-C was first launched from this site on 20 September 1956, a flight reaching an altitude of 680 miles and a distance of 3,300 miles downrange. Jupiter Cs were also used for testing nose cones and ablative materials from IRBMs and ICBMs; and until 1963 they were used as part of the training program for Italian and Turkish missile crews.

More than 70 missiles and rockets are now on display. Visitors may examine such famous missiles as the Thor, Atlas and Titan, and rarities such as the German V-1 and USAF Navaho. Additions to the missile collection are continuously being made along with other space age items of equipment such as radars and telemetry antennas.

The blockhouse contains indoor exhibits as well as an ICBM guidance computer and the original types of consoles and electronic equipment in use when the complex was the site of many historic launches.

Panoramic view of Air Force Space Museum.

The Space Museum has been built at little expense to taxpayers. The majority of these artifacts were either obsolete or used as training systems and then donated by the Armed Services, NASA and Missile Contractors.



Launch of America's first man in space aboard Mercury-Redstone on 5 May 1961.

Complex 17—Thor/Delta

Development testing of the Thor weapon system was accomplished in the areas occupied by the two "wide appearing" towers—Complex 17 (Pads A and B).

Thor was America's first operational intermediate-range ballistic missile (IRBM) with a nominal range of 1,500 nautical miles. On its first launch attempt (25 January 1957), the liquid oxygen start tank ruptured and the IRBM exploded. Other failures occurred. It was soon discovered that part of the exhaust gases from the engine were flowing back into the engine compartment and melting electrical cabling and plumbing lines routed there. The problem was solved by placing a heat shield just above the engines to deflect the gas away from the base of the missile. This shield was built into the Atlas weapon system to prevent this type of failure in that program as well. On its fifth launch attempt, the Thor scored a completely successful flight.

Despite a slow start the Thor, powered by a single Rocketdyne engine with 135,000 pounds of thrust (later increased to 150,000 pounds), went on to achieve a creditable record during 48 research and development launches on the ETR. Four complete Thor IRBM squadrons stood guard in England for several years until the Atlas and Titan ICBMs were deployed to assume defense of the United States. Thor is no longer used as a weapon system.

In addition to its interim military role as an operational IRBM, the Thor has had a longer and more illustrious role as a space booster. More U. S. satellites and spacecraft have been launched by Thor boosters than by any other rocket, thus earning it the title of "work-horse booster" for space projects.

The two- and three-stage Delta boosters were "born" in 1960 when an Air Force Thor missile was joined with a pair of upper-stage rockets to launch the famed Echo I balloon, the world's first communications satellite. These early models could hurl up to 610 pounds into a 200-nautical-mile circular orbit.

During a 10-year period, the Delta launched 70 space missions from the ETR, successfully placing into Earth orbit the majority of the U. S. research, weather and communication satellites, including the historic Early Bird. The Thor was also used as the first stage of the world's first international satellite, Ariel (S-51), launched on 26 April 1962, and the first communications satellite, TELSTAR. Other satellites included in this record are the Orbiting Solar Observatory, Echo, Explorer, Tiros, Relay, Syncom, Geos, Transit and ANNA.

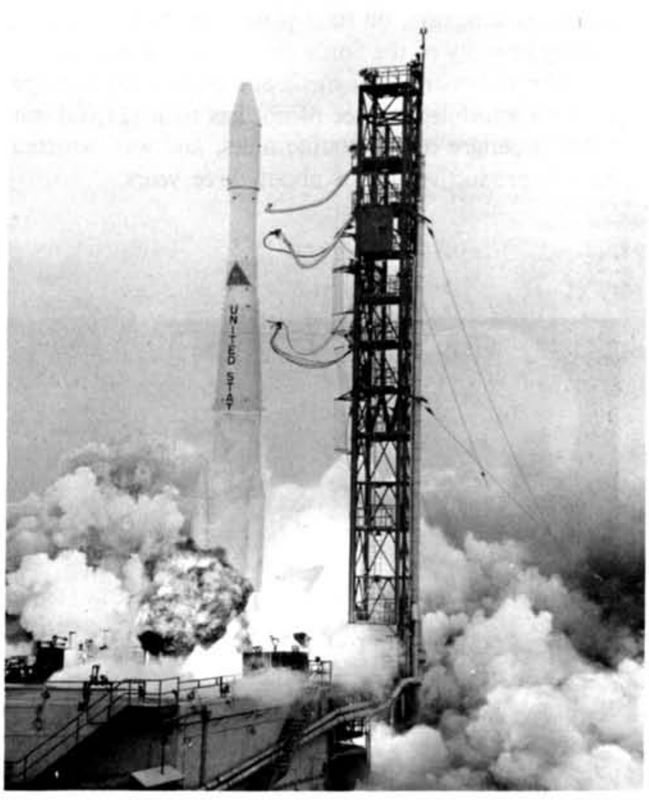
Most noteworthy of the payload boosted by Thor/Delta were Intelsat, Pioneer and IMP.

International Telecommunications Satellite Consortium (Intelsat)

A Long Tank Thrust-Augmented (LTTA) Delta (a modified Thor liquid-fueled first-stage main engine, augmented by three strap-on solid-propellant Castor II rockets) is used as the booster for the Intelsat Program.

Intelsat is a partnership of some 73 nations formed to establish a global commercial communications satellite system. Comsat Corporation, the U. S. participant in

Echo, a 135-foot aluminum-coated plastic balloon, was the nation's first passive satellite to be placed in orbit.



Launch of Delta which placed Pioneer VIII in orbit around the sun.

Intelsat, acts as manager on behalf of the consortium. The space segment of the system is owned by Intelsat, while the ground stations are owned by public or private organizations in the countries where they are constructed. NASA launches the satellite and is reimbursed for costs.

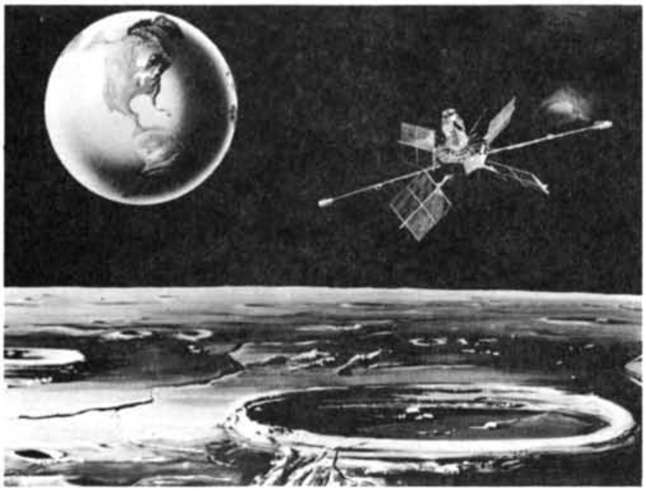
Pioneer Program

Begun by the Air Force in 1958 and transferred to NASA that year, Pioneers have been solar explorers, studying the solar atmosphere and returning data on solar experiments. The LTTA Delta (same configuration as for Intelsat) is used.

Interplanetary Monitoring Platform (IMP)

On 13 March 1971 the first "Super Six" long-tank Delta was launched carrying an Interplanetary Monitoring Platform (IMP). The "Super Six" Delta, with six solid strap-on Castor motors attached to the first stage, was the newest and most powerful version of Delta in its continuing "building block" growth progression. The three-stage, 106-foot-high "Super Six" generated approximately 325,000 pounds of thrust at lift-off, was able to send a 2,300-pound payload into a 350-mile Earth orbit, 420 pounds to the Moon, or 320 pounds to Mars or Venus.

The IMP I satellite, the seventh in this Earth-orbiting series of scientific spacecraft, provided data on solar and galactic cosmic rays, on solar plasma or "solar winds" (the varying intensity of the Sun's energy) as well as information on radio noises from magnetic and electric fields in space. It had a scheduled apogee of not less than 121,000 statute miles, a perigee of 145 statute miles, and was expected to have a productive life of about three years.



Artist's concept of composite IMP spacecraft.

Launch of "Super Six" long-tank Delta on 13 March 1971.

Complex 18—Vanguard/Blue Scout

The northernmost of the three Thor complexes, Complex 18, supported space programs—Vanguard initially, followed by Blue Scout.

Vanguard

One of America's initial satellite programs was the Vanguard which was, as its name implies, a pioneering effort. It was the one nonmilitary launch vehicle of the early space program.

The Vanguard was more or less a descendent of the Viking rocket. (The Viking was a long, slim, high-altitude sounding rocket launched from the White Sands Proving Ground in the early 1950s.) The three-stage, pencil-shaped Vanguard vehicle (utilizing the Viking as the first stage) was 72 feet long and only 45 inches in diameter at its widest point. (Contrast this with the 10-foot diameter of the Titan II.) It was designed by the Navy to orbit the nation's first satellite—also known as the Vanguard.

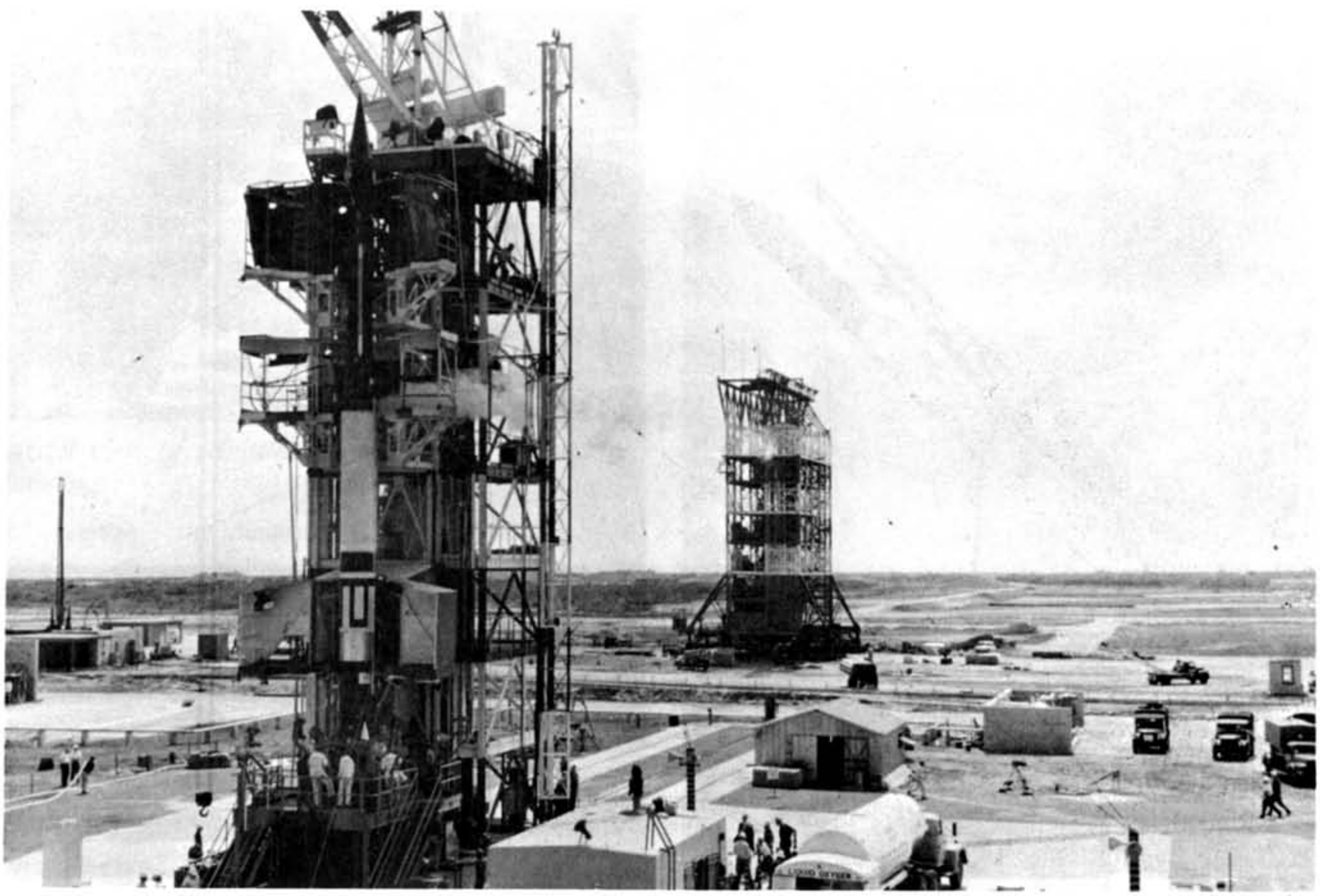
On 29 July 1955, President Eisenhower announced plans to launch a series of "small, unmanned, Earth-circling satellites" as part of our participation in the 18-month International Geophysical Year, commencing 1 July 1957 and ending in December 1958.

The Vanguard, like most of the space pioneering efforts, had its share of problems, both technical and political. It was eventually preempted by the Army's Jupiter-C and its Explorer I payload.

Despite its early failures, the Vanguard program provided useful data. The first successful Vanguard discovered that the Earth was slightly "pear-shaped" and examined the composition of the upper atmosphere. Other Vanguards examined weather conditions, mapped the Earth's magnetic field, and returned data on the lower edge of the Van Allen radiation region.

Scout

The Scout—the first U. S. all-solid-propellant space booster—was the outgrowth of a research probe program initiated in 1945. By mid-1957, the need to extend the capabilities of existing research rockets was recognized. The Scout then evolved from design studies into a four-stage vehicle capable of placing 130 pounds into a 300-mile orbit. Contracts for its development were awarded in 1958.



Three-stage, pencil-shaped Vanguard at launch pad undergoing checkout.

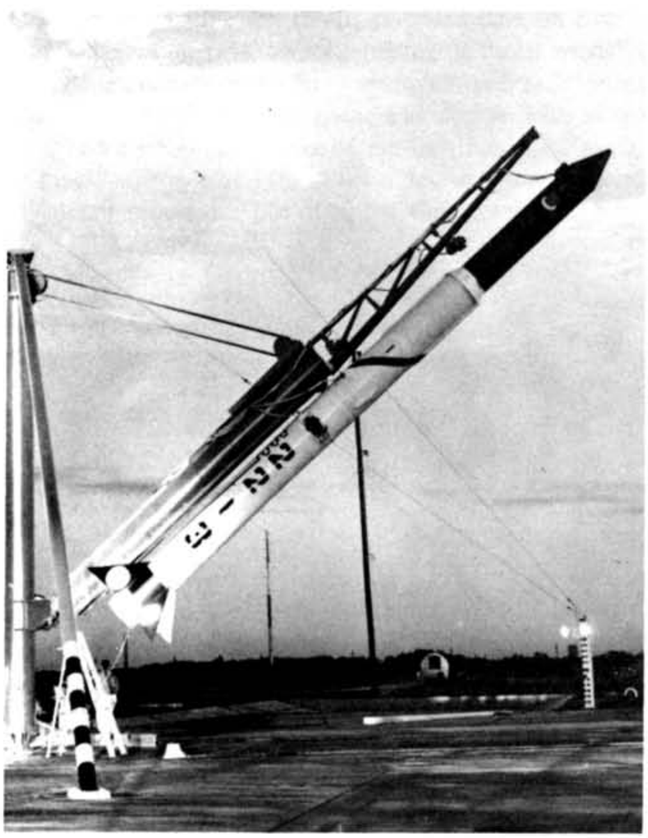
Scout, billed as the poor man's research rocket, was used by both NASA and the Air Force for a variety of space probes conducted at minimum cost. It was launched from the Western Test Range (later renamed SAMTEC) and Wallops Island as well as the Eastern Test Range in support of NASA's Explorer program, the Mercury program, and in international cooperative programs with France, Italy and the United Kingdom. It was also assigned to NASA University Explorer satellite programs, including Owl, Possum, Pilgrim, Sunblazer and Injun. For the DOD, the vehicle was used to launch OV3, Secor, Solrad and Transit satellites as well as classified payloads.

Designated Standard Launch Vehicle One (SLV-1), it was made up in three to five stages as needed to meet its mission—whether to place small payloads in orbit or to send them on space probes.

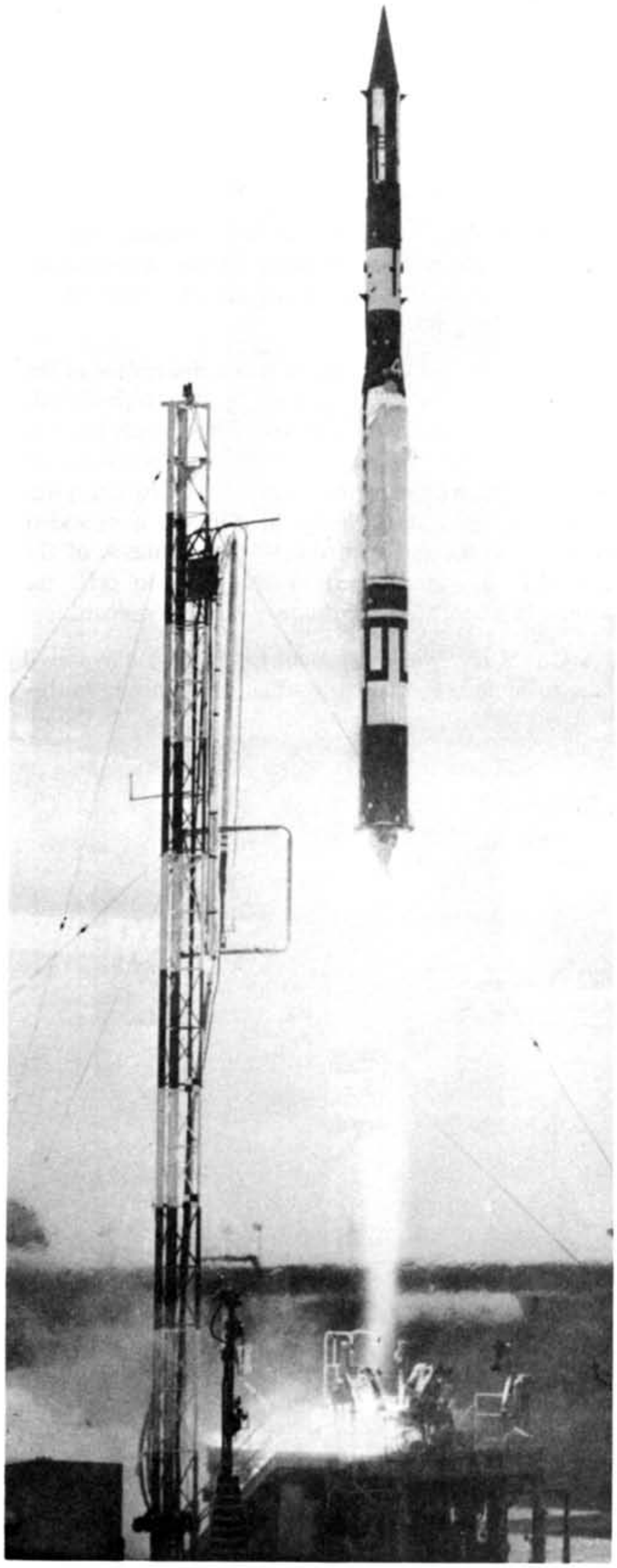
There were three main types of Scouts—the SLV-1A, which placed a 150-pound payload into a 400-mile polar orbit; the SLV-1B, used only for up-and-down trajectory flights; and the LV-1B, a three-stage vehicle.

The SLV-1B was used to carry aloft simulated human tissue, part of the continuing effort to learn more about the effects of the space environment on man's body.

Pad 18 is now inactive.



Blue Scout, a solid-propellant space booster, was first fired by the Air Force on 21 September 1960.

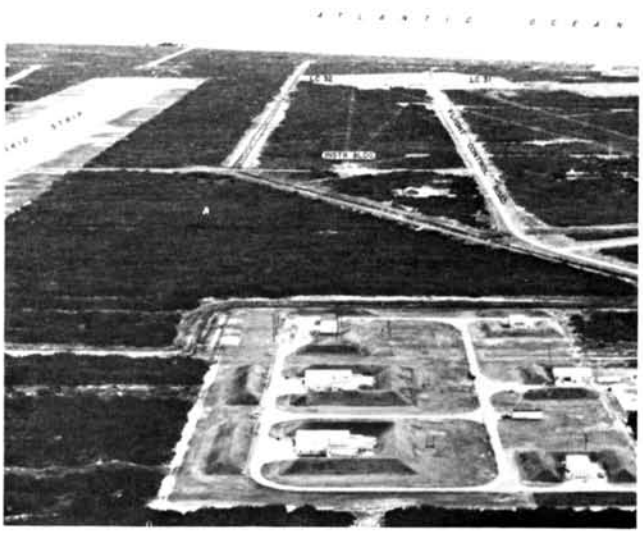


First successful flight of Vanguard took place on 17 March 1958, following a series of blowups on the pad.

Complex 31/32—Minuteman

The first complex area south of the east end of the Skid Strip was the launch area for the three-stage, solid-propellant Minuteman. The area may be identified from the road by the short, solid, red service tower and the two sand-bagged blockhouses that have a beehive appearance—all that remains of the above-ground testing structure of the Minuteman. The area includes two flat pads and two silos 12 feet in diameter and 90 feet deep. One of the flat pads was decommissioned in June 1963.

The Air Force Minuteman ICBM is a solid-propellant missile designed around the concept of instantaneous response to enemy attack. The three-stage missile is unlike the other ICBMs as it uses a rubbery solid-propellant in each of its stages. The 60-foot-tall missile weighs about 80,000 pounds and, guided by an all-inertial guidance system, is able to place a small warhead on targets in excess of 6,300 miles.



Aerial view of Minuteman assembly and checkout buildings.

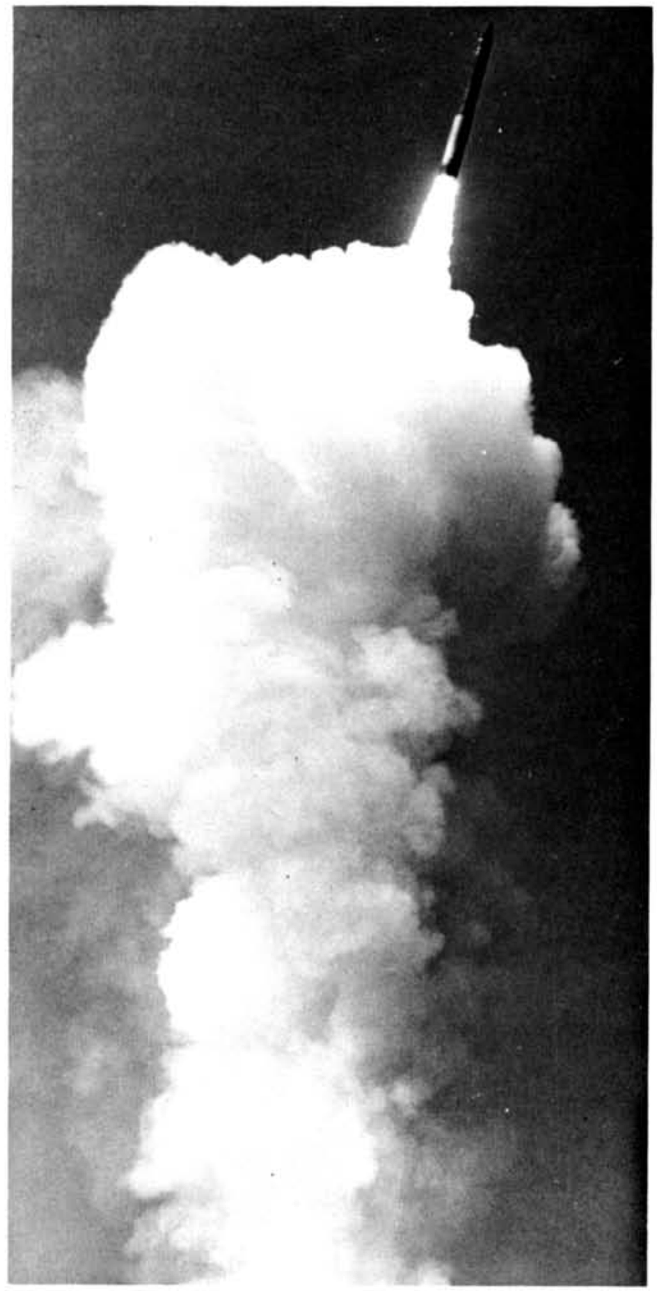
Testing of the Minuteman progressed in three phases at the Cape: Minuteman I, II and III. The first Minuteman I was launched on 1 February 1961. This initial Minuteman I launch was conducted above ground. On 30 August 1961, the Air Force launched its first Minuteman from an underground silo. Subsequent missile testing was conducted from these underground silos, which are not visible from the road.

Minuteman I was superseded by the newer and more powerful Minuteman II, first launched on 24 September 1964; and finally by the more versatile Minuteman III, launched from Cape Canaveral on 16 August 1968. Minuteman III had an improved third-stage motor which increased payload capability. This, combined with a new reentry system, gave the Minuteman III more flexibility in payload delivery and penetration.

The first flight of Minuteman IIIs was turned over to the Strategic Air Command on 18 June 1970, at Minot AFB, North Dakota. The first squadron of 50 missiles was declared operational at Minot on 8 Ja.iury 1971.

This misile had completed its research and development phase with the firing of Minuteman III at the Cape on 14 December 1970.

The Minuteman pads are no longer active.



Successful launch of the solid-propellant Minuteman weapon system.

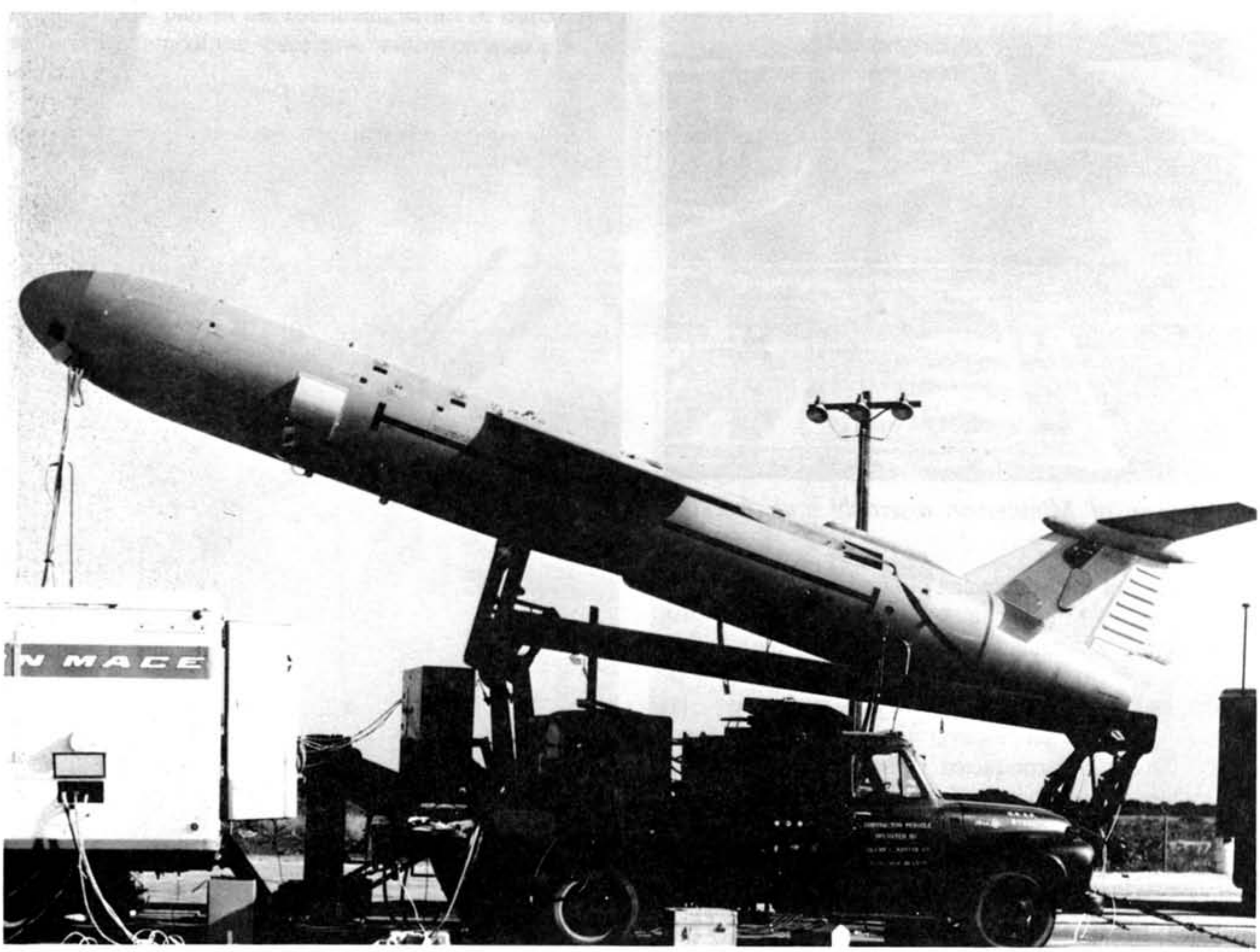
Complex 21/22—Mace/Matador

Next to the lighthouse road in a gray concrete building with a sloping green roof—the simulated hardsite for the Mace tactical cruise missile. Two large pipes extending from the lower back part of the hardsite are blast deflectors. The assembly area was in the hangar (Hangar C) across the road to the southwest. This same area also supported development of the Matador.

An improved version of the Matador, the Mace was a surface-to-surface missile that traveled just below the speed of sound at relatively low altitudes (11,000 to 40,000 feet), had a range of 1,200 nautical miles, and could deliver a nuclear warhead. The Mace and other aerodynamic cruise missiles, such as the earlier Snark and Matador, were built to fly in the atmosphere and required air to support combustion in their engines. They operated much like pilotless aircraft. In contrast, ballistic missiles are self-sufficient and fly beyond the atmosphere through space.

The Mace's maiden flight occurred on 29 October 1959. It was used to train missile crews at the Cape through July 1963. This weapon system was deployed by the Tactical Air Command in Europe and in the Pacific regions.

Launched from the Cape on 20 June 1951, the first air-breathing Matador represented a breakthrough in tactical missile testing.



Mace, an improved version of the Matador, was first flight tested on 29 October 1959.

Complex 36—Centaur

To the east, Complex 36 had two launch pads for Centaur. This Atlas-boosted, hydrogen-fueled space vehicle boosts payloads for missions such as soft lunar landings and planetary flyby probes.

The Atlas-Centaur is a 2½-stage vehicle using the Atlas for the first 1½ stages, and the liquid-hydrogen-fueled Centaur as the upper stage. It is capable of lifting heavier weights than the Atlas-Agena combination.

Twenty-four Centaurs were launched through the early part of 1971:

8 - R&D	2 - ATS
7 - Surveyors	2 - MM69
2 - OAO	2 - MM71
	1 - Intelsat IV

Of these, the most noteworthy were the Surveyor and Mariner Mars launches.

Surveyor

NASA's Surveyor program, a series of unmanned lunar soft-landing flights, yielded a wealth of photos and engineering and scientific data that helped to select Apollo Moon landing sites.

Seven Surveyors were launched from Complex 36 using the Centaur as the booster. Surveyor 1 was launched on 30 May 1966, soft-landing on the Moon and returning 11,150 photos of the Moon's surface. From the six remaining Surveyors, we obtained analyses of Moon soil, determined the Moon's weight-bearing quality, measured solar rays and performed other lunar explorations.

The last Surveyor, Surveyor 7, was launched on 7 January 1968.

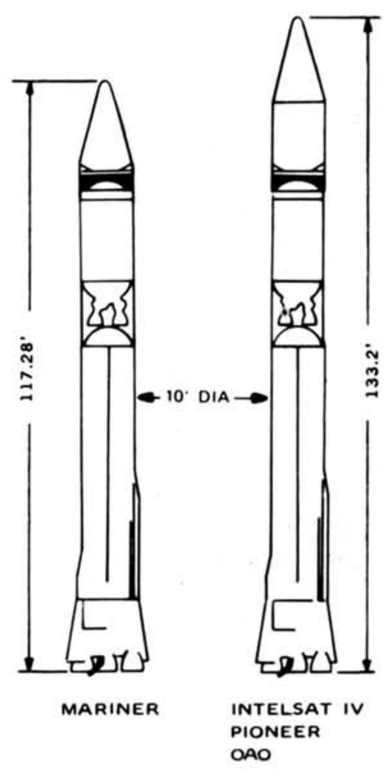
Lift-off of Mariner Mars 7.

Mariner

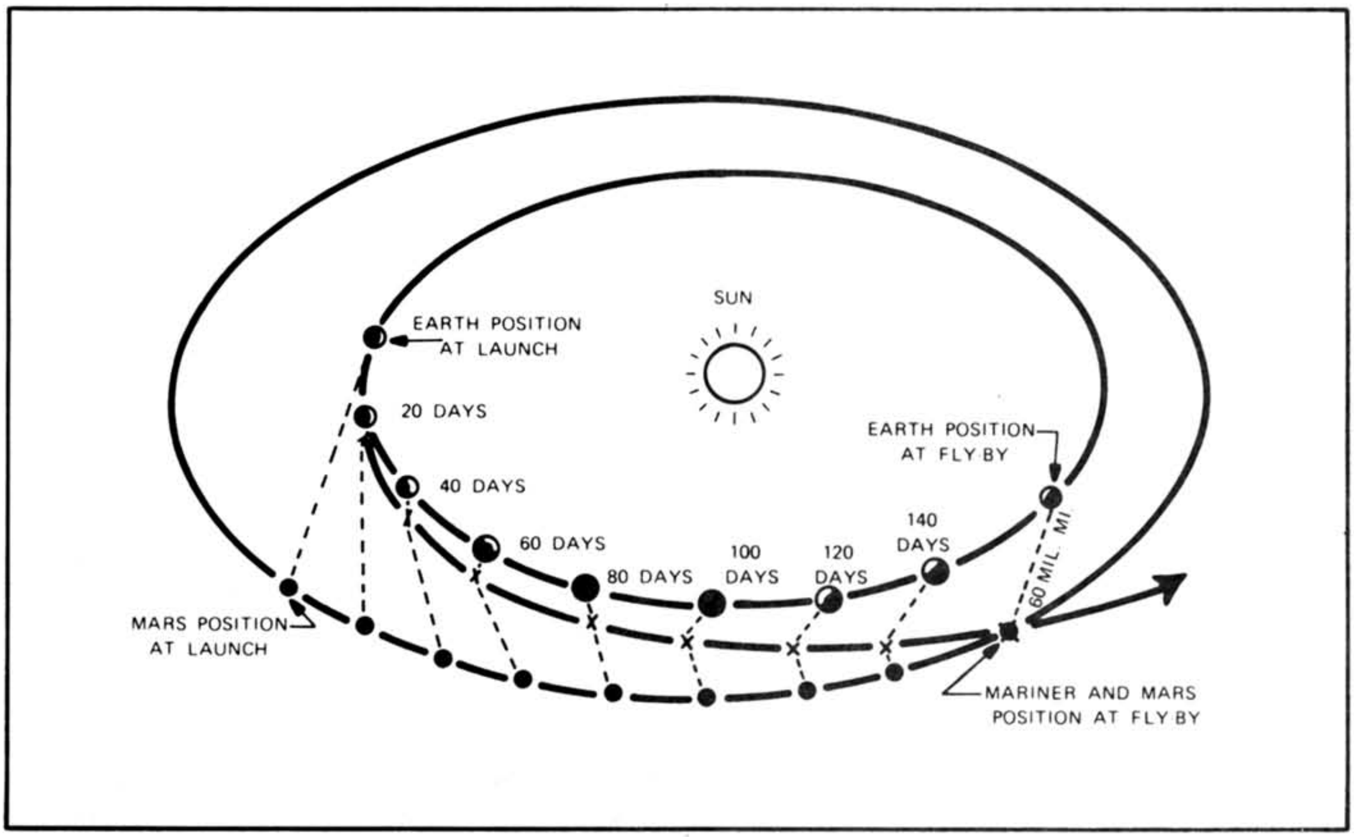
The launches of Mariners 6 and 7 marked the first use of Atlas-Centaur vehicles for interplanetary missions. They were followed by the launch of Mariners 8 and 9 in May 1971. Before reviewing the results of these missions, it is necessary to review some of the history of the Mariner program.

NASA-sponsored Mariner planetary probes have been launched on flyby missions of both Venus and Mars. Mariners 1 through 5 were launched from Atlas Complex 12, using the Atlas-Agena launch vehicle.

Mariner 1, destined for Venus in July 1962, was a launch abort; Mariner 2 was successfully launched in August 1962, flew by Venus at 21,594 miles, and continued in solar orbit. Mariner 3 and Mariner 4 were both launched in November 1964 on missions to Mars. Mariner 3 was unsuccessful because the last-stage, satellite-protective shroud did not satisfactorily deploy in orbit. Mariner 4, however, was the most successful flyby of another planet: it was the first to return pictures of another planet, it transmitted scientific data both from interplanetary measurements and from Martian atmospheric and surface experiments on its flyby of Mars at 6,118 miles on 14-15 July 1965; and continued in solar orbit. Mariner 5, launched in June 1967, was a second successful Venus close flyby and also entered solar orbit. Mariners 6 and 7, the successful twin-Mariner Mars 69 probes, are explained in detail below.



OPERATIONAL CENTAUR CONFIGURATION



TYPICAL MARINER FLIGHT PATH TO MARS

Mariner Mars 69

The primary mission objectives for both Mariner 6 and 7 Mars 1969 flybys were the scientific study of the surface and atmosphere of the planet to establish the basis for future experiments in search of extraterrestrial life, and technological development for future Mars missions. The flights were also designed to further demonstrate engineering concepts and techniques required for long-duration flight away from the sun.

Two 900-pound Mariners were launched from Pads 36A and 36B: Mariner 6 on 24 February 1969, and Mariner 7 on 24 March 1969.

Mariner 6 climaxed its five-month journey to the red planet on 31 July 1969, when it swept past the Martian equator at an altitude of 2,120 miles. On 5 August 1969, Mariner 7 repeated the feat with a trajectory that took it from the equator down to the South polar cap, passing within 2,190 miles of the planet. The pair of spacecraft transmitted 143 analog pictures of Mars as they approached the planet, plus 58 photos during the flybys.

Mariner Mars 71

The primary objective of the Mariner Mars 1971 mission was to investigate Mars by conducting three-month orbital missions using instrumented spacecraft. Low and high orbit missions were originally planned, one for each spacecraft, for the purpose of performing scientific experiments and for observing and mapping the planet.

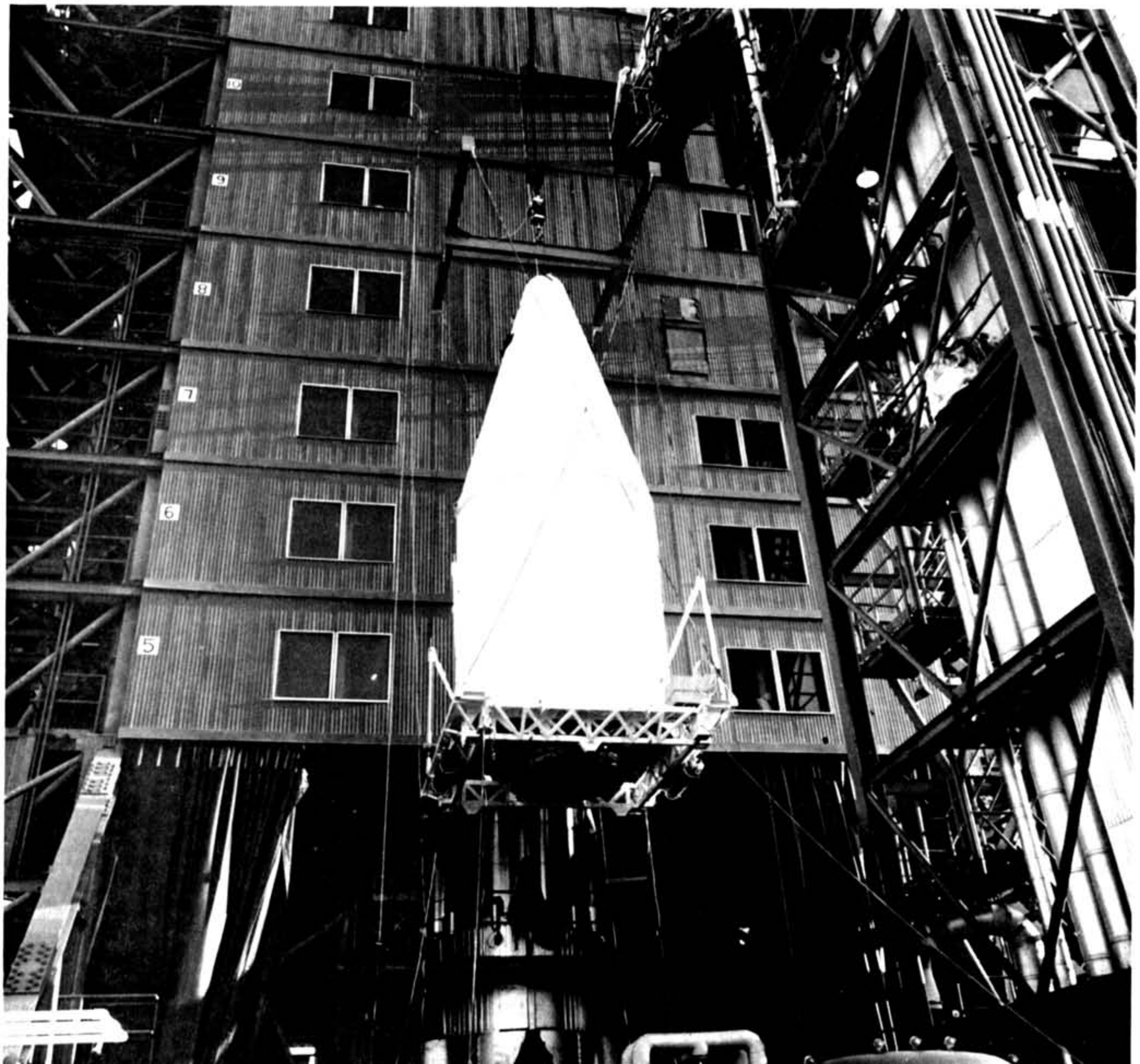
Two 2,200-pound Mariners were launched from Pads 36A and 36B, as planned. Because of the increased weight of the payloads, the Atlas engines were uprated—

NASA Centaur Mariner 8 launch from Complex 36A on 8 May 1971.

booster thrust was increased from 336,000 pounds to 342,000 pounds and sustainer thrust from 58,000 pounds to 60,000 pounds.

Mariner 8 was launched on 8 May 1971 but failed to achieve orbit; Mariner 9, however, was successfully launched on 30 May 1971. Because of the failure of Mariner 8, Mariner 9's mission was changed to include both high and low planet orbits. Mariner 9, climaxing a six-month journey to the planet, arrived at its Mars destination in early November 1971.

Concepts for Mars missions included a Titan-Centaur combination, Project Viking. This 1975 Mars mission was launched from Titan III Pad 41. Two spacecraft orbited Mars, detached soft landers and descended to the surface.



Orbiting Astronomical Observatory satellite in shroud being hoisted at Complex 36B for mating to Atlas-Centaur.

Complexes 11, 12, 13 and 14—Atlas

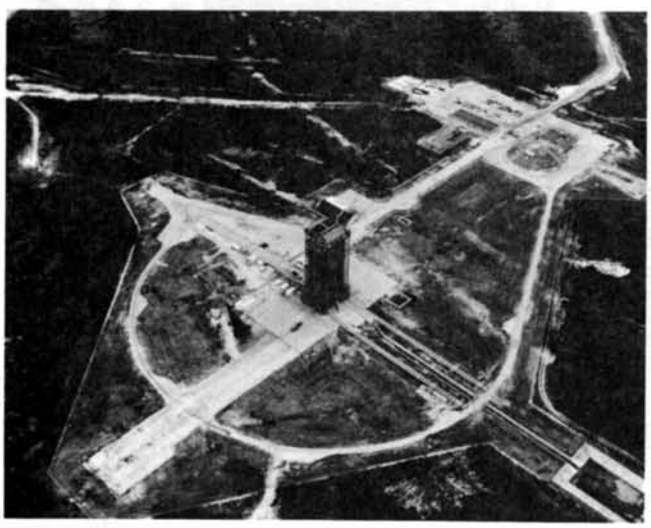
The Atlas was developed by the Air Force as the nation's first operational intercontinental ballistic missile (ICBM). Several models evolved, designated "A" through "F," with flight testing beginning on the Eastern Test Range (ETR) in June 1957.

Launched from Complexes 11, 12, 13 and 14, the Atlas is a "one of a kind" missile: its airframe is not held up by an internal skeletal structure but by high-pressure gas. Without this high-pressure gas, the thin airframe skin (about as thick as a dime) would buckle. Although this missile has a one-piece frame, it is classified as a stage-and-a-half missile because it discards two of its three Rocketdyne engines (called boosters) after approximately two minutes of flight and continues on with the remaining single "sustainer" engine.

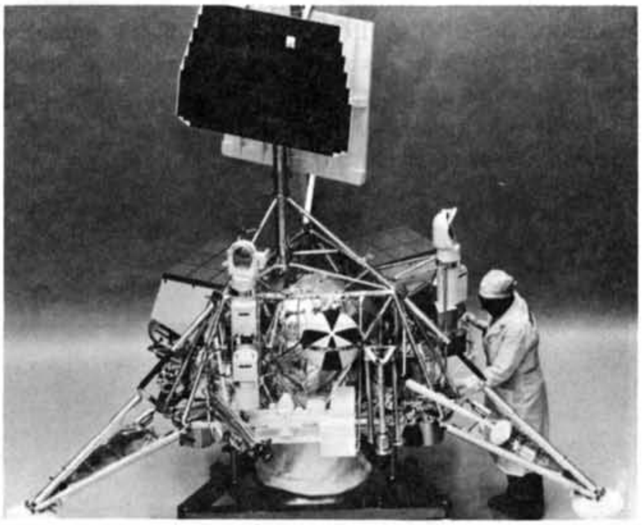
The basic Atlas weapon system stands about 82 feet tall, is 10 feet in diameter, and weighs about 255,000 pounds when fully fueled. Its booster engines are rated at 165,000 pounds of thrust each and the sustainer at 59,000 pounds. It has a range of over 6,000 statute miles.

The Atlas scored a number of firsts. On 28 November 1958 it became the first U. S. ICBM to reach full ICBM range of 5,000 nautical miles. (The Thor-Able, designed as an IRBM, flew 5,000 nautical miles on 9 July 1958.) In May 1960, the Atlas flew 9,039 statute miles into the Indian Ocean, a first for this distance.

On 18 December 1958, the Atlas demonstrated its ability and versatility as a space launch vehicle. An entire Atlas vehicle, PROJECT SCORE, was placed into orbit carrying a tape-recorded Christmas message from President Eisenhower to the world. On command from the ground stations, the Christmas message was relayed from the orbiting vehicle. Although this was not a communications satellite in the sense of the later TELSTAR or Relay programs, it was another first for the United States.



Aerial view of an Atlas Complex.



Prelaunch checkout of Surveyor. Launched by Atlas-Agena, Surveyors made explorations and soft-landings on the Moon.

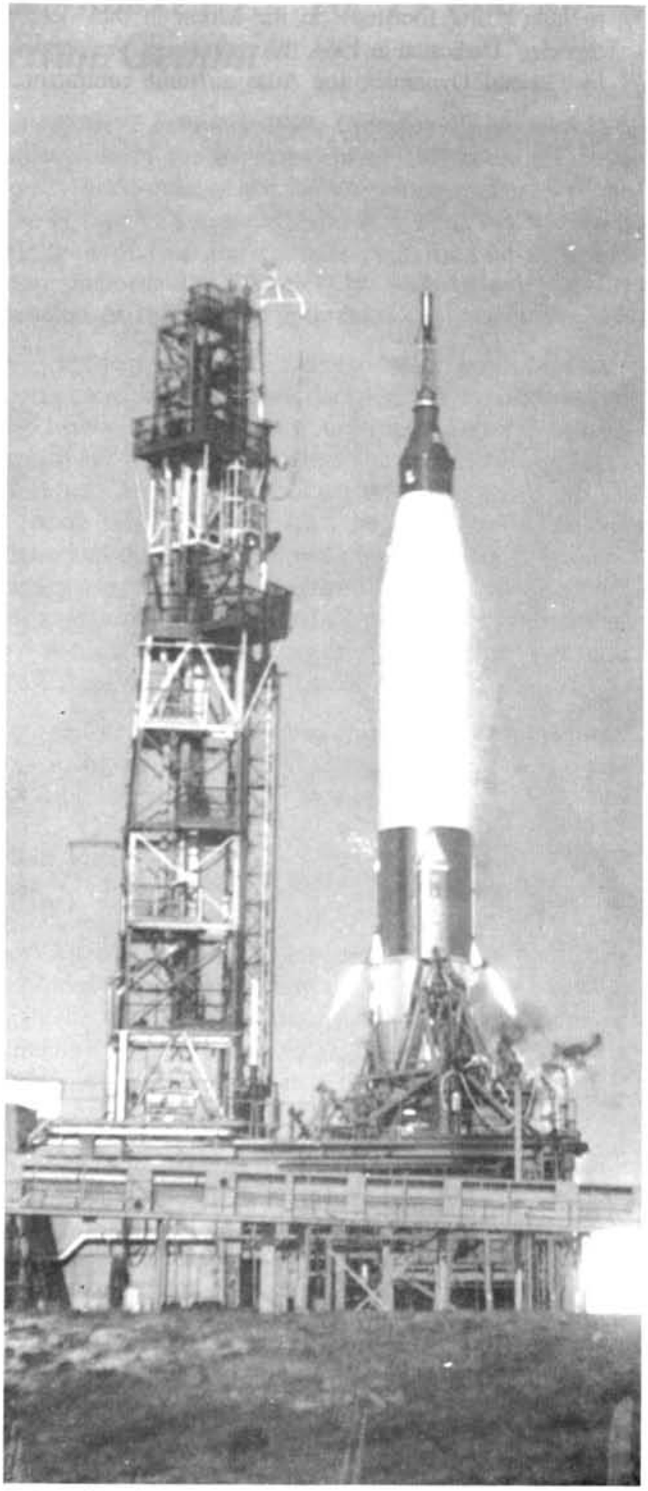
In addition to its ballistic missile role the Atlas, combined with a second-stage Agena, performed a variety of other missions ranging from low Earth orbits to deep space missions. Missions included the Ranger Moon-probe spacecraft, Mariner interplanetary spacecraft used for Venus and Mars flyby missions, as well as the lunar explorations and lunar soft-landings of the Surveyor. The Atlas-Agena combination was launched from all four Atlas Complexes—11, 12, 13 and 14.

The Atlas-Agena vehicle could boost a 5,000-pound spacecraft to 300-mile orbit or an 800-pound spacecraft to Earth-escape velocity. Its greatest asset, however, was its ability to maneuver in space.

Complex 14

The most famous of the Atlas Complexes—Complex 14—was identified by the typical Atlas "A frame" gantry. This complex was the launch site for the Project Mercury manned orbital missions—the second phase in the manned orbiting program. Project Mercury was designed to orbit a one-man spcecraft, measure the pilot's reactions and abilities during flight, and return him safely to Earth.

Modified Atlas ICBMs were used to send the four Mercury astronauts into orbit from Complex 14, starting with John Glenn's manned orbital flight on 20 February 1962 and ending with Gordon Cooper's flight on 15 May 1963. During this period Astronauts Glenn and Carpenter each went 3 orbits; Schirra made 6 orbits; Cooper, 22 orbits.



Lift-off of Mercury-Atlas 5, which placed the chimpanzee Enos into earth-orbit. The chimp was safely recovered after two orbits.

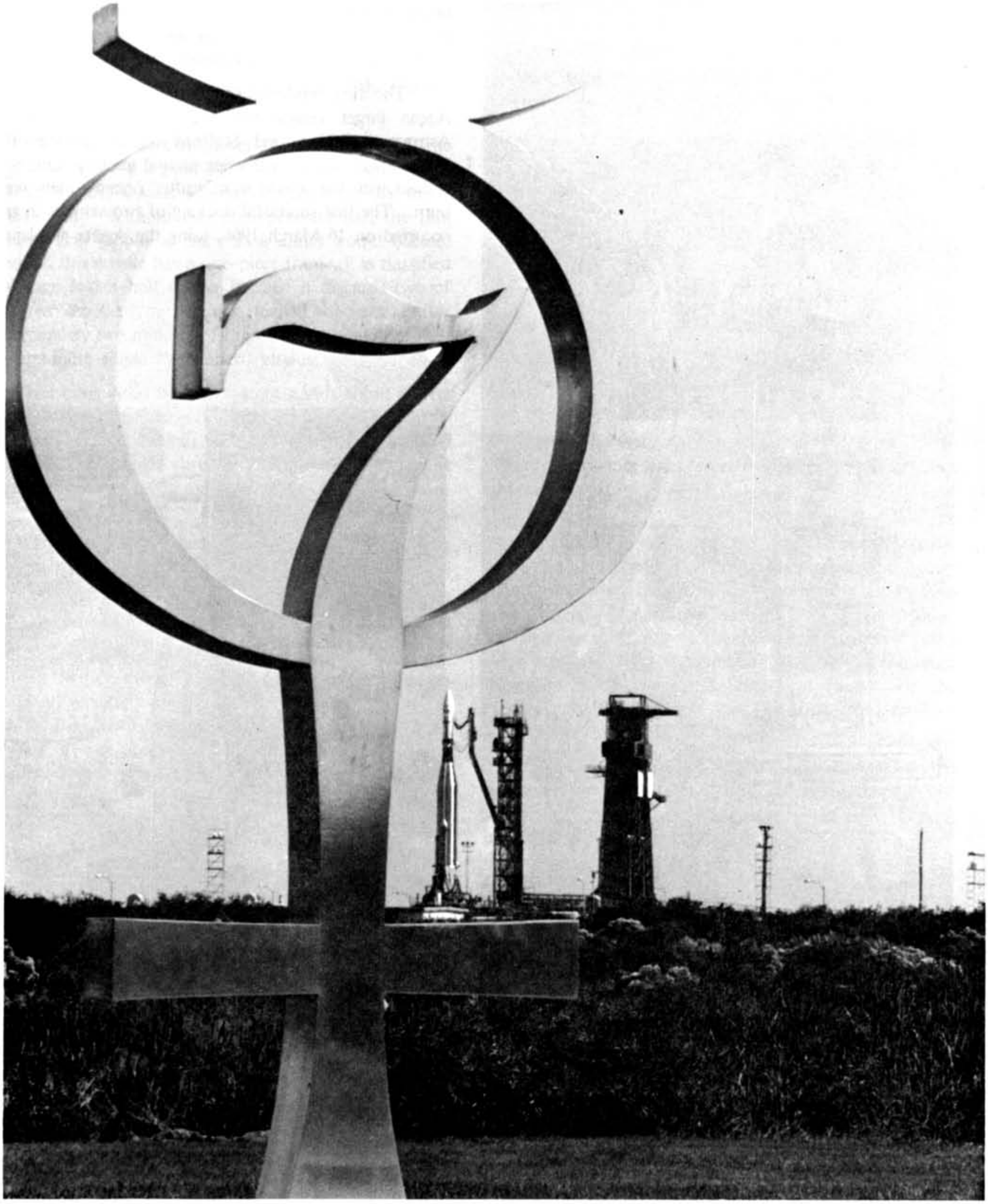
Mercury paved the way for Gemini by demonstrating that U. S. astronauts could withstand the high accelerations of a rocket launching, a prolonged period of weightlessness, and then a period of high deceleration during entry.

Complex 14 also played an important role in the Gemini program. Of the half-dozen objectives assigned to Project Gemini, rendezvous and docking were of utmost importance. Atlas-Agena was selected as the target vehicle. Launches were made from Pad 14 prior to a Gemini-Titan II launch and the rendezvous and docking exercises were performed in space.

The first rendezvous and docking mission with an Agena target vehicle was scheduled to be flown by Astronauts Schirra and Stafford on 25 October 1965. This mission was aborted when ground tracking stations lost contact with the vehicle shortly after Agena's main engine burn. The first successful docking of two vehicles in space occurred on 16 March 1966, using the Agena as planned.

Prelaunch checkout of Atlas-Agena D, which placed nuclear detection satellites in orbit.

Near Complex 14 is the Project Mercury monument. This 13-foot-high astronomical symbol for planet Mercury stands in honor of those who took the initial steps leading to man's first footsteps on the Moon in the Mercury 7 capsule. Dedicated in 1964, this monument was constructed by General Dynamics, the Atlas airframe contractor.



Mercury monument with Atlas–Agena in background.

Complexes 15, 16, 19 and 20—Titan/Gemini

Since 2 February 1960, Complex 19 has played a major role in the development of this country's large liquid-fueled missiles and launch vehicles. That was the date of the first successful flight of a Titan I ICBM from this third of four test facilities built for that program. More importantly, Complex 19 was the site for the launches of the Gemini program.

Project Gemini marked the beginning of sophisticated, manned space flight—it was the intermediate step between the earlier Mercury flights and the manned Apollo missions to the Moon. The invaluable experience of Project Mercury had shown that man could survive a rocket ride into space, that he could survive orbital flight, and that he could serve a useful function in space. Gemini expanded and refined these scientific and technological endeavors, adding a second crew member and a maneuverable spacecraft. With Project Gemini, whole new vistas opened up for man.

Before all this could begin, however, missile history was made in the Titan I and Titan II research and development programs.

Titan History

Titan I

Titan I, the Air Force's second ICBM project, was developed as insurance against the possibility that the Atlas might be late in development. Originally developed as a military weapon system, it was capable of delivering a nuclear warhead more than 6,000 miles.

Titan I, a two-stage, 90 by 10-foot missile, weighed more than 220,000 pounds and carried a nose cone nearly twice as heavy as that on the Atlas. Powered by two Aerojet-General Corp. first-stage engines of 150,000 pounds of thrust each, and a single engine of 80,000 pounds of thrust, it used a radio-command guidance system.

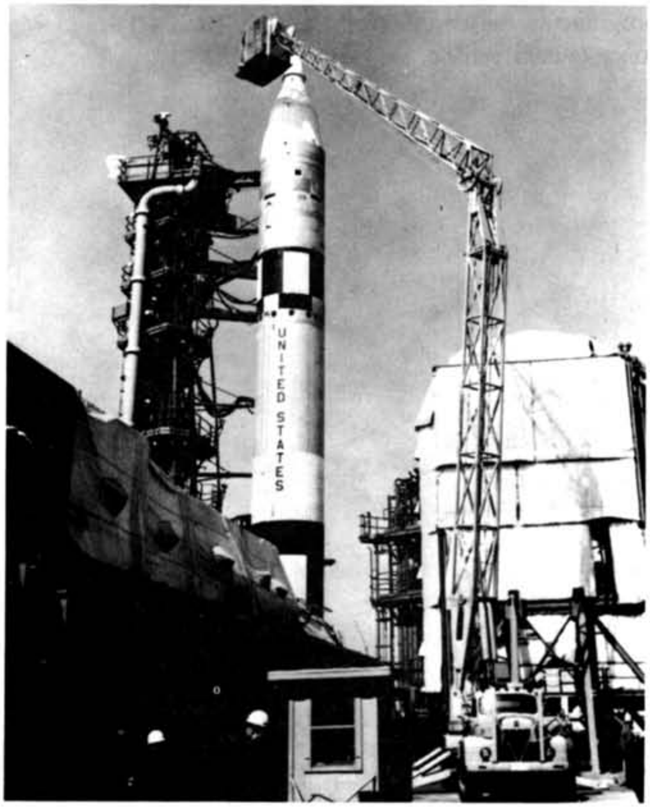
First flown on 6 February 1959, the Titan I encountered some development problems—as did all missiles in these early testing years. It was launched from four areas, Complexes 15, 16, 19 and 20, all presently deactivated.

With a research and development test launch record of only four failures in 47 launches, the Titan I proved to be one of the most dependable of U. S. missiles. It did, however, use liquid oxygen and kerosene for propellants—its reaction time was less than desired.

Titan II

In June 1960, while the other ICBM programs were well underway, the Air Force announced its decision to develop a second and totally different Titan missile system—Titan II.

The Titan II represented an important advance in technology—the use of storable propellants which combine the power associated with liquid rocket engines and the responsiveness of solid fuels with a highly simplified and therefore more reliable propulsion system. The use of these storable propellants makes it possible to keep the missile for long periods of time, ready for launch in less than a minute. Other advantages of the Titan II include its capability of being launched directly from the bottom of its underground silo, and its hypergolic propellants which eliminate the need for an ignition system.



Titan II at launch pad.

Taller (at 102 feet) and heavier (nearly 300,000 pounds) than any pervious ICBM, its fuel can be stored in the rocket for several hours should a "hold" or delay occur in the launch countdown. This was a decided advantage over previous manned flight programs. Unlike the Atlas, which uses liquid oxygen stored at minus 300 degrees F, the Titan's fuel can be maintained at room temperature, or about 70 degrees.

At lift-off, the Titan II generates 430,000 pounds of thrust, or the equivalent of 46,000 average-sized American automobiles with their throttles wide open. Guided by an all-inertial guidance system, the Titan II was designed to be fired directly from the bottom of an underground silo and to hurl the heaviest nose cone—the General Electric Mark 6—farther than any other missile.

The Titan II was first launched successfully on 16 March 1962, less than two years after the development announcement. By the close of its research and development flight test program at Cape Canaveral, it had had only one total failure in 23 launches. No other ICBM has had so few vehicles in its flight test program or so few total failures.

The successful conclusion of its development as a weapon marked the realization of its many potentialities as a launch vehicle—for both the civilian space program in Project Gemini and the Air Force military space program as the core vehicle for the Titan III standard space launch vehicle.

Arrival of Gemini booster at Cape Skid Strip. These boosters were flown into the Cape aboard a Boeing 377 Stratocruiser.

Gemini-Titan II (GT) Launch Vehicle

NASA in December 1961—before the first test flight of the Titan II—announced Project Gemini and selection of Titan II as the launch vehicle for the two-man spacecraft planned for the program. With this decision, the Gemini program became a combined NASA/Air Force effort. The Air Force was assigned responsibility for launch vehicle development, preparation and checkout of the Titan II, and launching the astronauts for NASA. NASA, on the other hand, was responsible for Gemini program development and for the research and development of the Gemini capsule.

The Titan II was a logical choice for Project Gemini for a number of reasons:

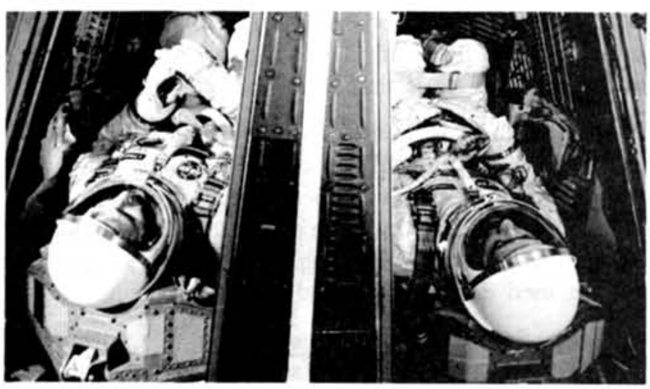
(1) It was the most powerful U. S. rocket in an advanced stage of development and the only rocket which would be available to meet the Gemini flight schedule.

(2) Using storable propellants, Titan II allowed for easier operational handling in support of the planned demands of a rendezvous.

(3) Using propellants that are hypergolic (they ignite on contact), the Titan II rocket required no ignition system and its overall system was therefore greatly simplified. This simplification increased built-in reliability and eased the job of mating the rocket to a manned spacecraft.

To convert a war machine such as the Titan II ICBM into a man-rated (safe for men) launch vehicle, the Air Force had to add four things to the already-reliable basic design of the vehicle. These prime modifications were:

- — a malfunction detection system (MDS), designed to sense problems in any of the vital booster systems and transmit this information to the astronaut crew.
- — a redundant flight control system which could take over the job of the primary system should it fail in flight.
- — redundancy in the electrical system with necessary changes to provide power for such added launch vehicle equipment as the MDS.
- — substitution of radio guidance for inertial guidance used in the Titan II ICBM version to provide a weight reduction and also to provide a more responsive system during critical orbital injection.



Astronauts McDivitt and White in Gemini capsule.

The Gemini capsule, built by the McDonnel Aircraft Corporation, was basically the same conical shape as its Mercury predecessor but had a number of additional features. With a crew of two, the Gemini spacecraft weighed 3½ tons, twice as much as the Mercury craft. About 30 percent larger, it measured 18 feet 5 inches long, 10 feet across at the base and 39 inches across at the top.

Gemini Mission

The objectives of Project Gemini reflected new aspirations for manned space flight. Gemini mission objectives included:

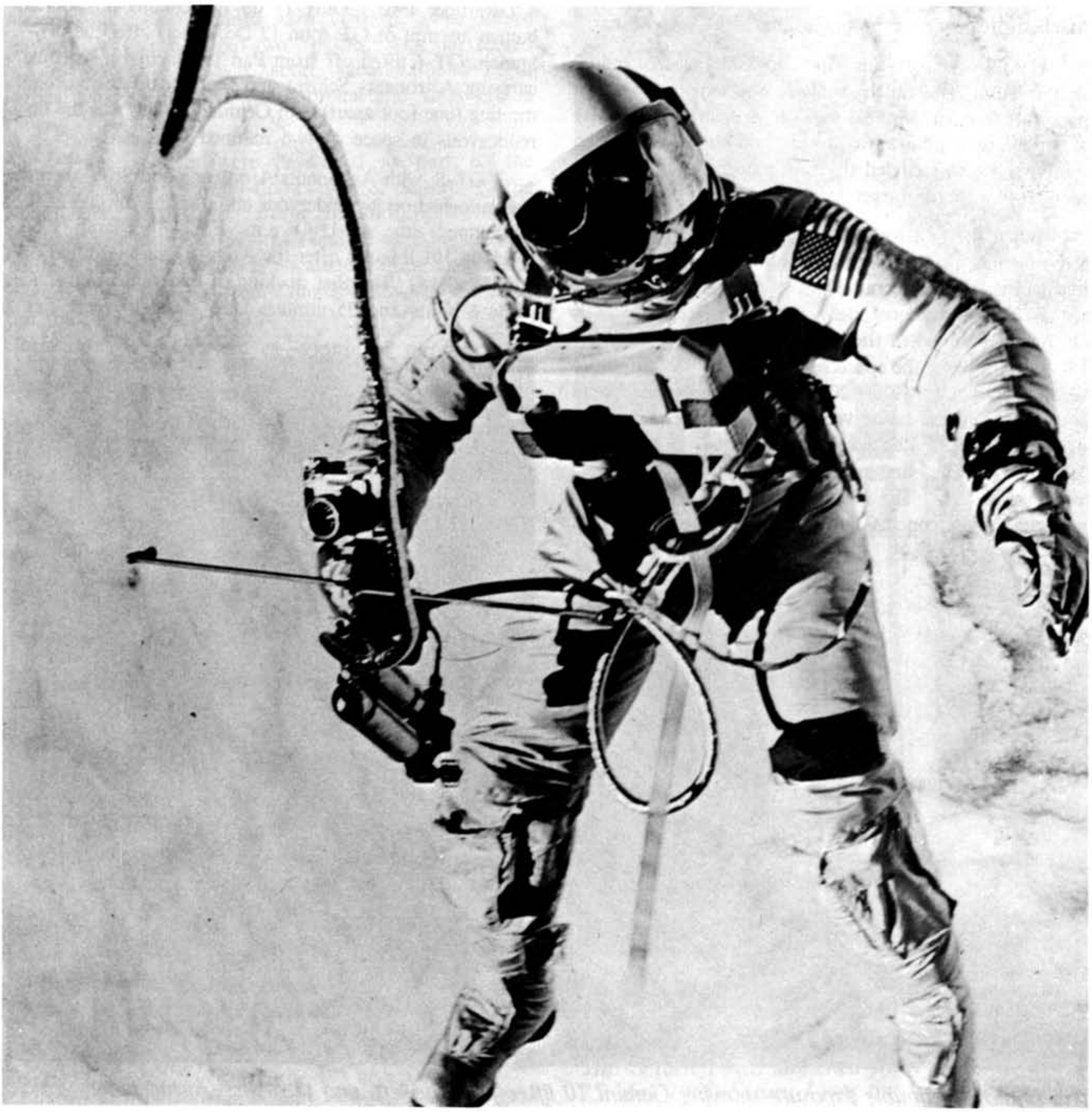
(1) Continued study of weightlessness to determine man's capabilities during long-duration space flights of up to two weeks.

(2) The development of early rendezvous and docking techniques with orbiting spacecraft and, once this was accomplished, providing flight crews with rendezvous and docking experience.

(3) Experimentation with orbital flight maneuvering of manned spacecraft both before and after docking.

(4) Study of man's ability to perform in free space by permitting the astronauts to step outside their spacecraft while in orbit.

(5) The use of the Gemini spacecraft as a manned laboratory vehicle for other scientific experiments and extravehicular activities.



Astronaut Ed White's extravehicular walk in space, 3 June 1965.

Rendezvous and Docking

Of the half-dozen objectives assigned to Project Gemini, rendezvous and docking were the most important. Without the ability and training necessary to join two spacecraft in orbit, future Apollo astronauts would not be prepared to accomplish the return to Earth after Moon exploration. The operational experience had to be gained from the Gemini program.

All conditions being nominal, the target vehicle (Atlas-Agena) was launched from Pad 14 and inserted into a circular orbit. Shortly after Agena completed its first orbit (about 101 minutes after lift-off), Gemini was launched on an azimuth compatible with Agena's path.

For the rendezvous and docking missions, the Gemini-Titan II launch vehicle inserted the Gemini spacecraft into an elliptical (egg-shaped) orbit. Because its perigee (low point) was lower than the Agena's, the Gemini spacecraft circled the Earth faster and gradually caught up with the target vehicle.

When the two were in proper position, the engines in the Gemini's orbital attitude maneuvering system were fired to increase spacecraft velocity and place the vehicle in a circular orbit almost identical to that of Agena. The astronaut crew tracked the Agena by radar and began to close in on it using the spacecraft propulsion system. Once the spacecraft was within 20 miles of the Agena, visual maneuvering of the target vehicle was possible. When the two vehicles were docked, they operated as one unit, including use by the spacecraft crew of the Agena propulsion system. The spacecraft was then detached from the Agena at the conclusion of the mission before reentry.

Atlas-Agena Rendezvous Missions

The first rendezvous and docking mission with an Agena target vehicle was scheduled for 25 October 1965. Shortly after lift-off, ground tracking stations lost all contact with the vehicle. As a result, the Gemini 6 launch was scrubbed.

On 28 October 1965, NASA announced it would attempt a rendezvous of the manned Gemini 6 spacecraft within the 14-day orbital lifetime of the Gemini 7 spacecraft.

GT-7, with Astronauts Borman and Lovell aboard, was launched on its 14-day mission precisely on schedule, 4 December 1965. Only 11 days (including an aborted launch attempt of GT-6 on 12 December) after the GT-7 launch, GT-6 lifted off from Pad 19 exactly on schedule, carrying Astronauts Schirra and Stafford to their orbital meeting (one foot apart) with Gemini 7. This was the first rendezvous in space of two manned vehicles.

GT-8, with Astronauts Armstrong and Scott aboard, was launched on its rendezvous and docking mission at the preplanned time of 11:41 a.m. EST, 16 March 1966, precisely 101 minutes after the Atlas-Agena had lifted off from Pad 14. The first docking of two vehicles in space came 6 hours and 35 minutes later—another space first.

The rest is history—in ten completely successful Gemini launches, 20 men were placed in orbit during 1965 and 1966.

The Gemini Program was completed with the launch of GT-12 on 11 November 1966.

Complex 19 has subsequently been deactivated.

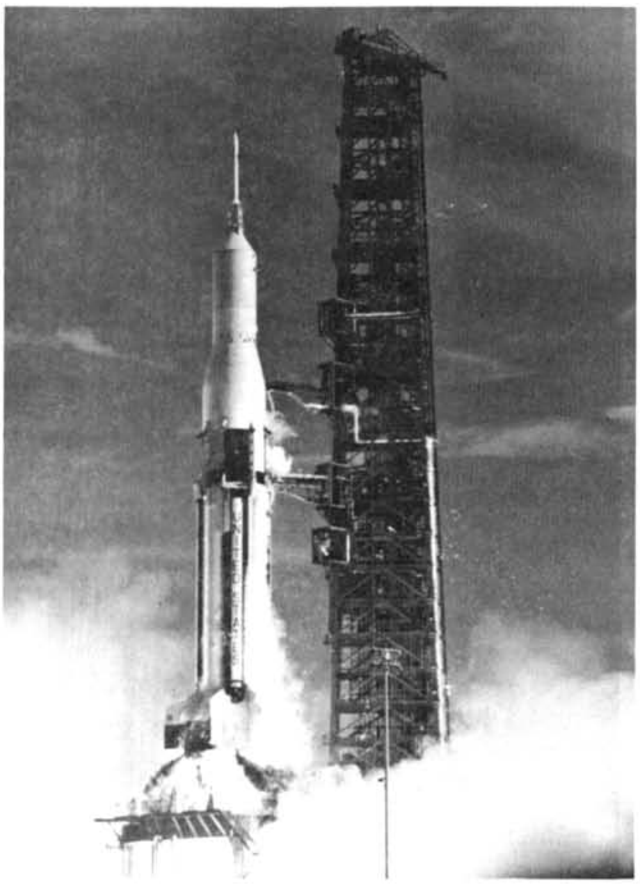
This photo is a double exposure showing Gemini 10 lift-off on the left, and the Atlas-Agena target vehicle on the right. In actuality, these events occurred 101 minutes apart.

Complexes 34 and 37— Apollo/Saturn

To the north of the Range Control Center are the movable structures of Complexes 34 and 37, sites for the flight testing of the Saturn I and Saturn IB launch vehicles. A total of 15 Saturn vehicles (I and IB) were successfully launched from these two complexes.

To accomplish the manned Moon landing mission, NASA had to incorporate a "steppingstone" approach leading to the development, testing and ultimate accomplishment of manned lunar landings. The Saturn program was divided into two "blocks" with interrelated phases: Block I—launch, abort, suborbital and Earth orbital phases; Block II—earth orbital and lunar orbital phases.

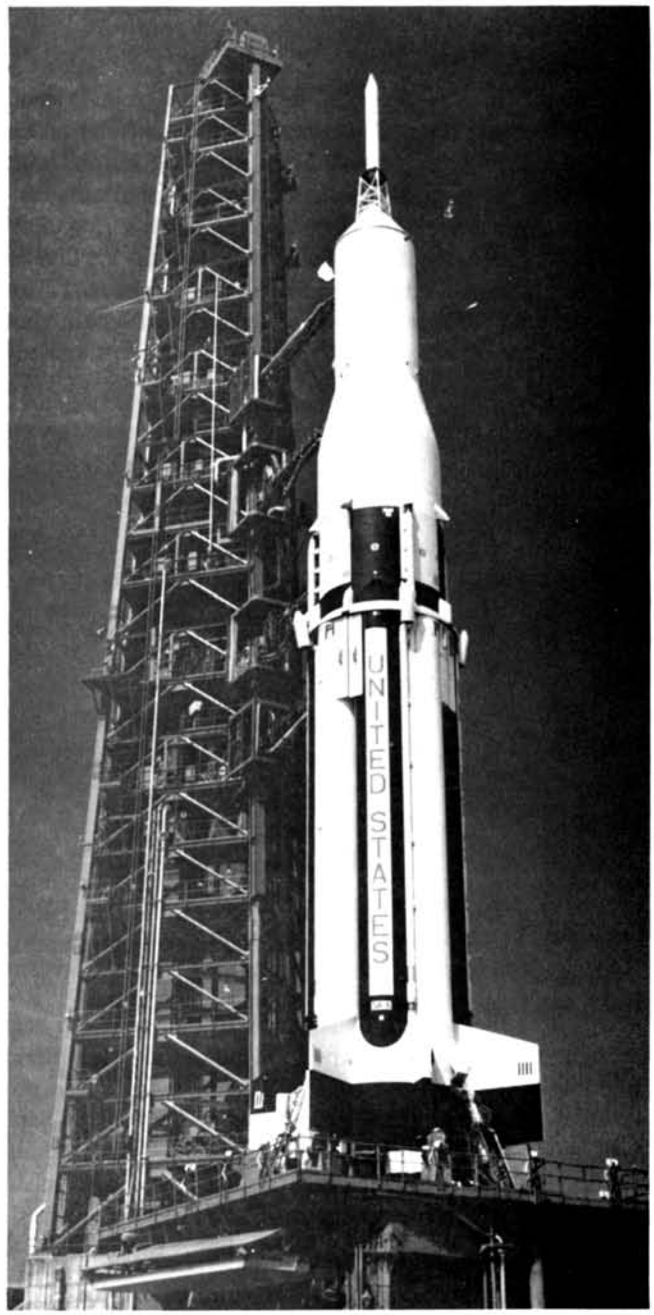
Three vehicles were developed as part of the steppingstone approach—the two-stage Saturn I, the intermediate two-stage Saturn IB, and the advanced three-stage Saturn V. Saturns I and IB were flight tested from Complexes 34 and 37 located at Cape Canaveral. Saturn V was launched from Complex 38, which is located on the Florida coastal strip.



Lift-off of a Saturn IB, launch vehicle for Earth-orbit Apollo missions.

Specific figures on weight, height and amount of propellant for the three Saturn vehicles vary depending on the launch vehicle produced and its mission. Generally speaking, the booster configurations were created with the following stage combinations:

—Saturn I, consisting of S-1 first stage and S-4 second stage. This vehicle was used to develop large rocket engine technology.



This Saturn I was launched from Complex 37B on 25 May 1965. Saturn I was the first of three phases of Apollo program development.

— Saturn IB, consisting of the S-1B booster and S-4B second stage, the latter being the same unit (with minor modifications) as used on the third stage of the Saturn V. This two-stage vehicle had a first-stage thrust of 1,600,000 pounds; was one of two vehicles used with Apollo spacecraft (the other was the Saturn V); and was used for Earth-orbital missions of the Apollo program.

— Saturn V consisted of the S-1C first stage, S-2 second stage, and S-4B third stage. With a maximum off-the-pad thrust of 7,500,000 pounds, the Saturn V was used for some Earth-orbital missions as well as lunar missions.

The suborbital flights tested the heat shield and the operation of subsystems. The Earth-orbital portion of the flight test program tested the operational abilities of subsystems; compatibility and operations during Earth orbit of the three vehicles (Saturns I, IB and V); and also developed qualified teams for checkout, launch, flight operations, mission support, recovery and flight analysis.

The Saturn I (a 171-foot-high vehicle) included checkout of the Apollo vehicle. First launched on 27 October 1961, the first four flights carried "dummy" second stages. The Saturn I has a perfect record of ten successful flights.

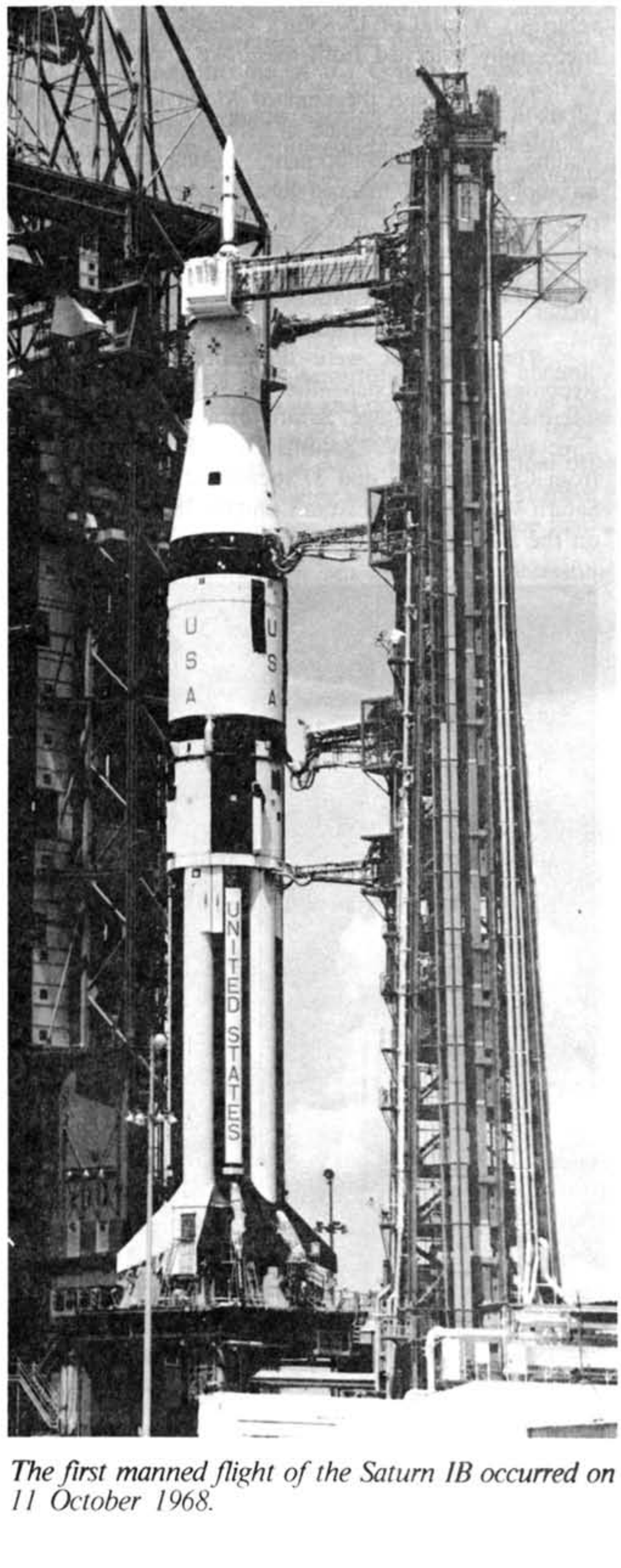
On the sixth Saturn I test flight (16 February 1965), a Pegasus meteoroid technology satellite was placed in orbit. Two additional Pegasus satellites were placed in orbit by Saturn Is on 25 May 1965 and 30 July 1965, concluding the program.

Pegasus, deriving its name from the Greek mythological flying horse, was a meteoroid detection satellite with a wing spread of 96 feet, designed to gather information on the number and size of meteoroids in near-Earth orbit. For example, a meteoroid the size of a man's fist traveling at 18,000-plus mph is capable of damaging and/or destroying spacecraft. The Pegasus satellites provided vital data needed in designing manned spacecraft for Projects Gemini and Apollo.

The flight phase of NASA's Apollo program began when the combined Apollo Command and Service Modules (CSM) configurations were twice successfully launched into suborbital Apollo-Saturn missions by Saturn IB launch vehicles in February and August 1966. Another Saturn IB was flown in four orbits of the Earth in July 1966, but incorporated none of the Apollo modules.

Additional flights of the 230-foot-high Saturn IB vehicle supplied payloads to orbiting vehicles and performed checkout of the rendezvous technique with the Lunar Module (LM) and the command modules in Earth orbit. All missions were unmanned except the final launch in the Saturn IB series (Apollo 7), which was the first U. S. three-man mission. This 11-day Earth-orbital flight in October 1968 successfully concluded the Saturn IB test program.

Complex 34 is also the site of the tragic fire in which three astronauts were killed.

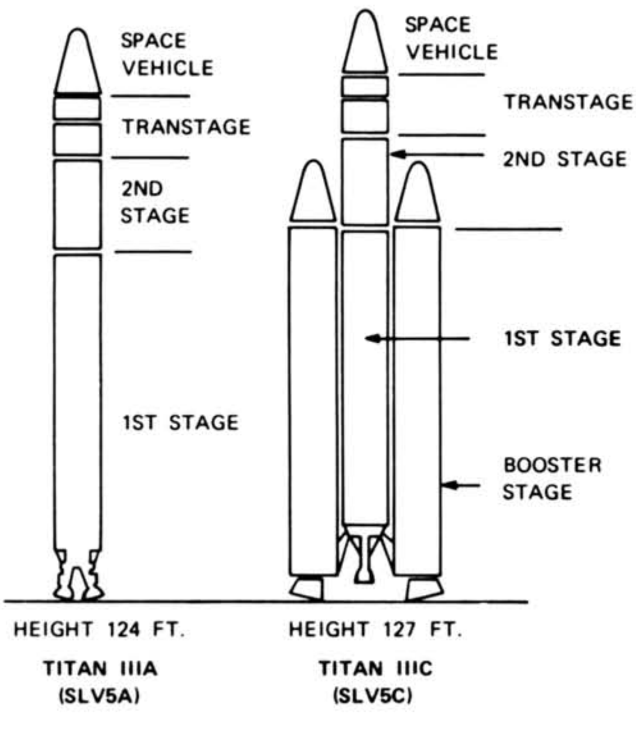


The first manned flight of the Saturn IB occurred on 11 October 1968.

Complexes 40 and 41— USAF Titan III

The mission requirements of the U. S. Air Force led to the development of the Titan III family of launch vehicles. Development of the Titan IIIC, the initial family vehicle, began in December 1962. This was followed by the development of the Titan IIIB, Titan IIIM and Titan IIID launch vehicle systems.

Titan III, developed by the Air Force for manned and unmanned military space missions, carried communications satellites, Vela satellites, and space research experimental vehicles into orbit. It was developed in two basic configurations for space launches from Cape Canaveral—Titan IIIA and Titan IIIC.



TITAN III CONFIGURATIONS

Titan IIIA

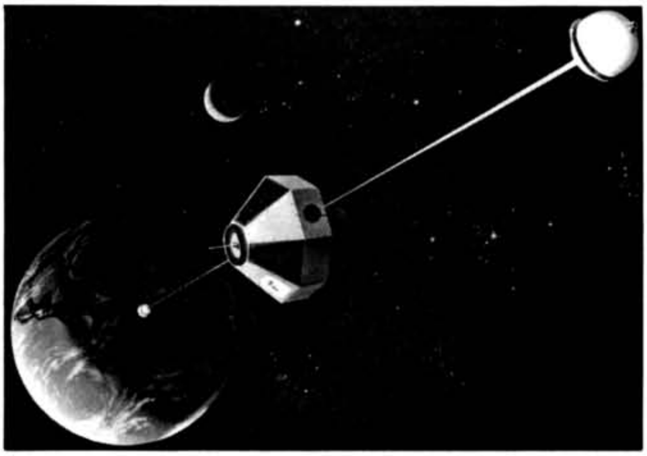
Titan IIIA (Core) consists of a three-stage core using liquid-propellant propulsion systems. First and second stages consist of the basic Titan II ICBM with structural modifications to provide for increased loads. A new Stage III (Transtage) is liquid fueled and designed to provide multiple restart capability in space to change orbits and achieve deep space trajectories. All three stages use storable propellants which can be left aboard a launch-ready vehicle over extended periods. These propellants are hypergolic (burn spontaneously when mixed), eliminating the need for an ignition system.

The three-stage Titan IIIA has a diameter of 10 feet and stands 124 feet tall. It can deliver 5,900 pounds into a 100-nautical-mile circular orbit and 3,600 pounds into a 1,000-nautical-mile circular orbit.

Four Titan IIIAs were launched from Cape Canaveral between 1 September 1964 and 6 May 1965. A scheduled fifth Titan IIIA flight was cancelled as all research and development objectives had been met and the program was ready to progress to Titan IIIC.

Titan IIIC

The second configuration, Titan IIIC, is essentially the Titan IIIA (Core) plus two five-segment strap-on solid motors (Stage 0) attached on opposite sides of the core. Because of this parallel type of stage arrangement, the Titan IIIC is a broad vehicle, measuring slightly more than 30 feet across at the extreme. The vehicle, weighing 1,400,000 pounds when all stages are fully fueled, provides 2½ million pounds of thrust at lift-off. A universal payload fairing, 10 feet in diameter and varying in height from 15 to 50 feet depending on payload requirements, completes the Titan IIIC profile. With the typical 17-foot fairing in place the launch vehicle stands 127 feet tall.



Artist's concept of a Gravity Gradient Test Satellite (GGTS), which was designed to demonstrate gravity gradient stabilization in equatorial, near-synchronous orbit. These satellites were launched by the Titan III.

Titan IIIC can launch payloads ranging to 28,400 pounds in low Earth orbit, 2,160 pounds in synchronous equatorial orbit, and depending on mission requirements, between 1,700 and 4,000 pounds to Mars/Venus.

Some interesting facts concerning the Titan IIIC's 120-inch boosters are:

- These boosters were the largest and most powerful solid-propellant rockets yet launched.
- Each of the 250-ton rockets weighed more than the Statue of Liberty (225 tons).

- The two boosters used on each Titan IIIC contained enough solid propellant (840,000 pounds) for 14 Minuteman ICBMs. This solid propellant (consisting of ammonium perchlorate oxidizer, aluminum particles fuel, a synthetic rubber binder) stabilized the mass and controlled the burning rate.
- The 840,000 pounds of propellant in the two boosters included about 135,000 pounds of synthetic rubber—nearly enough for 10,000 automobile tires.
- The 74 tons of steel in the two booster rocket cases were enough to produce 37 standard-sized automobiles.
- The nearly 2.5 million pounds of peak thrust generated by the twin boosters equaled about 18 million horsepower, enough to power 6,000 of the largest railroad locomotives or 60 of the biggest aircraft carriers. If converted to electricity, the thrust would equal 13 million kilowatts, more than six times the capacity of the Niagara Falls power plant.

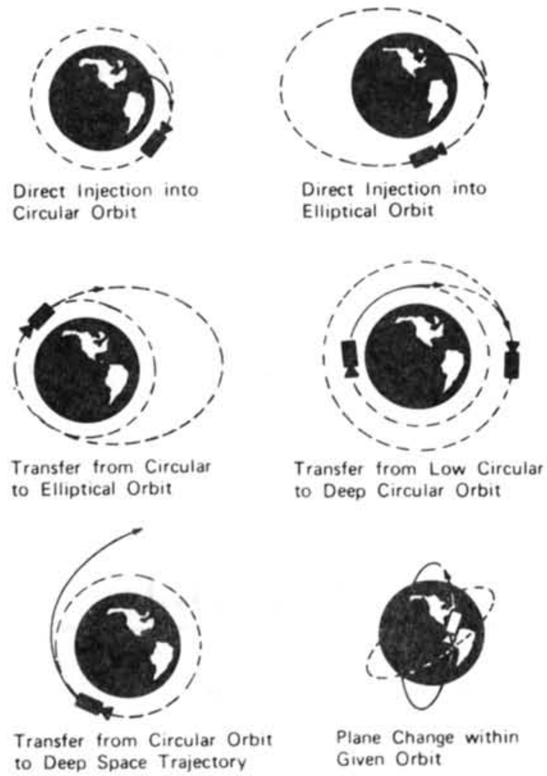
Titan IIIC lift-off on 5 May 1971.

Titan III Mission Flexibility

The Titan III gave greater mission flexibility than any other launch vehicle or system then under development. When delivered to the pad, the vehicle could be launched immediately or "held" indefinitely. The system was designed in such a way as to permit launch of a Titan III within two seconds of a preselected launch time or to permit a readiness condition close to launch to be held for as long as 30 days. It had the inherent ability to react rapidly to mission changes with total replacement of one vehicle by another within a short turn-around time.

Titan III flight plan options included: (1) low altitude elliptical orbit by direct injection, (2) low altitude circular orbit, (3) low altitude circular orbit with Hohmann transfer to another orbit, (4) synchronous orbit, and (5) deep space trajectory to escape velocity.

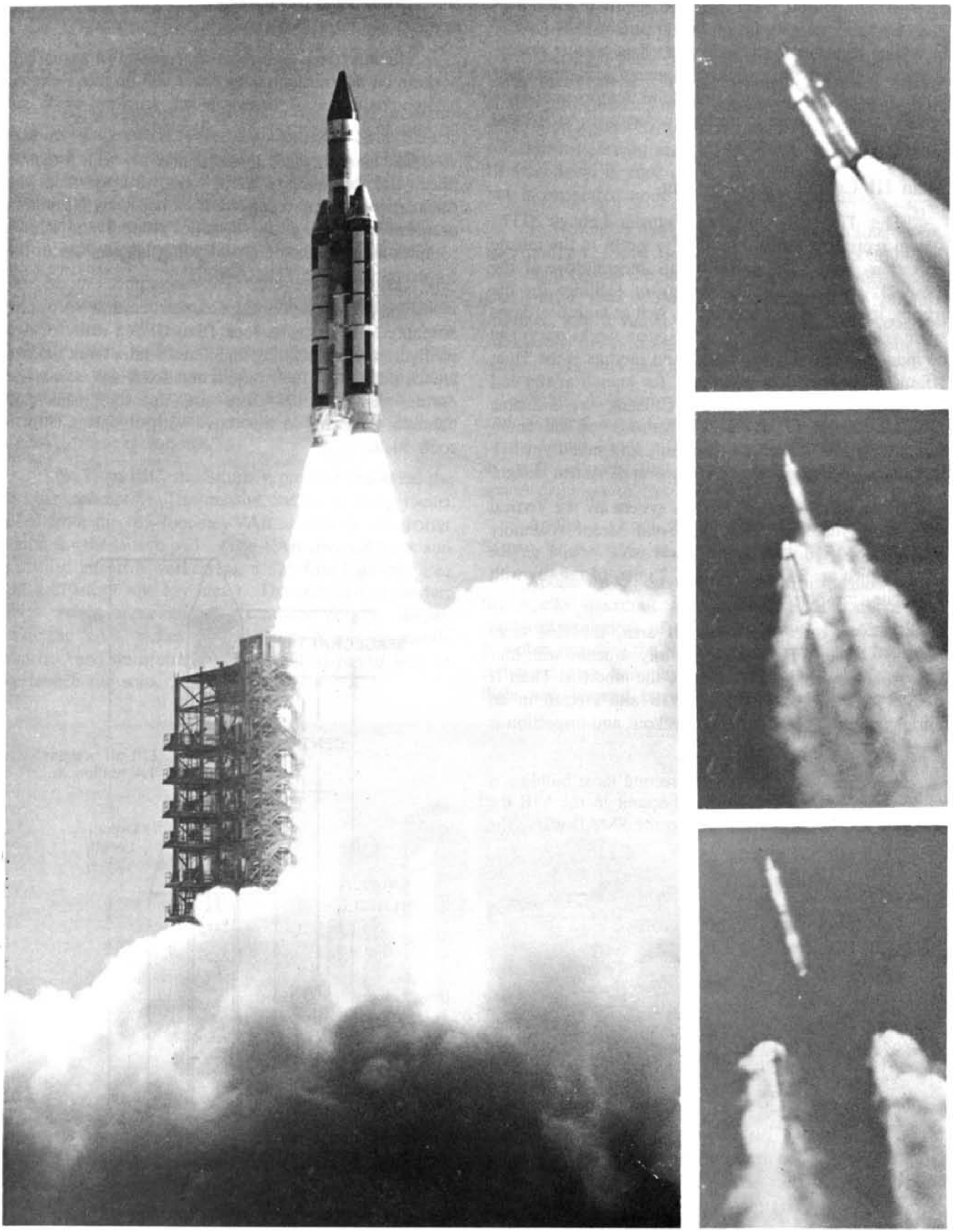
The following figure illustrates several characteristic flight plans that have been performed by Titan III vehicles. Direct injection into elliptical and near-circular low Earth orbits could be achieved by all of the Titan IIIs without upper stages. However, all vehicles in the Titan III family are adaptable to available upper stages that provide additional performance capability.



TITAN III FLIGHT PLAN OPTIONS

Building Blocks to Space

Mission flexibility is further demonstrated by the "building block" concept—a system originated with the Titan III. The "building blocks" are composed of the standard two-stage core, the stretched core, the five-segment solid rocket motor (SRM), and the standard Transtage. Agena and Centaur upper stages, resulting from other USAF and NASA development programs, can also be employed as part of the "building blocks." Additional Titan III "building block" growth configurations were under consideration for performance improvement and new mission applications.



Titan IIIC solid motor separation photographed with Airbone Lightweight Optical Tracing System (ALOTS).

To illustrate the "building block" concept, current Titan III configuration can place efficiently in low Earth orbit payloads ranging up to 28,400 pounds. However, by adding segments to the solid-propellant booster motors (such as an increase to two seven-segment solid-propellant booster motors), and by using solid motors and core vehicle stages of larger diameter, payloads up to 103,000 pounds can be accommodated.

Titan III Complex, ITL System

The Titan III Integrate-Transfer-Launch (ITL) system represents a new "mobile" concept in the missile operations field. Developed as an integral part of the Titan III system, the ITL consists of facilities for the receipt, integration and transfer, as well as launch of large space vehicles and payloads. The system works much like an industrial assembly line whose end product is the Titan III space booster, delivered ready for launch at the end of the line—the launch pad. Utilizing the available facilities, the Titan III takes advantage of maximum standardization, simplified checkout, and minimum risk techniques made possible through overall system design.

Principal elements of the ITL system are the Vertical Integration Building (VIB), the Solid Motor Assembly Building (SMAB), two launch pads with mobile service towers which are 240 feet tall, and 7 miles of railway with a mobile transporter.

As you enter the Titan III area, the first large building you see is the VIB—a 23-story structure with four bays. After arriving at the Cape, the modified Titan II booster (core) is taken to the VIB and erected in an upright position. A complete checkout and inspection is then made of the missile.

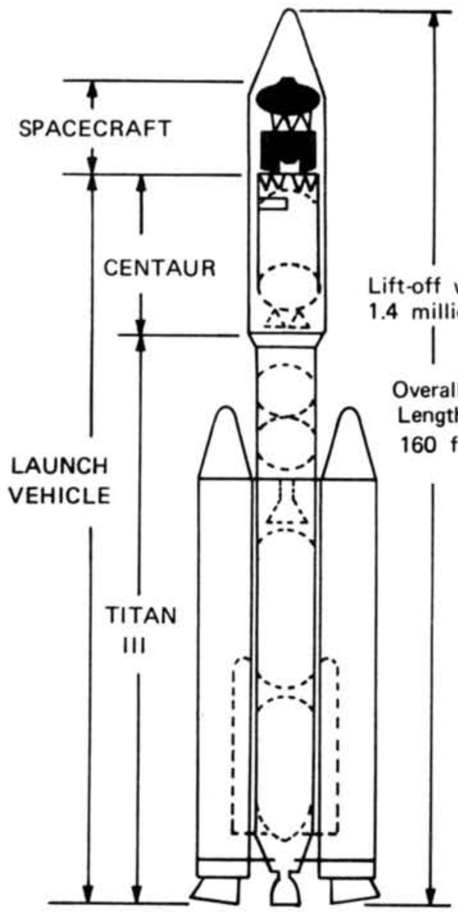
Looking farther north, the second large building is the SMAB. After a complete checkout in the VIB the Titan II core is moved on rails to the SMAB where the two 5-segement, 120-inch solid motors are attached to the core. These solid rocket boosters give the Titan IIIC its tremendous lift-off power at launch.

Aerial view of Titan III Integrate-Transfer-Launch area.

The integrated booster is then moved in an upright position on the transporter by two 1,000-hp diesel-electric locomotives to one of the two launch structures which can be seen in the distance—Pad 40 or 41.

The land on which these facilities are built is mainly filled land, 6½ million cubic yards, dredged from the Banana River. Soil compaction, obtained by placing an overburden of fill at the specific building and launch complex sites, made the use of piling unnecessary in the construction of the ITL.

The ITL concept anticipates simultaneous "off pad" assembly of as many as four Titan IIIs, in either of two configurations, permitting high launch rates from the two launch pads. All fuels (liquid and solid) are storable at normal temperatures—there are no equipment and handling problems as associated with cryogenic (super-cool) fuels.



VIKING SPACE VEHICLE

Complex 39A/B–Saturn V Moon Launch Vehicle

NASA operations moved to the Merritt Island location of Complex 39 for the launches of the Saturn V rocket. The Saturn V, which towers 360 feet high (it is taller than a 35-story building) and has a lift-off thrust of about 7.5 million pounds, is the launch vehicle used for placing the manned Lunar Module (LM) on the Moon with a capability for the return flight to Earth.

Major components of Complex 39 include the Vehicle Assembly Building (VAB), where the space vehicle is assembled and tested; the Launch Control Center (LCC), which houses control equipment for launch operations; the launch site (Pad 39A or 39B), from which the space vehicle is launched on Earth orbital and lunar missions; and the giant crawler-transporter, key to NASA's "mobile concept."

Like Titan IIIC, the Saturn V program employed the "mobile concept." The massive Saturn V lunar rocket rolled from the 465-foot-tall VAB aboard its transporter bound for the launch pad. (The VAB covers 8 acres and is divided into two work areas, a 525-foot high bay area and a 210-foot low bay area.) The crawler-transporter, which weighs approximately six million pounds, slipped inside the VAB, picked up the Saturn V and its mobile launcher, and transferred the 12.5-million pound load to the launch site some 3.5 miles away.

Apollo Missions

The flight phase of NASA's Apollo program began when the combined Apollo Command and Service Module (CSM) configurations were twice successfully launched into suborbital Apollo-Saturn missions by Saturn IB launch vehicles in February and August 1966. Another Saturn IB was flown in four orbits of the Earth in July 1966, but incorporated none of the Apollo modules.

In November 1967, the Apollo 4 mission (there were no Apollos 1, 2 and 3) flew the Saturn V/Apollo in the first flight test of the Saturn V booster, incorporating an Earth-orbit type CSM, a Spacecraft Lunar Module Adapter, and a Lunar Module Test Article. Apollo 4 successfully demonstrated the spaceworthiness of both the Saturn V booster and the CSM.

Apollo 5, flown with the Saturn IB in January 1968 and launched from Complex 34, was a space flight test of the Lunar Module (LM) descent and ascent engines, as well as the first flight demonstration of the spaceworthiness of the LM itself.

Apollo 6 (April 1968) returned to the use of the Saturn V, primarily as another test of the booster.

Apollo 7 (October 1968) was the first manned test of the Apollo spacecraft and included evaluations of the combined operations of the Saturn, the CM and the SM, as well as exercising the NASA manned space flight tracking, command and communications network. This manned flight was boosted by a Saturn IB from Complex 34.

Crawler-transporter with Vehicle Assembly Building in background.

Apollo 8 (December 1968) completed multiple objectives: it was the first manned spacecraft to fly in lunar orbit (for a period of 20 hours); it demonstrated the coordinated performances for lunar missions of the CM and SM hardware (the LM was not flown); it proved the launch vehicle's lunar-injection flight capabilities and the in-flight procedures and equipment over lunar distances; it tested CSM crew performances; and it exercised ground-based mission support facilities and procedures.

Apollo 9 (March 1969) was an Earth-orbital engineering test of a manned LM, the first manned LM flight.

Apollo 10 (May 1969), the last rehearsal for a manned lunar landing, flew an eight-day mission to orbit within nine miles of the Moon. It was the first complete, manned Apollo mission and included a separate eight-hour orbit of the Moon by the LM.

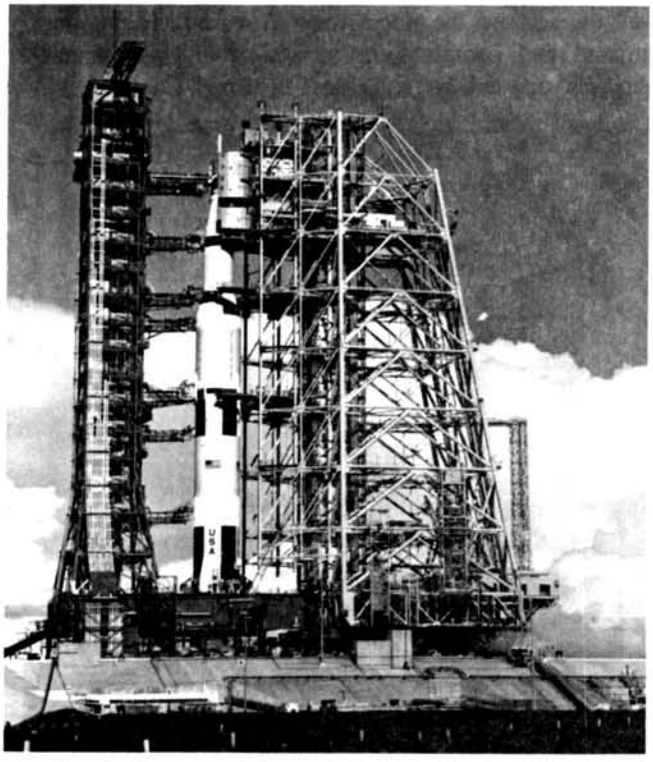
Apollo 11 (July 1969) signaled the success of man's first lunar landing. The crew of Apollo 11 explored the Sea of Tranquility for 2.8 hours, deployed three experiments, then lifted off the Moon after 21.6 hours to rendezvous with the CSM and return to Earth just 98 months after the establishment of a manned lunar landing as a national goal.

Apollo 12 (November 1969), the second American manned flight to the Moon, was launched on a 10-day mission. The astronauts landed the LM in the Ocean of Storms, deployed seven scientific experiments, retrieved parts of the nearby Surveyor 3, performed two selenological (moon astronomical) surveys on November 19 and 20, then lifted-off from the Moon after 31.6 hours to rendezvous with the CSM, returning to Earth after completing a flight of 244.6 hours.

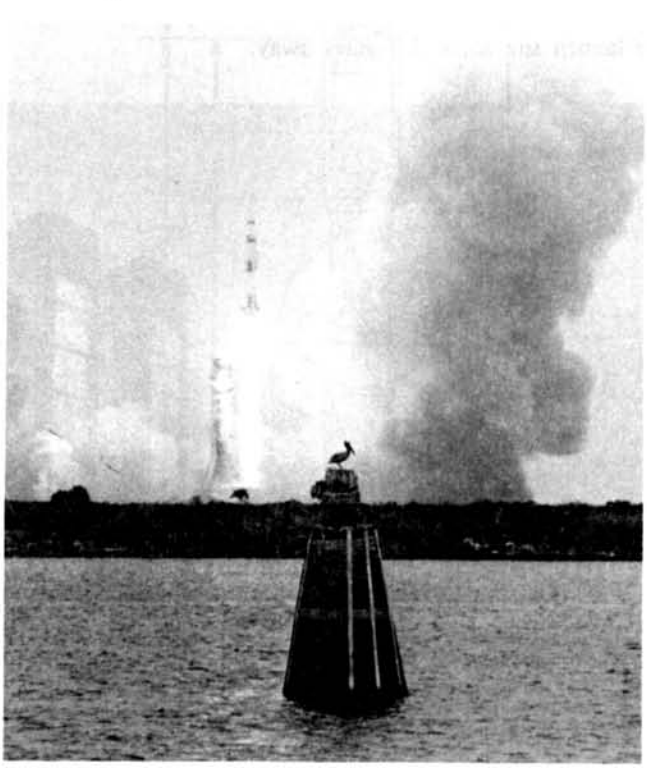
Apollo 13, the third scheduled manned flight to the Moon, was successfully launched 11 April 1970. The three-man crew was four-fifths of the way to the Moon when, late at night on April 13th, an explosion occurred which ripped open an oxygen tank in the service compartment of the Apollo 13 spacecraft. Lunar landing plans were immediately cancelled. On April 17th, after a turbulent 536,000-mile adventure to the edge of the Moon and back, the three-man crew safely landed about 600 miles southeast of Pago Pago in the South Pacific.

Apollo 14 signaled the success of the third manned lunar landing. The first American in space, Astronaut Shepard, and his two fellow astronauts were successfully launched 31 Jaunary 1971. After spending 216 hours in space, 34 hours of which were spent on the surface of the Moon at the Fra Mauro site, the astronauts were safely returned to Earth on 9 February 1971.

Apollo 15 was successfully launched from Complex 39 on 31 July 1971. Its mission was to descend to the surface of the Moon near the majestic mountain range, the Apennine Mountains. After three days of experiments on the Moon's surface, the three astronauts were reunited and safely returned to Earth.



Apollo 11 spacecraft during countdown demonstration, Complex 39A.



Manned Apollo after lift-off.

Complex 43—Weather Rockets

Complex 43, located east of Complex 36B, is the launch area for meteorological (weather) sounding rockets. These weather rockets are launched as part of a worldwide concerted effort to understand the entire atmosphere as well as providing synoptic weather data (atmospheric and weather conditions as they exist simultaneously over a broad area). In addition, these rockets are vital to aerospace research because they often test, at a minimal cost, instruments that will be adapted for on-board satellite systems.

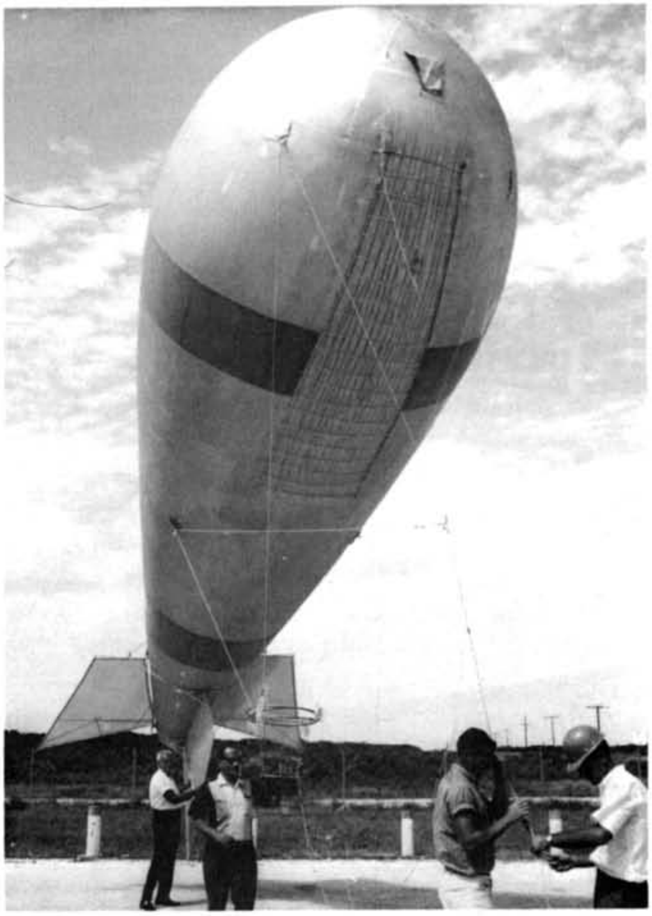
It is difficult to achieve a simpler launcher than this. Weather rockets are hand-placed in launcher tubes prior to lift-off.

Weather towers and balloons provide a vast store of weather data from the Earth's surface to approximately 100,000 feet (the level at which balloons burst). Satellites are effective sources of data above 600,000 feet. It is in the "twilight zone"—the middle region—where meteorological sounding rockets provide atmospheric data at altitudes too low for satellites and too high for balloons.

Sounding rockets are not new—they were fired by Dr. Goddard and members of foreign rocket societies during the 1920s and 1930s. They differ from satellites as they perform up-and-down flights, do not go into Earth orbit, and return data from the upper atmosphere and fringes of outer space by either telemetry or capsule recovery. Low altitude probes usually examine geophysical properties of the upper atmosphere, including atmospheric winds, cloud cover and the properties of the ionosphere (the outer atmosphere where electrical charges affect the transmission of radio signals on Earth). On the other hand, higher altitude sounding rockets return information about cosmic rays, radiation belts, ultraviolet rays, solar flares and other cosmic phenomena. When these rockets go above 4,000 miles they are called geoprobes.

A minimum of four weather rockets were launched weekly from the five launching pads located at Complex 43 in support of experiments for the Air Force Environmental Rocket Sounding System (AFERSS) network (ten stations located in Hawaii, Canada, Alaska, California, New Mexico, Thule, Kwajalein, the Cape and two downrange stations—Antigua and Ascension) and the Air Force Cambridge Research Laboratories (AFCRL). The rockets used in support of the Air Force are the Loki Arcas, Super Loki, and the Viper Dart, with ranges of 200,000, 250,000 and 450,000 feet, respectively. Rockets launched for NASA include the Cajun Dart, Nike and Mighty Mouse. The latter is used in assessing information on electrical discharges.

Payloads released from these unguided fin-stabilized rockets are tracked by C-band radar and by the

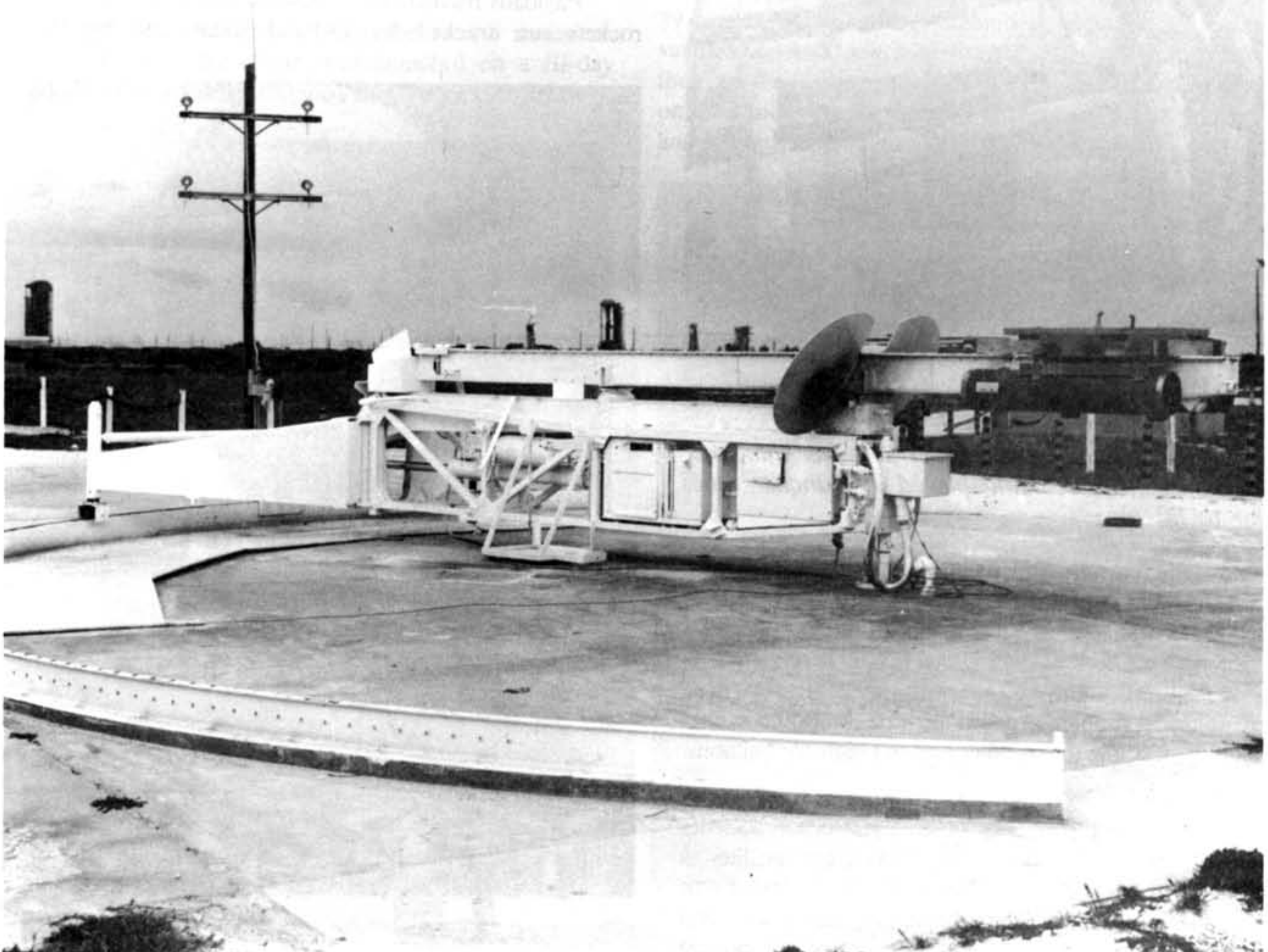


Weather balloon prior to lift-off.

AN/GMC-2 Rawin Set located at the Cape Weather Station. The data gathered is then processed by a general-purpose digital computer (CDC 3100), which provides tabular printouts of weather parameters such as altitude, pressure, temperature. The data is then supplied to Range Users, the Cape Meteorologist, and disseminated on national weather teletype circuits.

The Cape Weather Station and Meteorological Data Reduction Center also supports the Weather Information Network and Display (WIND) system. Sensors installed on 17 towers located at Cape Canaveral and Merritt Island measure wind direction and speed, air temperature, temperature difference and dew point temperature. These 17 towers range in height from 54 to 500 feet.

Air Force meteorologists plotting weather maps.



View of Mighty Mouse launch pad, Complex 43.

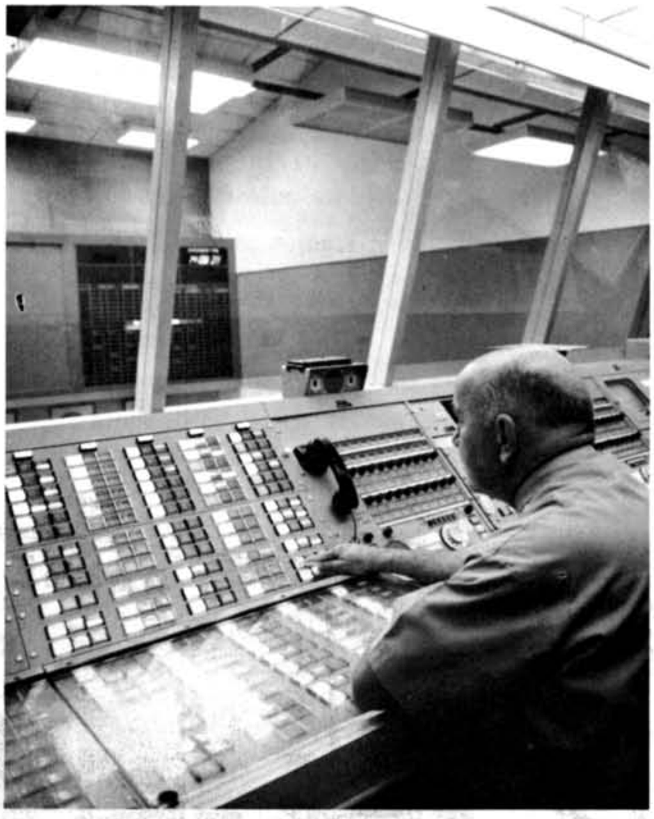
Range Control Center

The focal point for the entire Eastern Test Range is the Range Control Center (RCC). All launches as well as the status of the Range are monitored from this building.

Range Safety

One of the vital functions performed in the RCC is the Range Safety operation. A command destruct console is manned during all launch operations by an Air Force Range Safety Officer (RSO). If a launch vehicle should vary from its course far enough to endanger life or property, the RSO can terminate the flight of the vehicle as he monitors its performance.

Much of the uprange instrumentation is committed to help these officers to make their decisions. Immediately in front of the RSO are plotting boards showing in realtime the missile flight path or present position in rectilinear coordinates. Other plotting boards show predicted impact points (IP) that indicate where missiles will impact if destroyed or if an engine fails at any instant. This prediction is furnished by providing radar and/or telemetry guidance data to a CDC 3600 computer which solves ballistic equations instantaneously to determine the predicted impact point. Above the plotting boards are closed-circuit television screens showing both cross-range (programmed) and downrange (flight line) views of the early portion of the flight.



Range Operations console.

If flight termination is necessary, the RSO actuates the arm/destruct switches. Liquid-fueled ballistic missiles are terminated by shutting off the flow of fuel to the engines and rupturing the fuel tanks. Solid-fueled ballistic missiles are destroyed by blowing out the forward end of the propulsion chamber and/or splitting the entire length of the missile with primacord. Aerodynamic missiles (no longer flight tested on the ETR) were destroyed by blowing off a wing or part of the aerodynamic structure to render them unstable.

If a missile is to be destroyed, it must be destroyed during powered flight, since the impact point cannot be controlled after engine burnout. On a typical ICBM flight to Ascension, for example, this means that the decision must be made in about 5 minutes even though impact would not normally occur for another 15 to 30 minutes.

Range Operations

Another vital function performed inside the RCC is that of Range Operations.

In a typical operations room, the Test Operations Coordinator (TOC) is responsible for overall coordination of scheduled AFETR support of all test operations. These test operations include launches, orbital tracking, satellite command and control, and a large variety of prelaunch and instrumented checkout tests not only for the Air Force but also for the Army, Navy, NASA and other government agencies. These Range Users rely on the support services of the AFETR in their missile and space exploration projects.

The AF Range Control Officer (RCO) is also located in the Operations Room of the RCC. He is responsible for overall control of the AFETR Range resources, including resolution of conflicts in the use of Range instrumentation that occur while tests are in progress.

Several antennas can be seen on the roof of the RCC. The dish-shaped antenna is for the Mod II radar which positions aircraft on special projects in the vicinity of the Cape and tracks weather rockets. The tall multiple dipole antenna on the northern end of the building is the transmitting antenna for a completely independent, mobile generator-powered command control system to protect against electrical power failures in the primary system.

Range Control Center, Cape Canaveral.

Port Facilities/Navy Poseidon Program

Port Facilities

At the southern edge of the Cape is a deep-water port—Port Canaveral—where large missile components are delivered, Range tracking ships are berthed and serviced, and operations are conducted in support of missile-launching submarines used in the Navy Poseidon program. The Port also provides an access point for barges transporting the giant Saturn V rockets to NASA's Complex 39 for prelaunch checkout.

South Side

The south side of Port Canaveral, from west to east, is used by small pleasure boats, and party and commercial fishing boats. This side also has pier facilities for Range Instrumentation Ships (RIS), commercial vessels (primarily carrying petroleum products, lumber and cement), and tugboats used to berth Navy ships at Port Canaveral. The tall silos store bulk cement.

Navy submarine Henry Clay and destroyer Richard E. Kraus at Port Canaveral.

North Side

On the north side are the military port facilities. The facilities serve, from west to east, the Marine Recovery Vessel, an LCU which is instrumented for use as a missile recovery boat in the Canaveral and Bahama areas; Military Sea Transport Service (MSTS) vessels that carry heavy cargo to downrange stations, as well as RIS also operated by the MSTS; and U. S. Navy-operated nuclear-powered Poseidon missiles.

In addition to the Army Transportation Corps, the office buildings in the cargo area are occupied by the Port Captain, the Marine Recovery Operations Section, and the MSTS officers and men.

On the water tower at the east end of the area is a red strobe light which flashes when a Poseidon submarine is docked or entering port, as an indication to all boats to maintain a minimum distance of 100 yards from the Navy area. Another warning device is located on a pole near the rock jetty at the southeast corner of the Cape. Using a flashing red light at night or a hoisted red balloon during daytime, it warns small boats that the prohibited area off the Cape is active.

Range Instrumentation Ships (RIS)

Range Instrumentation Ships (RIS), in addition to instrumented aircraft, provide data coverage in areas between land stations. These ships are occasionally berthed in the Port.

The ships are equipped with an integrated tracking and data recording instrumentation complex. They have similar instrumentation and data capabilities, providing digital and analog inertially referenced trajectory data, multiple frequency radar cross-section data on multiple targets, complete telemetry data on all major links, meteorological data, and miscellaneous film and chart data. The ships support tests in the Pacific as well as the Atlantic Ocean.

Navy's Polaris/Poseidon FBM

Several of the Navy's Fleet Ballistic Missile (FBM) submarines are equipped to launch either Polaris or Poseidon missiles. Two versions of the Polaris missile (A-2 and A-3) are already operational. The new Poseidon (C-3) missile, outfitted with separately targeted warheads, was in its final stage of development at Cape Canaveral.

The first land-pad launch of Poseidon occurred from Cape Canaveral on 16 August 1968; the first launch from the missile test firing ship, the USNS Observation Island, occurred 16 December 1969; and the first submerged firing occurred 3 August 1970 from the USNS James Madison.

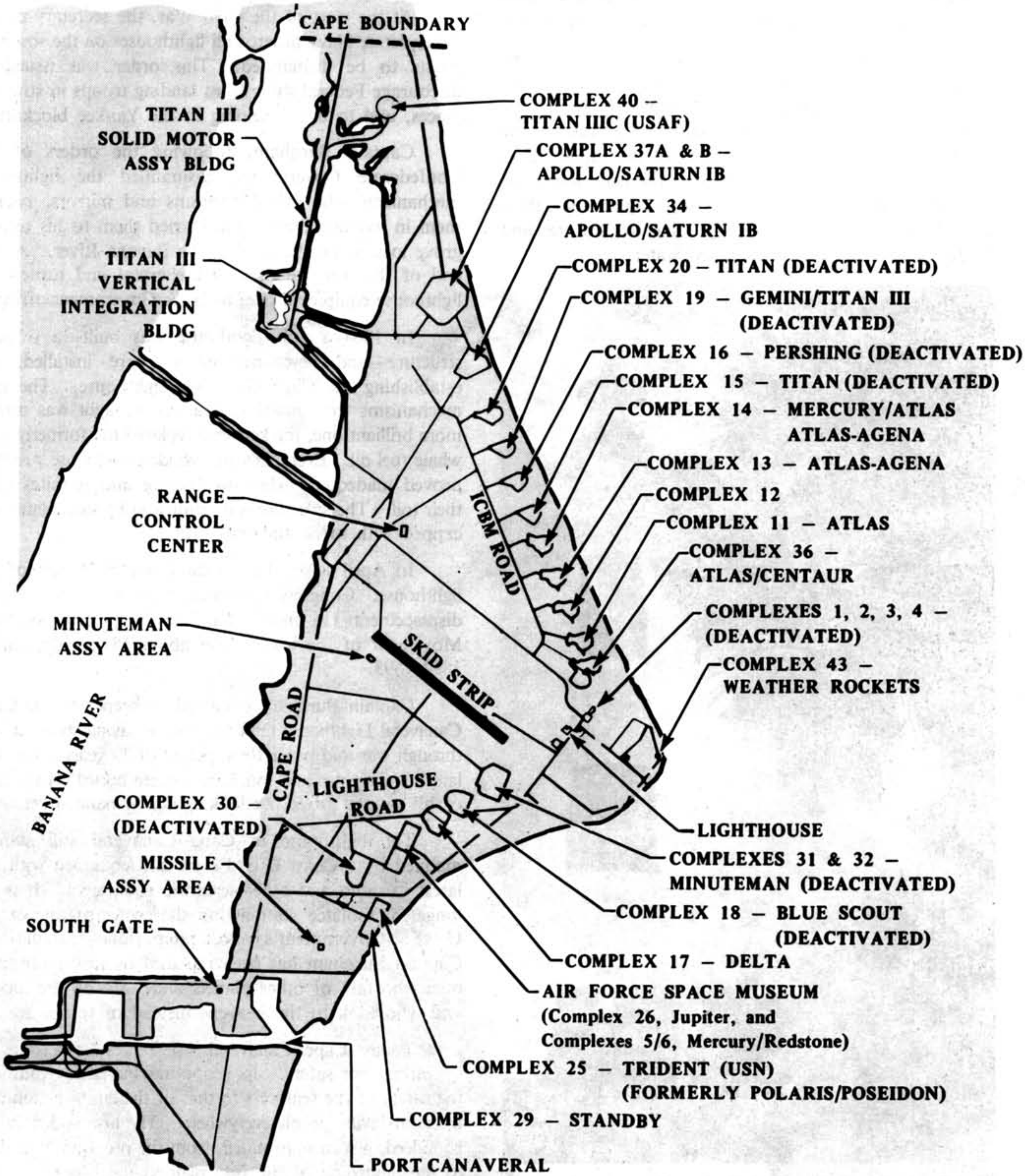
The Poseidon missile is larger than the Polaris and much more advanced. It doubled the payload of the Polaris A-3 and was twice as accurate. Overall, the Poseidon was eight times more effective than the A-3 and, through incorporation of penetration aids, its effectiveness against a hardened target was greatly increased.

The Poseidon missile is carried by the Navy's 41 FBM submarines. The present worldwide network of Polaris facilities, including overseas anchorages and continental U. S. missile assembly facilities, provides the necessary base on which Poseidon can be integrated into the fleet.

Polaris A-3 launch from submarine at sea.

Range Instrumentation Ship.

CAPE CANAVERAL AIR FORCE STATION



Lighthouse History

In our frenzied endeavor to explore outer space, a small community on the East Coast of Florida has repeatedly become illuminated in the eyes of the world. Cape Canaveral—with its missile launchings and space explorations—has come to represent defense and safety.

This is not the first era in which the Cape has been such a representative. In 1843 this point along the coast was selected as a place of protection and safety for seafaring men and vessels as they sailed along these coastal waters. For many years the waters of the Indian River and the vast ocean to the east were the only means of transportation up and down the coast. **Lighthouses, thus, played a most important role—guiding the seafarer and leading him to safe and protected waters.**

The lighthouse was re-erected at its present site in 1894.

One of the first lighthouses to be built along our coast was at Cape Canaveral. The original lighthouse was constructed of brick, with construction beginning in 1843 and completed in 1847. It was not until 1853, however, that a permanent lighthouse keeper—Captain M. O. Burnham—was to arrive and stay.

At the start of the Civil War, the secretary of the Confederate Navy ordered all lighthouses on the southern coasts to be dismantled. This order was issued to discourage Federal ships from landing troops in strategic places, and to avoid helping in the Yankee blockade.

Captain Burnham, following the orders of the Confederate Government, dismantled the lighthouse mechanisms—the valuable prisms and mirrors, packed them in wooden crates, and carried them to his orange grove located on the edge of the Banana River. At the end of the war, he dug up the crates and turned the lighthouse equipment over to U. S. Government officials.

In 1868 a new lighthouse was built—a wooden structure—and new mechanisms were installed, re-establishing the Cape Canaveral lighthouse. The new mechanisms were made in France; the light was now a more brilliant one, for kerosene replaced the formerly used whale fuel oil. Eventually the wooden lighthouse structure proved inadequate when weathering and termites took their toll. The structure was reinforced by steel plates and capped with brick and concrete.

In April 1886, the sea came within 70 feet of the lighthouse. Congress appropriated funds for the beacon's displacement 1½ miles inland to its present location. Movement of the tower took about 18 months during 1892-1893.

Captain Burnham remained as keeper of the Cape Canaveral Lighthouse until his death—having served it well through war and peace for a period of 30 years. He, and later his daughter and son-in-law, were buried on the edge of his orange grove overlooking the Banana River.

The lighthouse at Cape Canaveral still stands, manned by a Coast Guard crew and equipped with the latest in radio and other scientific equipment. It is no longer an isolated station, but the center of one of the U. S. Government's most important installations. Captain Burnham has been replaced by new pioneers—men who talk of other planets and walk on the moon, and who look to the heavens instead of to the sea.

Today Cape Canaveral still serves as a base of operations for safety. Its scope has increased from just the safety of the seafarers to that of the entire nation and freedom-loving people everywhere. The historic lighthouse is, indeed, a witness to much, from the pre-Civil War days to the launching of the first men to the Moon.

Captain Burnham was the third lighthouse keeper, serving from 1853 until his death in 1886.

Miscellaneous

Cemeteries

There are approximately 40 gravesites located on the Cape. These graves, recent ones as well as those of early settlers and others marked "unknown," are carefully protected, identified and preserved by the Cape Range Contractor.

This gravesite, which is typical of those at Cape Canaveral, is located near a large Indian burial mound.

The main burial plot has several graves which are located on the median strip just inside the south gate on Cape Road. Most of the other gravesites are family burial plots which were on the settler's individual homestead. One of these burial plots contains the grave of Captain Burnham, one of the first Cape lighthouse keepers, who died in 1886. Many other gravesites, equally as old, are carefully preserved in honor of these former inhabitants of the Cape.

Indian Mounds

In 1950 when construction of missile launch sites began at the Cape, excavations of the land uncovered many artifacts which indicate there had been a primitive civilization in the region. The majority of these artifacts were uncovered from Indian burial mounds and middens (large refuse mounds) at the Cape and on Merritt Island.

The one known remaining Indian mound at the Cape is near the unmarked grave of Captain Burnham, mentioned above. This mound and others were examined by a crew of archaeologists who visited the Cape in the 1930s under the auspices of the Smithsonian Institution.

Preparation of the typical burial mound found in Florida began with a shallow circular hole where the basal zone was composed of sand and charcoal. A few burials would begin at this level with sand covering them to form a low mound. Other bodies were added with more sand covering them. The size of the mounds would depend upon the number of years used and the size of the village. Some of the mounds were hastily prepared, with an entire population seemingly "dumped." The skeletons from these hastily prepared mounds were of all ages and were relatively unharmed, indicating that the Indians were probably wiped out by epidemics, mostly of European origin.

From the large burial mounds found along the coastal areas of Florida, archaeologists and anthropologists have been able to reconstruct the various levels of Indian culture, with the more recent burials placed at the upper levels. The more prominent Indians, such as chiefs and sub-chiefs, would almost always be buried in the center area of the mound, and were occasionally accompanied by their wives (they were polygamous) and bucks. Artifacts buried with the dead included pottery shards, shell dippers, knives and chipped projectile points, and jewelry, indicating the Indians believed in life after death. Several burial mounds contained partial skeletons, possibly indicating the Indians were also cannibals.

Any prehistory knowledge as to what Indians existed here and where can only be surmised. They probably came to the Cape by sea and lived from sea harvest. Some writers have speculated that one of the tribes that might have lived here were the "Carib."

Research on the Carib (short for Caribales, or cannibals) Indian reveals that they were scattered through the Amazon Basin, the Guianas, and the Caribbean, and varied considerably in appearance and culture. Because the Carib were hostile to both the Spaniards and friendly Indians, the term was extended to include all hostile Indians.

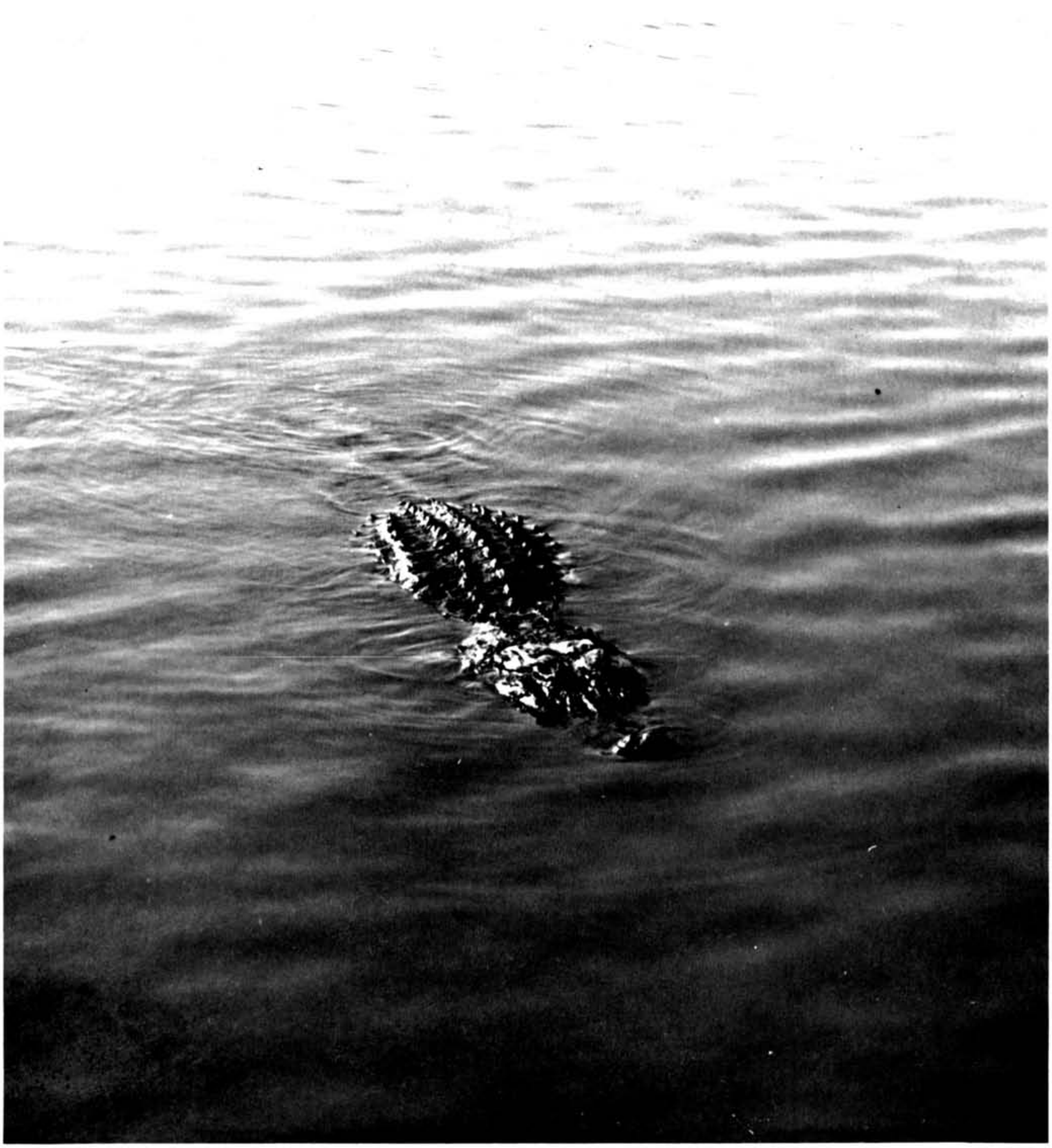
However, if legend and historical records are correct, the first visitors at the Cape were probably the aboriginal Ais. It is known that the Ais inhabited the Indian River, which was referred to as the Ais River (or Ais-to-chatee-hatchee) by the Spaniards, other Indians, and early settlers. These Indians disappeared from the area long before the arrival of Captain Burnham and other lighthouse keepers.

Wildlife

Cape Canaveral is not only a missile site but a wildlife refuge as well. This scrubland is a home for such uncivilized creatures as mosquitoes, alligators, reptiles, lynxes, scorpions, raccoons, bobcats and wild pigs, to name a few. This wildlife is protected from hunters, and food, such as wheat, oats and rye, has been planted at various times to aid them. 'Gators located in ponds have become so tame that Cape workers regularly visit them, feeding them marshmallows and bread.

Estimates on the number of deer at the Cape run as high as 1,000. (This figure does not include deer located within NASA property on Merritt Island.) An average of 50–60 deer per year are accidentally struck and killed by cars traveling on the Cape roads late at night.

The Cape is a bird sanctuary as well. For a number of years the local Audubon Society has registered one of the highest counts of bird species in the United States (as many as 225 varieties, including dove, duck, quail, Canadian geese and the American bald eagle).



Wildlife are in abundance on both the Cape and Merritt Island. This friendly fellow is one of several who enjoy marshmallows and bread fed by Cape workers.

FOOTNOTES

[1]Tebeau, Charlton W., *A History of Florida,* Coral Gables, Fla., University of Florida Press, 1971, p. 16.

[2]Ibid., pp. 9, 12.

[3]Ibid., p. 13.

[4]Ibid., pp. 16, 17.

[5]Ibid., p. 17.

[6]Ibid., pp. 16, 17.

[7]Cato, Homer, Historian-Archaeologist, Micco, Florida, personal interview, 2 August 1971.

[8]Tebeau, op. cit., p. 15.

[9]Ibid., p. 18.

[10]Marx, Robert F., *Shipwrecks in Florida Waters,* Eau Gallie, Fla., Scott Publishing Co., 1969, p. 1.

[11]Ibid., p. 2.

[12]Patrick, Rembert W., et. al., *Florida Under Five Flags,* 4th ed., Gainesville, Fla., Univ. of Florida Press., 1967, p. 2.

[13]Tebeau, op. cit., p. 19.

[14]Ibid., p. 32.

[15]Ibid.

[16]Patrick, op. cit., p. 8.

[17]Tebeau, op. cit., pp. 34, 35.

[18]Kerrigan, Anthony (translator), *Barcia's Chronological History of the Continent of Florida,* Westport, Conn., Greenwood Press, 1970, p. 187.

[19]Tebeau, op. cit., p. 35.

[20]Kerrigan, op. cit., p. 98.

[21]Tebeau, op. cit., p. 36.

[22]Ibid., p. 37.

[23]Marx, op. cit., pp. 8, 15 and 17.

[24]Ibid., p. 12.

[25]Ibid.

[26]Ibid., pp. 12, 15 and 16.

[27]Ibid., p. 31.

[28]Ibid., pp. 28, 31.

[29]Ibid., p. 31.

[30]Kerrigan, op. cit., pp. 51, 52.

[31]Ibid., p. 52.

[32]Ibid., p. 37.

[33]Ibid., p. 38.

[34]Ibid.

[35]Williams, Ada Coates, "Brevard County," Chapter XXI, *East Coast of Florida,* Vol. I, Del Ray, Fla., Southern Publishing Co., 1962, p. 257.

[36]McPhee, John, *Oranges,* N. Y., Farrar, Straus and Giroux, 1967, pp. 90, 91.

[37]Ibid, p. 89.

[38]Williams, op. cit., p. 257.

[39]Ibid., pp. 257, 258.

[40]Article "Arsonists of Castle Tracked," "Today" newspaper, Cocoa, Fla., Saturday, December 30, 1967.

[41]Williams, op. cit., p. 258.

[42]Ibid., p. 259.

[43]Ibid., p. 261.

[44]Ibid.

[45]Ibid., p. 262.

[46]Ibid., p. 263.

[47]Ibid.