AGREEMENTS/SUBAGREEMENTS APPLICABLE TO WALLOPS 11/12/91

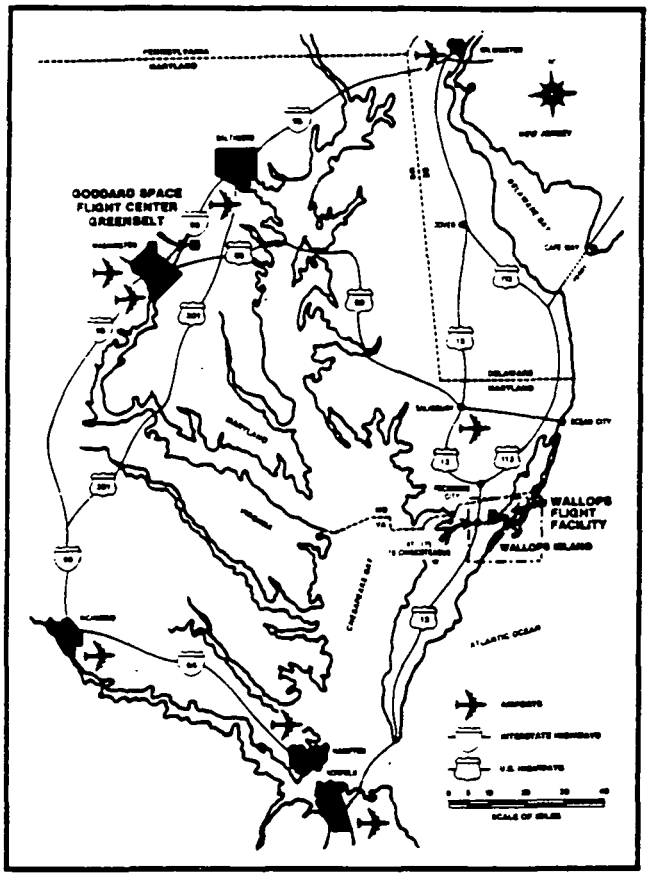
Company/Agreement	Subagreement Status
SSI/EER Agreement (old) Signed 9/4/86 Agreement (new) Signed 3/26/91	-Three launches supported at WSMR. Launch number four in progress. All new support now expected to be requested under new Agreement. -SUBAGREEMENT is required for WFF support and is in review at Headquarters. COMET launch scheduled for late 1992.
LTV Agreement Signed 11/21/88	-Initial discussions held for support activities at WFF. SUBAGREEMENT for support is required. No further progress to date.
Conatec Agreement (old) Signed 5/22/89 Agreement (new) Signed 12/21/90	-Initial discussions held for support at WFF and other locations. No progress to date. All support now expected to be requested under new Agreement. -SUBAGREEMENT is required for WFF support. No further progress to date.
OSC Agreement Signed 7/3/90	- SUBAGREEMENT is required for WFF support and is in review at Headquarters. First launch support scheduled for early 1991.

Geography

The Wallops Flight Facility (WFF) is a part of the NASA Goddard Space Flight Center in Greenbelt, Maryland.

Wallops Flight Facility is located on Virginia's Eastern Shore approximately 40 miles southeast of Salisbury, Maryland, and 150 miles southeast of Greenbelt. Wallops consists of three separate sections of real property — the Main Base, the Wallops Island launch site, and the Wallops Mainland — comprising a total of 6,200 acres and 84 major facilities valued at more than $105 million. Approximately 380 civil service and 560 contractor employees staff the installation with an annual payroll of more than $30 million.

Wallops is comparable to a small town in many respects. For example, it has fire and security protection, water and sewage treatment plants, trash collection, roads, street lights, electrical lines, water and sewage lines, bus service, a library, and a health clinic to operate and maintain, along with other services to the "residents" of Wallops.



Location Map

History

In 1945, the National Advisory Committee for Aeronautics (NACA) added a new dimension to its capability for aerodynamic research at high speeds when it authorized the Langley Research Center to proceed with the development of Wallops Island as a site for research with rocket-propelled models. This step was prompted in large part by the need for extending capabilities for aerodynamic research through the speed of sound and into the supersonic range of speeds with continuous coverage of flow phenomena at all speeds involved. Transonic wind tunnels had not yet been developed, and supersonic wind tunnels were far from adequate for exploration of the many aerodynamic problems that required immediate consideration.

The availability of small solid-fuel rockets and advances in instrumentation made progress possible with a wide variety of experiments that could not be performed using existing research capabilities. The great demand for aerodynamic information of all kinds at continually increasing speeds was met by constant improvement in the techniques for applying rocketry and flight instrumentation techniques to acquire a broad spectrum of scientific and engineering aerodynamic data. Rocketry and instrumentation were considered only as a means to an end, continually being improved and varied to provide a thoroughly coordinated supplement to the constantly advancing capability of ground-based research facilities.

Starting with initial operations in 1945 and continuing throughout the years, Wallops Flight Facility, as a launching site used for science and research purposes, has retained a flexibility and responsiveness to the continually varying requirements of scientific research to achieve important advances in aeronautics and space science. Nearly all requirements for propulsion have been met with relatively small solid rockets staged in various ways to meet the needs of any given research task. The largest and most sophisticated of the launch vehicles has been the versatile Scout four-stage solid-fuel vehicle, capable of launching small scientific satellites, space probes and re-entry missions.

A very important result of the programs carried out at Wallops was effective preparation of the NACA to take on responsibilities as the nucleus

of the National Aeronautics and Space Administration (NASA). The know-how and knowledge stimulated and developed during the research programs at Wallops coupled with NACA research activities with man-carrying aircraft at the Dryden Flight Research Center, Edwards, California, helped prepare the NACA for its subsequent responsibility.

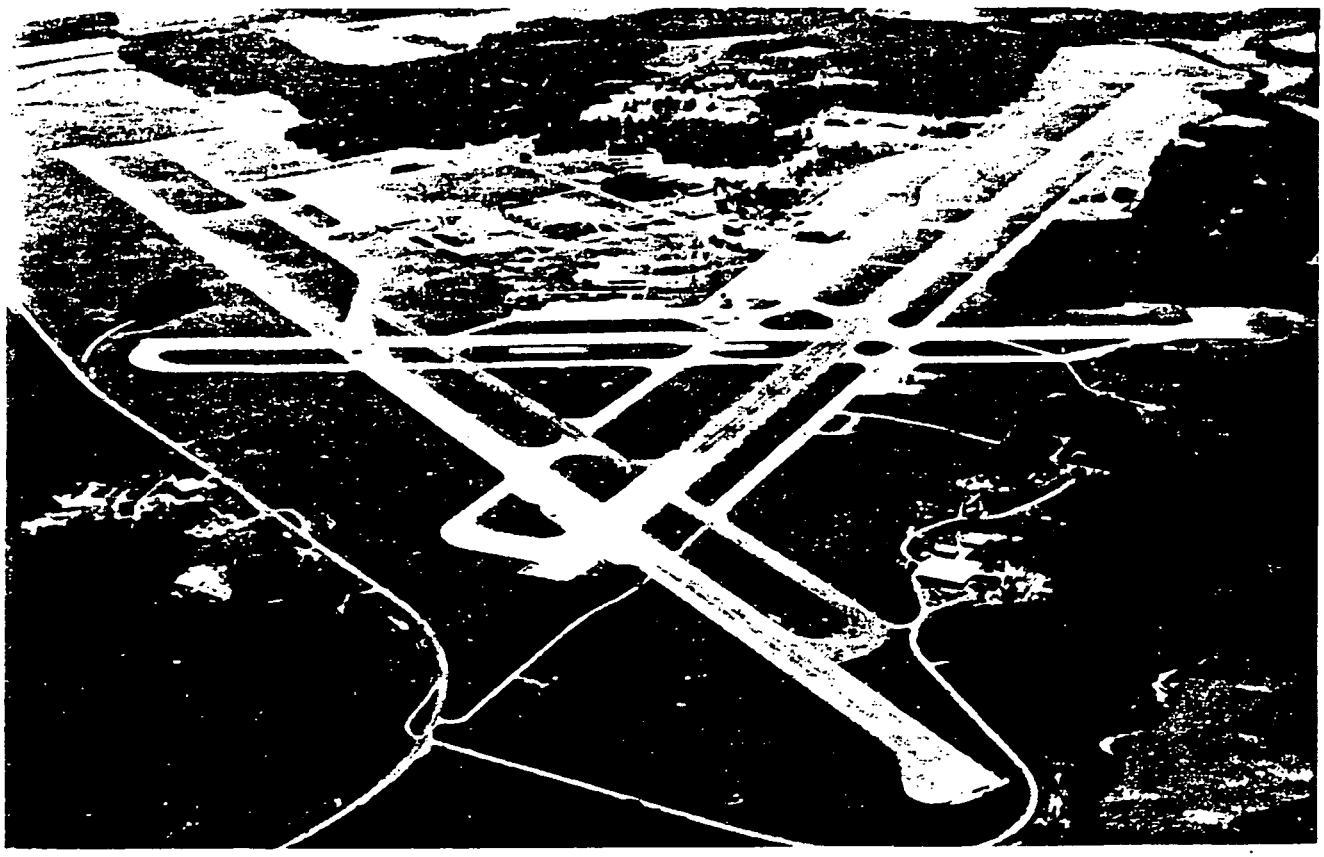
After NASA was established in 1958, the Navy decided to close its Chincoteague Naval Air Station, which was located about seven miles northwest of Wallops Island. In 1959, NASA Wallops expanded and took over these existing facilities, which included buildings, utilities, hangars and an excellent airport.

Today, WFF is at the center of NASA's Suborbital Programs. Sounding rockets, balloons, and aircraft are used actively in NASA programs concerned with space science, applications, advanced technology, and aeronautical research. Missions are conducted locally and throughout the free world.

Twenty-one satellites have been orbited from Wallops since 1961, including the first satellite to be launched by an all solid-fuel rocket vehicle — Explorer IX. Included in these small scientific satellites are micrometeoroid, geodetic, solar, radiation detection, weightlessness on inner ear, stratospheric aerosol, high-energy and astrophysics experiments.

Mission

The primary mission of the WFF is to manage and implement NASA's sounding rocket and balloon programs, to conduct observational Earth sciences studies, to provide aircraft and other flight services, and to operate a launch range and research airport in support of these and other activities. WFF has the diversity of skills and facilities to provide management, design, development, fabrication, testing, operations, tracking, and data acquisition. WFF is committed to provide quick response services that are safe and low cost. When required, Wallops will use its unique resources to support other programs.



Wallops Main Base

Space and Earth Sciences

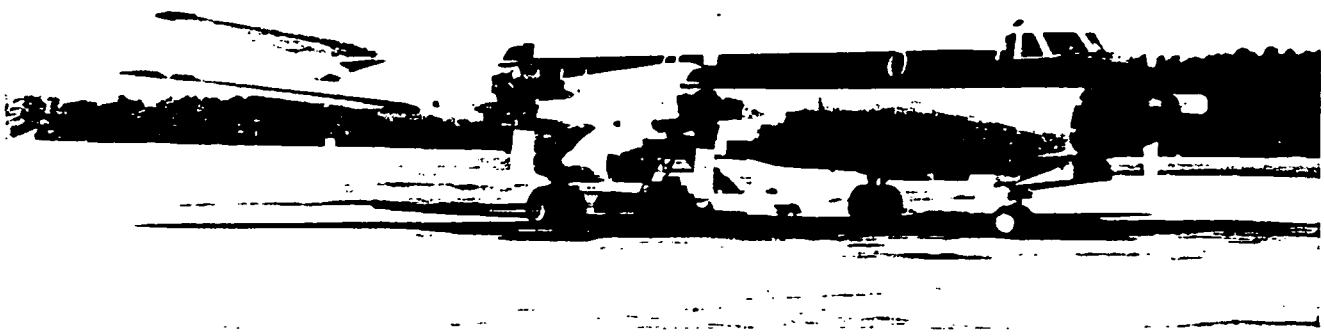
Wallops uses the specialized skills available at this facility to identify, plan, and conduct scientific studies related to NASA Earth Science programs. A description of some of the current research programs follows.

Atmospheric Dynamics - These studies are primarily aimed at increasing the accuracy of measurements used in weather forecasting. Rockets and balloons are regularly launched at Wallops to confirm the calibration and validity of pressure, dew point, wind speed, and temperature measurements. These rocket and balloon measurements also provide calibration of data taken by meteorological satellites. The measurement profiles are compared with satellite readings to determine whether satellite measurements have changed over time due to sensor aging or failure. Sensor correction and measurement quality studies and recommendations are made by Wallops. These help insure the compatibility and accuracy of measurements made by different rockets, balloons, and satellite instruments throughout the world. In addition, atmospheric behavior and structure are studied by this group. In conjunction with other investigators, research is conducted on the interactions between atmospheric electricity and chemistry. This work will contribute to a better understanding of the Earth's atmosphere and its extremely complex nature.

Atmospheric Optics - Experimental and theoretical studies aim at a better understanding of how light interacts with the atmosphere. Processes that occur in the air on Earth receive the most attention, but atmospheric interactions on other planets are also of interest. Programs include laboratory measurements of the scattering and absorption of light by the molecules and particulates (aerosols) that make up an atmosphere. A parallel program develops mathematical models of these processes. Through such projects atmospheric constituents are being measured. For example, two important gasses — ozone and nitric oxide — through their unique interactions with light can now be measured remotely from space and aircraft.

Ocean Physics - NASA Wallops studies ocean physics to monitor and measure such important and diverse variables as ocean wave height and ocean biological activity. New instruments are developed which enable measurements to be made through remote sensing of the oceans by aircraft or satellites. These instruments make direct measurements or are used to acquire complimentary data. Two basic study areas of ocean physics are emphasized, microwave altimetry for ocean surface studies, and ocean color for ocean biology studies.

Microwave Altimetry includes research to determine the average sea surface height over the globe as well as small scale variations caused by currents or gravity effects. Investigations also determine ocean surface currents from satellites and aircraft as well as measurements of ocean surface wave structure.



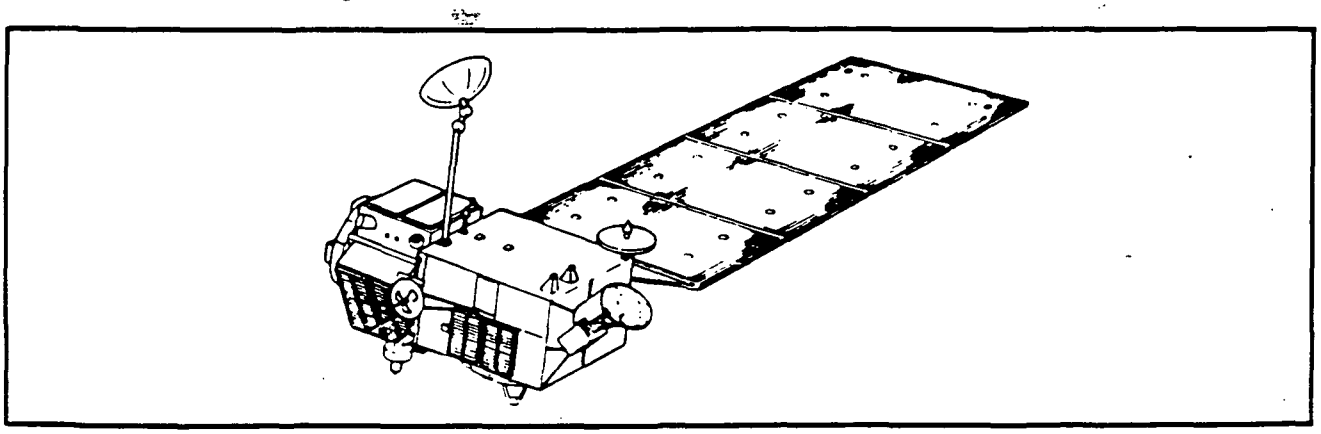
Wallops P-3 Aircraft

These altimeters can also measure land topography. Complimentary instruments precisely measure the location of relative and geocentric positions of well-marked land points. Wallops has developed spacecraft altimeters flown on the Geodynamics Experimental Ocean Satellite (GEOS-3) in 1972, and on the Sea Satellite (SEASAT-1) in 1978. New Wallops altimeters will fly on the Ocean Topography Experiment Satellite (TOPEX) in 1992 and on the Mars Observer Satellite in the 1990's. The Surface Contour Radar (SCR) is another Wallops research instrument which is flown on the Wallops P-3 aircraft.

Ocean Color Research centers on the study of visible and near infra-red (IR) radiation and reflectance from the ocean. This research provides valuable information on biological and physical processes occurring in the ocean and on ocean circulation and sedimentation. The Wallops Airborne Oceanographic Lidar (AOL) is an aircraft research instrument which studies ocean color by two methods. In the passive mode, a 32-channel spectrometer analyzes the light reflected from the ocean due to normal sunlight. In the active mode, a laser is fired downward from the aircraft and the resulting spectrum analyzed. These two modes together aid greatly in the determination of phytoplankton and chlorophyll concentrations and the identification of single-celled plants in the water. This information is also used by other scientists to understand the complete marine food chain of the oceans.

Wind-Wave-Current Interaction - This research is centered around the Wallops 'Wave Tank.' This unique facility is used to study the complex processes that occur at the boundary between earth's atmosphere and oceans. The tank itself is 60 feet in length, 3 feet wide and 4 feet deep, containing approximately 5,000 gallons of water. Environment stimulation machinery can produce winds from 0 to over 50 miles per hour and reversible water current of up to 100 gallons per second. In addition, hydraulic drives can produce a variety of wave patterns from either or both ends of the tank. This facility is one of very few world-wide in which air-sea interactions can be studied under controlled conditions. The facility is highly instrumented by many sensors to precisely measure conditions during experiments. Two mini-computers and a PC-type computer provide control, measurement and data analysis for the facility. Basic research and instrument development are performed by NASA, other government agencies, and universities. Typical research programs include short-wave modification by long-waves, wave interaction on current, rain effects on microwave scattering from the sea surface and gas exchange rates versus radar scatterometer power.

Research Flight Support Activities - NASA Wallops has performed pioneering studies in the use of the Global Positioning System Satellites (GPS) to determine precise location and altitude of research aircraft during experimental flights. This research has provided instrumentation which will define the position of an aircraft and its instruments to less than 10 centimeters (3.9 inches) in latitude, longitude and altitude. Continuing studies will also provide data on motion dynamics to further enhance experiment data. In addition, through the Navigational and Environmental Measurement System (NEMS), instruments are available to provide information on outside air temperature, dew point and pressure, as well as precise aircraft roll and pitch attitude, and vertical acceleration.



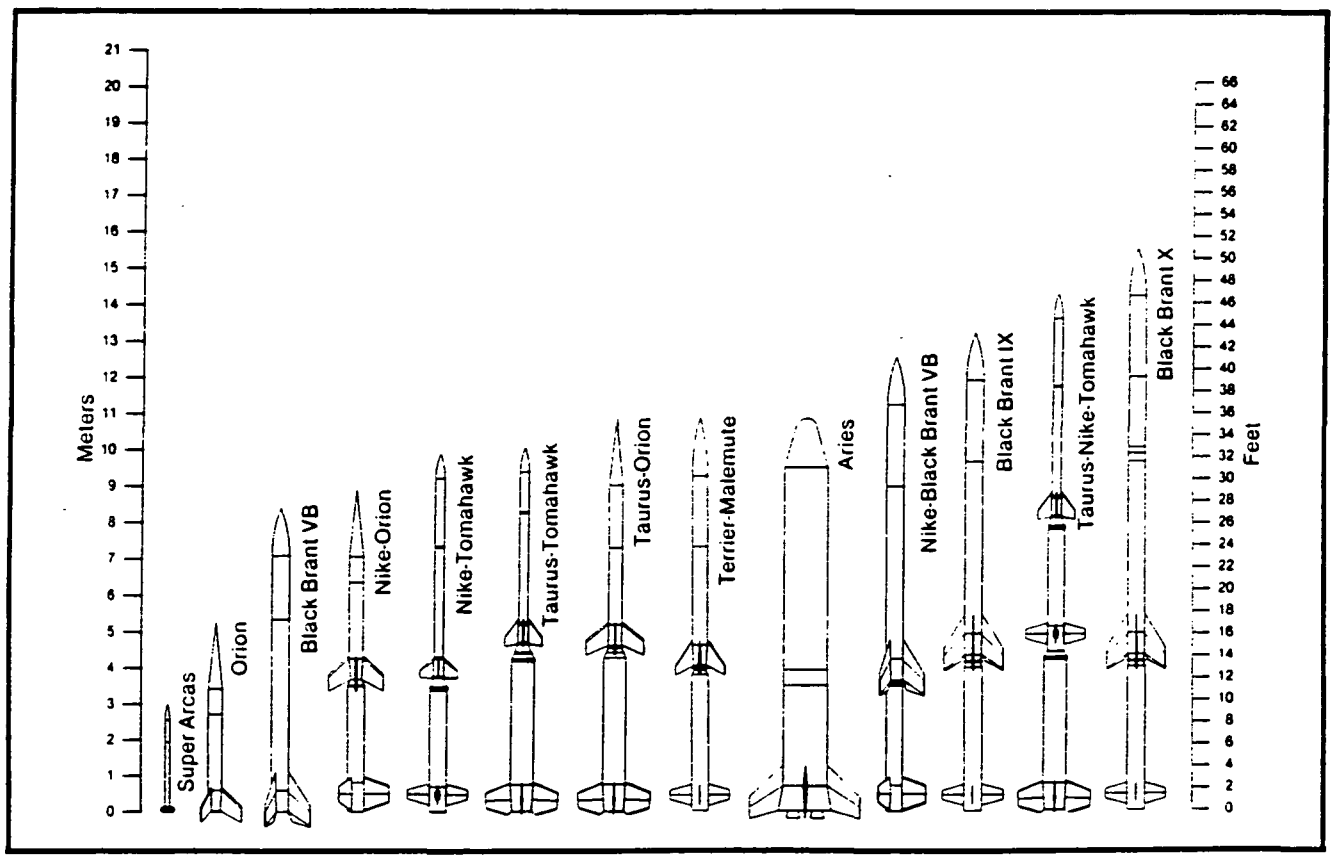
Topography Experiment Satellite (TOPEX)

NASA Sounding Rocket Program

The NASA Sounding Rocket Program, managed by Wallops, provides sounding rocket launch vehicles which carry research payloads with scientific instruments to altitudes ranging from thirty miles to approximately six hundred miles (three to four times higher than the space shuttle). The experiment time above the Earth's atmosphere ranges up to 15 minutes. Scientific data are collected and usually returned to Earth by telemetry links. Parachutes often are used to recover the instruments for reuse and special high-altitude parachutes sometimes are used to retard descent velocity so that experimenters have more time to gather data at high altitudes.

Sounding rockets provide the only means of making in-situ measurements at altitudes between the maximum altitude for balloons (about 30 miles) and the minimum altitude for satellites (about 100 miles). The Sounding Rocket Program serves not only NASA but other government agencies, universities, industry, and foreign countries as well. The program is, by design, a low-cost, quick-response activity when compared to Agency orbital missions.

The sounding rocket allows space scientists to conduct investigations at a specified time and place. The experiments provide a variety of information, including high altitude wind shear and velocity; density and temperature of particles in the upper atmosphere; properties and changes in the ionosphere, the natural radiation surrounding the Earth; and data on the Sun, stars, galaxies, nebulas, planets, and many other phenomena. Atmospheric scientists use sounding rockets to investigate the chemical makeup and physical processes taking place in the atmosphere, while scientists in the field of plasma physics investigate the energetic particle population in space and in the Earth's atmosphere. Sounding rockets assist both solar scientists' investigations of the Sun and its makeup, physics, variability, and its effect on the Earth, as well as scientists' studies of the universe outside the solar system to better understand its origin and the processes that occur there. Many graduate students are supported by and earn their degree based on their participation in this original research. Sounding rockets also are used to test and develop devices and instruments for orbital flight.



NASA Sounding Rockets

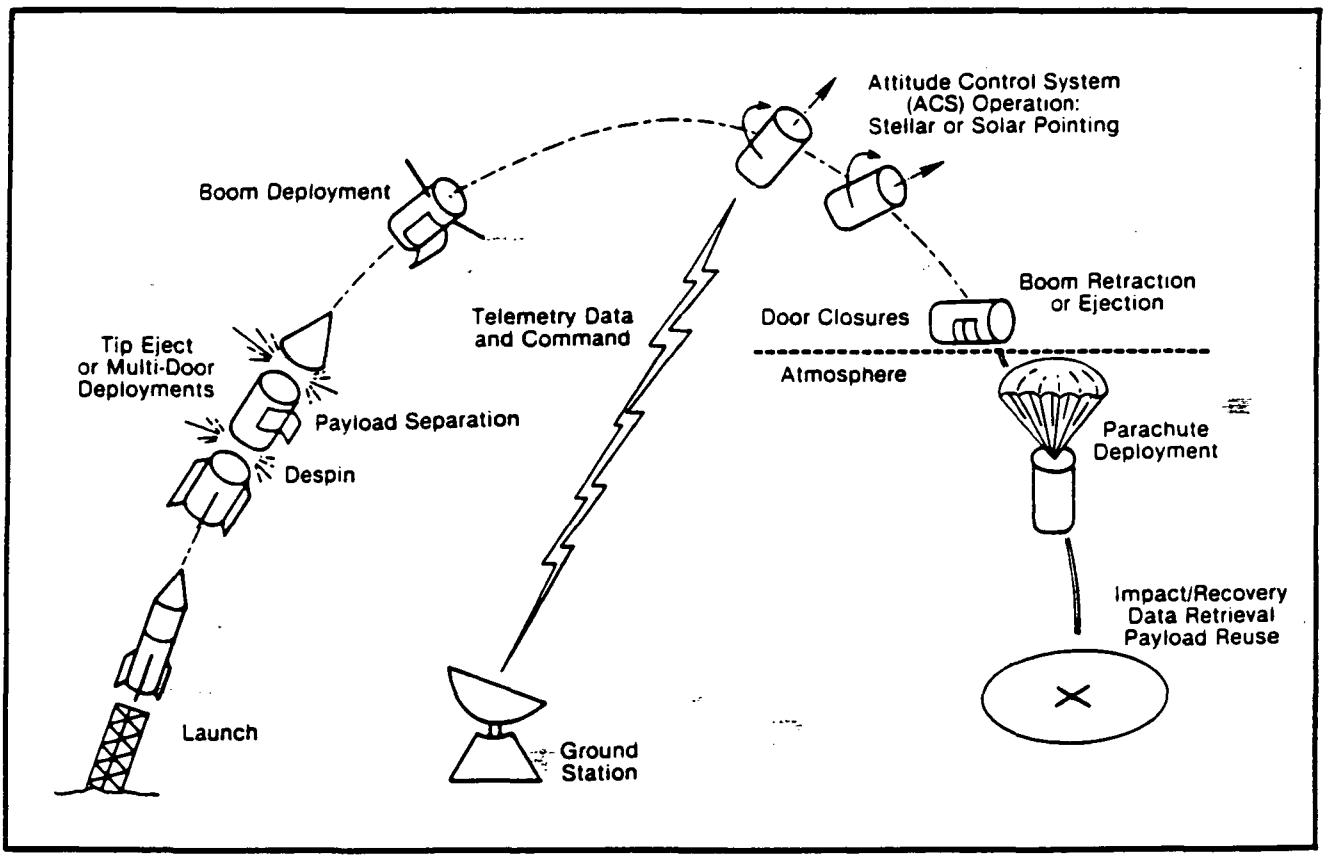
Thirteen different systems currently are included in the launch vehicle stable to provide the performance requirements necessitated by various experiments with diverse weight and altitude requirements. Payload weights have grown to 2,500 pounds, and payload diameters have increased to 44 inches. A significant characteristic of the Sounding Rocket Program is the inherent capability to respond quickly to scientific requirements with launch operations practically any place on Earth using either permanent or mobile range facilities.

Sounding rockets routinely are launched from established ranges such as Wallops Island, Virginia; Poker Flat Research Range, Alaska; White Sands Missile Range, New Mexico; and sites in Canada, Norway, and Sweden. Sounding rockets can be launched from temporary ranges when there is a need. Launch expeditions have been conducted from locations such as Punta Lobos, Peru; Rio Grande, Brazil; Keweenaw, Michigan; Red Lake, Canada; Cape Parry, Northwest Territory, Canada; Puerto Rico; Point Barrow, Alaska; Søndre Strømfjord, Greenland; Siple State, Antarctica; Alice Springs, Australia; and even an aircraft carrier in the Pacific Ocean.

Wallops interfaces with NASA Headquarters, other government agencies, universities, private industry, and the international community. Wallops provides engineering support for the Sounding Rocket Program including feasibility studies, payload design and development, vehicle engineering, attitude control systems engineering, payload recovery systems engineering, and test evaluation engineering.

Wallops also provides mission and payload management for the rocket program's flight projects. Wallops personnel develop and maintain computer programs for analytical studies and data analysis pertaining to the facility's functions. Financial support for principal investigators is also provided through the Sounding Rocket Program.

The Sounding Rocket Program currently supports 40 to 45 launches each year. Approximately 2,500 missions have been conducted since 1959 with an 86% mission success rate for that period and an 89% mission success rate for over 200 missions in the last five years.



Sounding Rocket Example Mission Profile

NASA Balloon Program

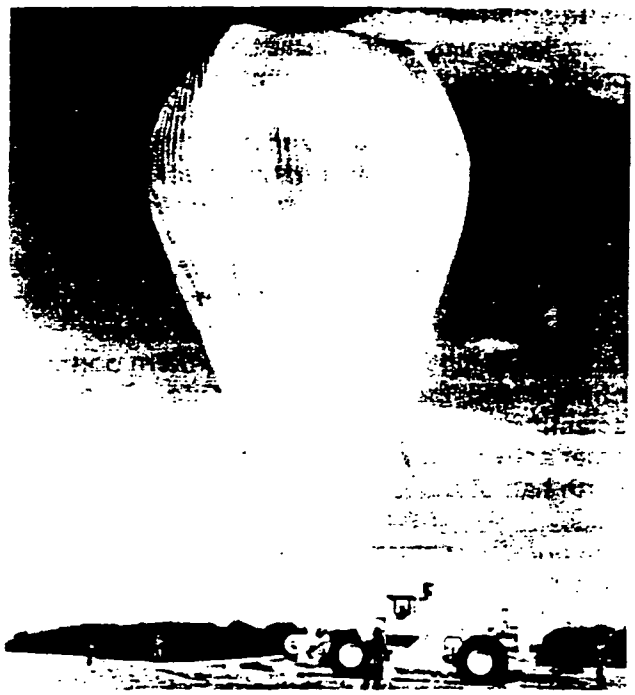
Wallops manages the NASA Balloon Program, including management of NASA's National Scientific Balloon Facility (NSBF) in Palestine, Texas. Balloons provide platforms to carry research payloads with scientific instruments to make measurements at altitudes up to 30 miles. Balloons provide much longer flight times than sounding rockets without the rigors of rocket liftoff, vibration, and G-forces, and, therefore, permit laboratory quality equipment to be flown. Through NSBF, Wallops provides balloons, helium, and operational support for launches from many sites including Palestine, Texas; Fort Sumner, New Mexico; Holloman Air Force Base, New Mexico; Laramie, Wyoming; Barking Sands, Hawaii; Poker Flat Research Range, Alaska; Ainsworth, Nebraska; Wallops Island, Virginia; and from foreign countries including Australia, Canada, and Brazil. Wallops provides the technical direction of the program, the research and development support for ballooning, and selected tracking and data acquisition and data processing in support of balloon flights.

Balloons are made of a thin, polyethylene material .8 mil thick and up to 30 million cubic feet in volume at full inflation, but they have historically varied in thickness from .5 to 1.5 mil and up to 50 million cubic feet in volume. Payloads up to 5,500 pounds can be accommodated, and flight durations may vary from 1 to 60 hours. A new capability in the form of long duration flights of up to two weeks is under development. A tethered balloon system also is used and can carry a 400-pound payload to one mile altitude.

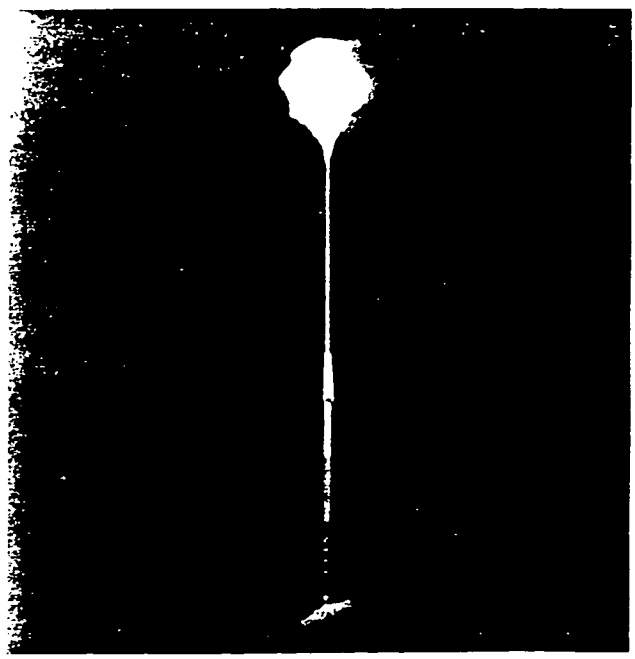
The Balloon Program offers capabilities and benefits for scientific research that cannot be duplicated by other research methods. Balloons provide measurements in areas too low for sounding rockets or satellites and too difficult for aircraft which cannot sustain flights for long periods or reach the required heights. The scientific payloads are furnished by the individual investigators and routinely are recovered for reuse of scientific instruments.

The use of balloons allows for multi-disciplinary experiments, vertical profile measurements, and scientific measurements at a specific altitude at a specific time or measurements at multiple locations over a particular time period. Balloons also allow for satellite data verification using systems launched in coordination with orbital coverage and for flight testing of materials, instrumentation, and experiments destined for future space missions.

The Balloon Program currently supports approximately 45 launches each year. Between 1976 and 1986, 493 balloons were launched with an overall success rate of 85%.



Inflating balloon prior to launch



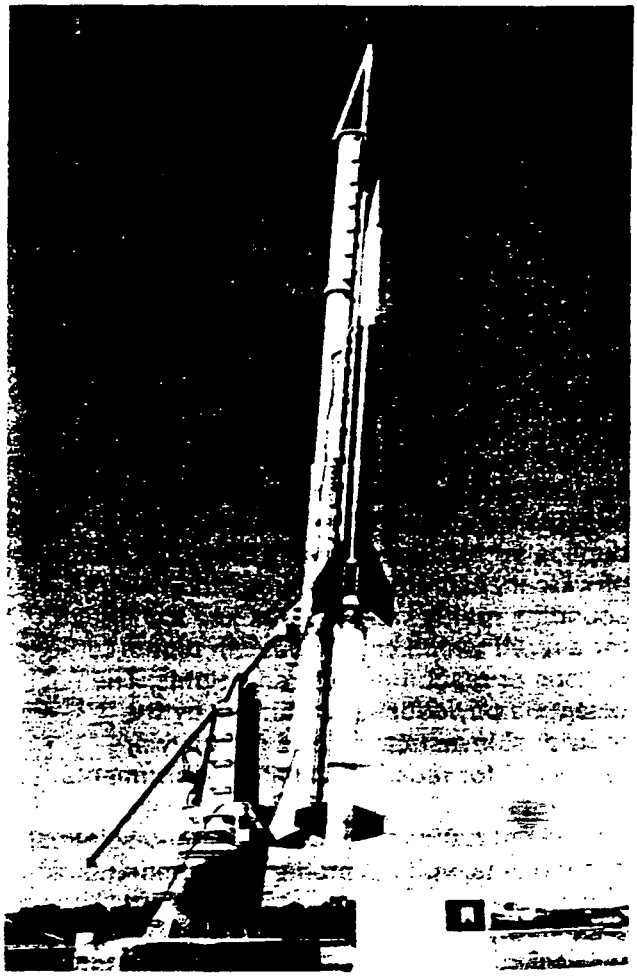
Balloon in flight

WFF Launch Range

The Wallops launch range is based on Wallops Island and extends out into the Atlantic Ocean using the surface area and airspace above to conduct various flight operations. The principal Island facilities are those required to process, check-out, and launch solid rocket boosters carrying scientific payloads on suborbital or low Earth-orbit trajectories. Included are launch pads, launchers, blockhouses, booster preparation and payload check-out buildings, dynamic balance equipment, wind measuring devices, communications and control instrumentation, TV and optical tracking stations, surveillance and tracking radar units, and other supporting facilities. Because the launch areas are located on the southern half of Wallops Island, most of the facilities mentioned here are in that area also, with special use facilities being located on the northern portion of the island. From time-to-time, ground-based scientific equipment requiring isolation from other activity may be located temporarily on the north half of the island.

The primary mission for the WFF launch range is to provide a safe and efficient site for the conducting of NASA sounding rocket operations and to provide an east coast base for launching the NASA Scout rocket booster, a large expendable launch vehicle built by LTV and used primarily to place small spacecraft into low Earth-orbit. Facilities on Wallops Island are used, as required, to support other NASA science and research programs, which may involve the use of small meteorological rockets or balloons to carry instruments to desired altitudes. In addition to support of NASA programs, the launch range is used for rocket and non-rocket programs of other U.S. government agencies, where such use does not impact on the NASA-sponsored activities. Typical other-agency programs supported include: VANDAL, a high speed target missile for the Naval Air Test Center; sounding rockets for the Air Force Geophysics Laboratory; and full-scale aircraft development programs for the Naval Air Test Center.

The principal work performed by the technicians who staff the facilities on Wallops Island fall into two phases; the preparation process and the countdown activity. During the former, the tasks performed by the launch crew have to do with the assembly and checking of the accessories (fins, interstage hardware, etc.) and the rocket motors, mating the payload to the assembled rocket vehicle, and placing the entire system on the selected launcher and performing preliminary tests to validate the integrity of the combined vehicle/payload systems. During the "countdown," the launch crew and payload team perform final checks of their respective systems and place them in a liftoff/flight configuration. As the countdown activity gets underway, other units of the launch range — including telemetry, radar, communications, and safety systems — are brought on-line to provide necessary support for the pending flight mission. A key element in this process is the Range Control Center, located on the main base, which functions to provide the overall control and direction of the countdown operations. From that location, the Test Director leads all the range elements through a step-by-step procedure for the orderly performance of a variety of preparatory tasks, satisfactory completion of which are required before the "go-for-launch" authorization can be given.



Black Brant IX on launcher

The Range Safety Officer monitors launch area operations, computes the wind profile and launcher settings, keeps track of ships and aircraft in the operating area, and follows the course of rocket flights. After the rocket leaves the launcher, radar and telemetry instrumentation systems track the flight of the rocket system and payload, recording the trajectory data and receiving and storing the experimental data, which typically is transmitted from the payload throughout the flight. Some of the payloads descend by parachute and are recovered either in mid-air by an aircraft or from the ocean surface by boat or helicopter.

Frequently, there are science objectives which only can be met by performing flight missions from locations distant from any established launch site. To support such rocket and balloon missions, WFF maintains a mobile launch facility which can be moved readily by aircraft or ship to the remote location and setup to provide essentially the same launch range capability which exists at Wallops. This mobile launch facility, which consists primarily of large vans and trailers, containing the essential preparation, check-out, launch, and tracking equipment, has supported the sounding rocket program at a variety of remote sites in both North and South America and Greenland. Individual elements of the mobile range, primarily the radar and telemetry vans, have been used to meet other rocket and balloon requirements at locations around the world.

Research Airport

The WFF Research Airport, wholly-owned and operated by NASA, provides a broad coverage of communications, telemetry, enhanced radar tracking, flight path guidance, and other supporting services to a variety of aeronautical research programs dealing principally with the aircraft/airport interface. The airport, orginally the Chincoteague Naval Air Station constructed during World War II, is equipped to provide the vital normal aircraft services. A control tower is in operation during working hours.

One of the three airport runways has been specifically modified for aircraft traction studies. This research runway has several sections made up of different surface materials and with grooved and ungrooved areas. These sections may be flooded with water and the depth controlled to within 1/10 inch. This same runway has a Microwave Landing System (MLS) installed. The MLS — the instrument landing system of the future — has been a joint research and development effort by the Federal Aviation Agency, the Department of Defense, and NASA. The MLS currently is being used by research projects developing systems technology and flight procedures for aircraft that will use the MLS to make automatic all-weather landings. The runway also is equipped with a high-speed turnoff where techniques are studied that will provide guidance information to aircraft, permitting them to exit automatically from runways at high speed.

Aircraft landing on flooded research runway

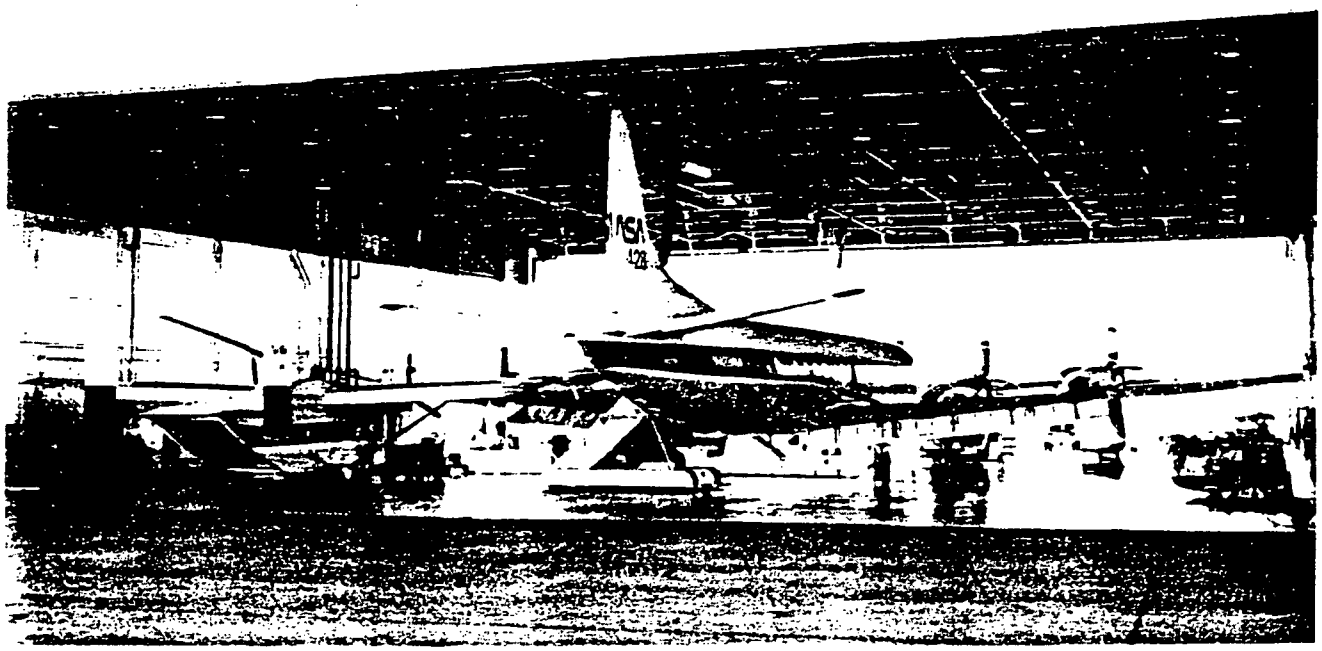
Other aeronautical research efforts at this sea level airport are concerned with environmental effects (usually noise), engine water ingestion, and safety and operating problems. One program is associated with a research effort to improve the stall/spin characteristics of general aviation aircraft and thereby enhance the safety of flight. Most of the projects orginate at other NASA centers, primarily the Langley Research Center at Hampton, Virginia; other government agencies, such as the Federal Aviation Agency; the military services; and a few from private industry.

Hangar space for the aircraft and laboratory space for the research teams are made available in hangar N-159 to the visiting aeronautical research programs. An Aeronautical Project Control Center is located in building A-1 just below the control tower. Here, all of the operational elements required to support aeronautical research tests are coordinated and controlled. Communications, information, and data are transmitted by radio and land lines, and the controllers are able to oversee visually all of the airport's operational area. The airspace surrounding the airport and the restricted airspace extending from the airport to the offshore warning areas are controlled from the tower and can be closed to other aircraft when necessary.

Aircraft Airborne Science

Some of the WFF aircraft are used as research platforms for scientific missions. Helicopters and several fixed-wing aircraft provide a variety of flight performance and payload-carrying ability. Science missions are conducted locally and on a regional or global basis.

The helicopters offer support for small scientific instrument packages which need to operate at low speeds and low altitudes. A twin-engine turboprop Skyvan aircraft with its large rear opening is easily configured for conducting local and regional research missions. One larger four-engine aircraft with nadir and zenith viewing ports and a large unpressurized bomb bay compartment is ideally suited for carrying complements of large scientific instruments for conducting oceanographic and ice research missions. Another four-engine aircraft, similarly modified with upward and downward viewing ports, has evolved into an excellent platform equipped with large complements of in-situ and remote gas samplers for conducting air chemistry research missions. Both of the large turboprop aircraft can carry scientific payloads of more than 10,000 pounds and often are deployed to foreign country bases from which missions are flown to underfly satellites and/or study scientific phenomena peculiar to specific sites. A T-39 high



Wallops aircraft in Building D-1 Hangar

altitude turbojet aircraft is used to take payloads of 1,200 pounds or less up to altitudes of 40,000 feet for research in the lower stratosphere, making comparisons with satellite derived information and for the development of instruments for future satellites.

A potential user of the aircraft can expect to receive support in planning his or her mission, in adapting and installing the instrumentation on the WFF aircraft, in obtaining the necessary flight clearances (both foreign and domestic), and in establishing additional support or logistics required for mission success. The operational policies of the WFF aircraft fleet have been developed over the years to facilitate the use of the aircraft for the user with a minimum of difficulty, but always with safety of flight as the first priority.

The scientific groups which use the WFF aircraft as research platforms come from several NASA centers, other government agencies, the academic community, and, occasionally, foreign countries.

Aircraft Fleet

WFF operates a fleet of six program support and one administrative aircraft. The aircraft range in size from a single engine small helicopter to a four-engine Lockheed Electra. The program aircraft are used to provide radar surveillance of offshore rocket impact areas to protect shipping and fishing boats; midair recovery; search for payloads to be recovered from the ocean surface; relay radio signals over the horizon; search and rescue and other flight support for aeronautical research programs; and as research platforms for scientific payloads.

The WFF aircraft fleet is operated, maintained, and managed by highly-qualified flight crews and personnel with the goal of providing efficient and safe airborne operations.

Tracking and Data Acquisition

Tracking and data acquisition activities at Wallops are covered by three functional areas: radar, telemetry, and data systems, including communications and optics. These activities support the full range of sounding rocket, balloon, and aeronautical research and development and scientific experimentation. Similar capabilities can be configured to support mobile operations worldwide. In addition, WFF has a satellite tracking facility as an integral part of the station telemetry capability.

Radar - Radar systems track sounding rockets, balloons, satellites, and aircraft to provide accurate velocity and positional data. Some targets are tracked by using the radar signals which are reflected from the target. This is called "skin tracking." Some targets carry a beacon which responds to the incoming radar signals by replying with a transmitted signal which is received and measured by the radar system. The range of support provided by radar systems at Wallops can vary from working with local aircraft in the vicinity of Wallops airport to tracking distant objects in space. Radar capabilities can be enhanced by laser tracking systems and sophisticated data processing systems to improve the precision and record, analyze, and process radar data. Some Wallops Flight Facility aircraft are radar equipped to support experiments and operations by providing range surveillance and tracking. The systems operate in the UHF, X, S, and C frequency bands.

Wallops Range Control Center

Telemetry - Telemetry is the technology most frequently used to acquire data from experimental instruments carried aboard satellites, space vehicles, sounding rockets, balloons, and aircraft. Data from the experiment are encoded and radioed to an Earth station for recording and analysis. Both analog and digital techniques of data transmission are used. Almost all systems operate with S-band (2200 to 2300 Megahertz [Mhz]) down-links and 550 Mhz up-links. A frequency of 1680 Mhz is used occasionally for down links on some of the smaller sounding rockets.

- Telemetry data systems have the capability of providing positional data for the target.

At Wallops Flight Facility, there are two 24-foot automatic trackers and two eight-foot automatic trackers. These are supported by antenna control and receiving stations, four readout Pulse Coded Modulation (PCM) stations, a digital PCM station, and a meteorological station.

FPQ-6 Radar on Wallops Mainland

Data Systems, Communications, Command and Control

Data Systems - Data are acquired during operations from radar, telemetry, optical, meteorological, timing, and communications systems. This data are processed by various computers at Wallops to provide vital information to experimenters and to support operations. A variety of data systems acquire, record, and display information in real time for command, control, and monitoring of flight performance.

Communications - Wallops Flight Facility operates ground-to-ground, air-to-ground, ship-to-shore, and intrastation communications systems. These systems are composed of radios, cables, microwave links, closed-circuit television systems, command and control communications, frequency shift tone keying systems, operational teletype systems, high-speed data circuits, and the WFF NASA Communications (NASCOM) Network terminal. Satellite communications and fiber optics are in growing use.

These systems provide the means for managing operations at Wallops and communicating and coordinating with related operations in other geographic areas (*e.g.* providing communications and tracking support for Space Shuttle operations at Kennedy Space Center).

Command/Destruct - A command/destruct system allows ground control of airborne vehicle (sounding rocket, balloon or aircraft) functions of on-board experimental devices. In the case of sounding rockets and balloons, the Range Safety Officer can terminate some flights in the unlikely event a malfunction presents a range safety hazard.

Optics - Optical systems play an important part in operations at Wallops. Remotely-controlled television cameras monitor range operations and provide safety related information. Tracking cameras, including both film and a long-range video tracking system, provide visual information from remote locations for project and range support.

Control Centers - Both control centers located at Wallops are on the Main Base. The Airport Project Control Center controls experimental activities of aircraft using Wallops Airport. The Range Control Center controls both launch and tracking and data acquisition operations.

The control centers are focal points for communications, operational management, and range safety. Vehicle operations, tracking and data acquisition are controlled, and performance data are displayed on plotboards and video monitors. Instantaneous communications with all participants in a mission provide the means for coordinating complex operations.

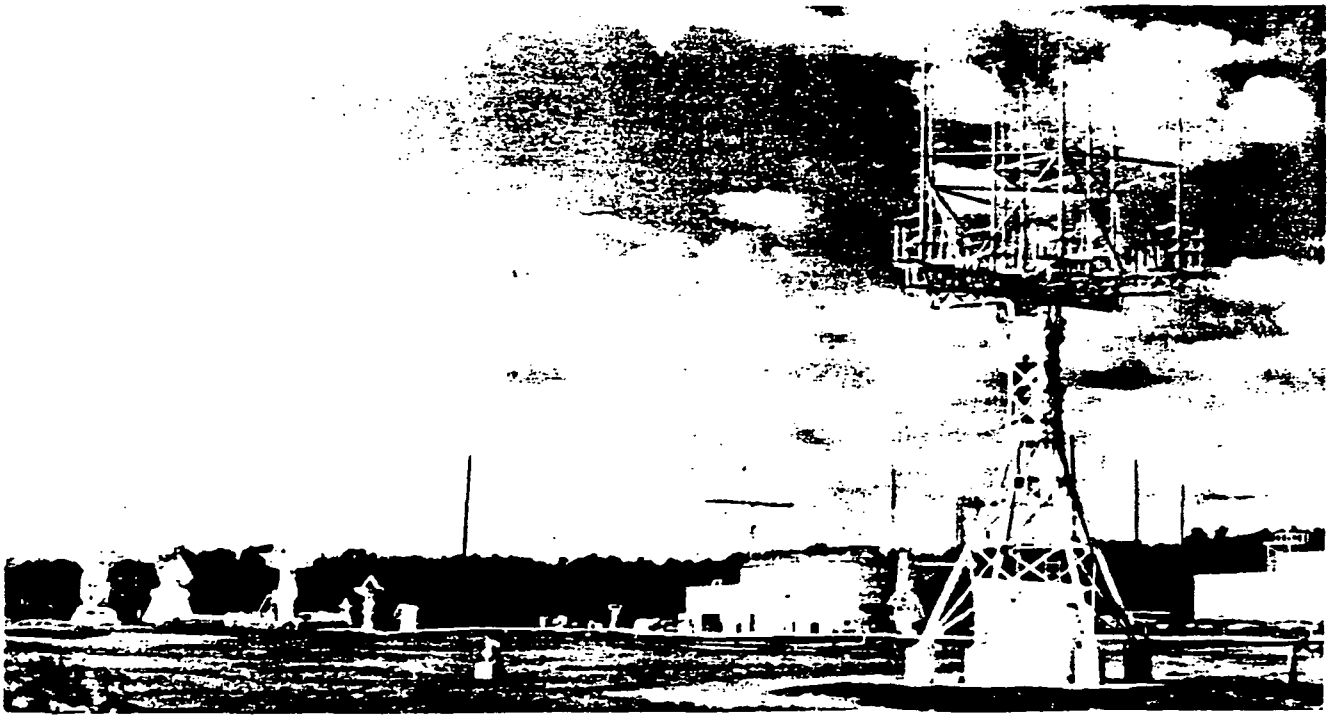
Airport Project Control Center

Mobile Systems

Wallops Flight Facility supports balloon and sounding rocket campaigns in other areas of the world. Campaigns have been conducted in Arctic and Antarctic regions, South America, Africa, Europe, Australia, and even at sea aboard a ship. To provide radar, telemetry, and data system support — simiar to capabilities permanently available here — mobile equipment has been developed which can be transported to where it is needed. These transportable facilities are self-contained with their own power, heating, and cooling. Personnel from Wallops Flight Facility usually accompany the equipment and may spend several months operating at these remote locations.

Wallops Orbital Tracking Station

In 1986, the Wallops Orbital Tracking Station was established. This ground-based satellite tracking and telemetry station acquires telemetry from satellites to support several important programs which include: the International Ultraviolet Explorer Satellite (IUE), the Interplanetary Monitoring Platform Satellite (IMP-8), the Nimbus-7 Meteorological Research Satellite, and the future Cosmic Background Explorer Satellite (COBE). High-speed data transfer to Goddard Space Flight Center at Greenbelt is provided by a satellite communications link.



Wallops Orbital Tracking Station

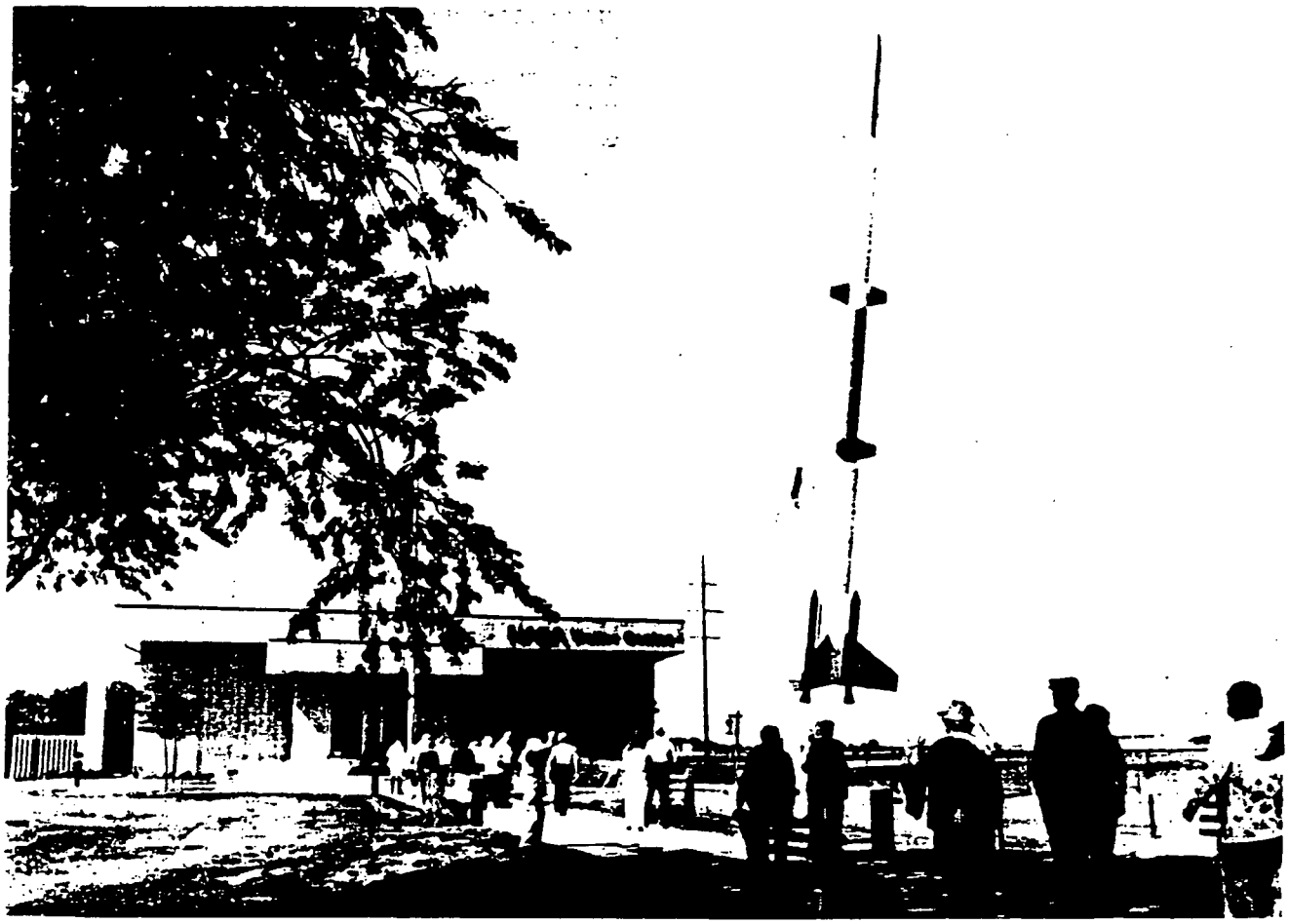
C-2.

Support of Others

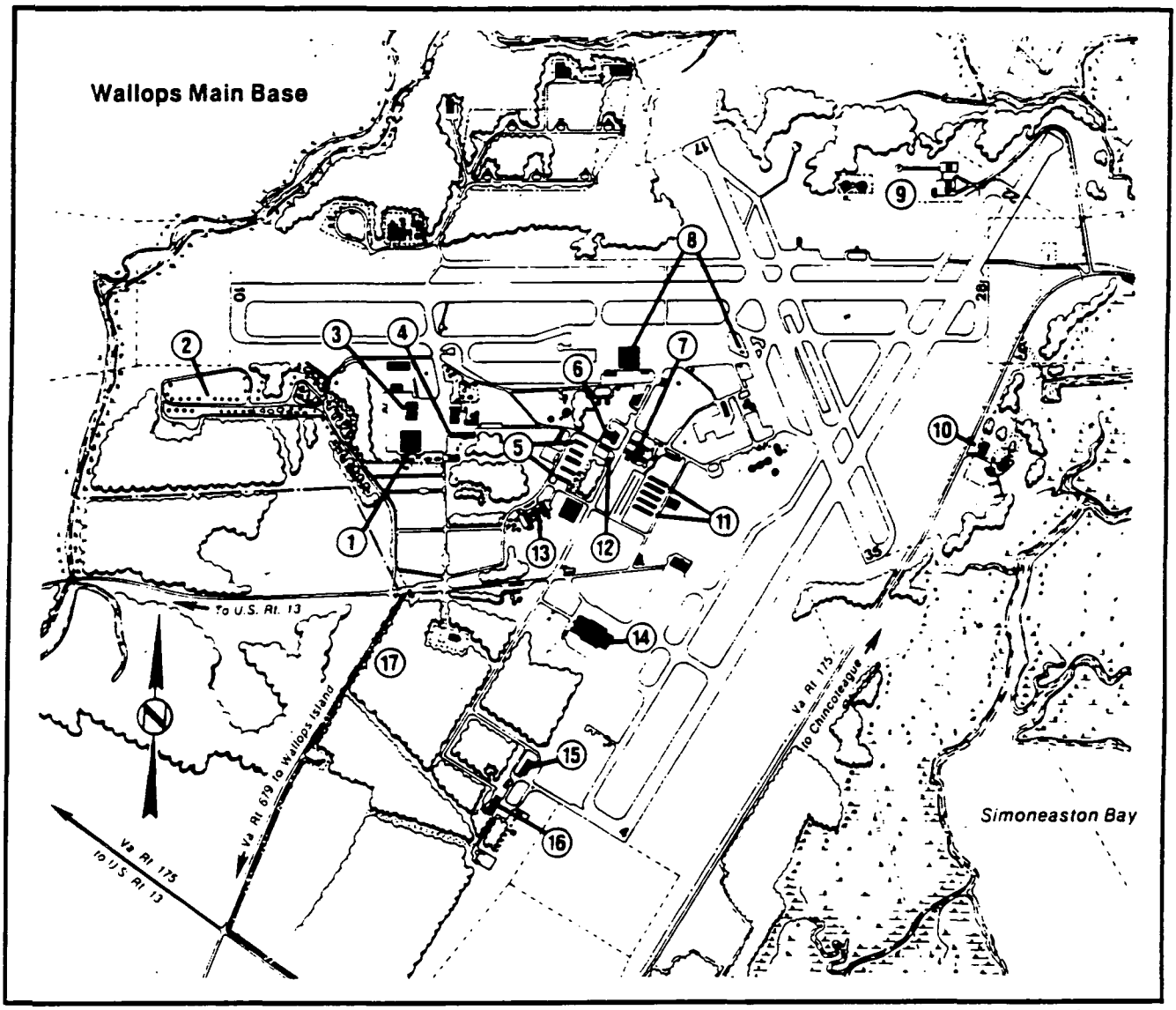
The unique resources at Wallops are used to support the programs of other agencies, non-profit laboratories and commercial space ventures. The use of the Wallops facilities contributes to research that benefits the space program, aeronautics, transportation, agriculture, fisheries, and other industries, as well as national defense. Elements of the Navy, Coast Guard, and NOAA are tenants on the Wallops facility that share the use of the facilities and services available. Some commercial corporations currently use the spin balance facilities, and others plan to use the launch facilities in the future.

NASA Wallops Visitor Center

The Wallops Visitor Center (VC) is located on Route 175 across the road from the Wallops runways about six miles from Route 13 and five miles from Chincoteague, Virginia. It houses a collection of spacecraft and flight articles, as well as exhibits about the history of manned flight, Wallops' research activities and other NASA research projects, with an emphasis on Wallops. Special movies and video presentations also can be viewed. There is a gift shop with space souvenirs, and refreshments may be purchased at the vending machines building. Guided tours of the Wallops' facilities are available to organized groups — including school and civic organizations — and tour groups. Each tour is designed to meet the educational level and interest of the group members. Special programs, which range from lectures and exhibits on NASA programs to monthly model rocket demonstrations, are held throughout the year. The Visitor Center is open daily for self-guided walk-through tours from 10 a.m. to 4 p.m. each Thursday through Monday (closed Tuesday and Wednesday) and on Federal holidays except Thanksgiving, Christmas, and New Years' Day. More than 50,000 persons visit the Wallops Visitor Center annually.



NASA Wallops Visitor Center



Wallops Main Base Legend

1. **Building F-10** - Fabrication and integration laboratories where sounding rocket payload systems are designed, fabricated, integrated and environmentally tested are located here. The environmental tests subject the systems to vibrations and acceleration levels comparable to what they will experience during rocket flight.

2. **Coast Guard Housing** - Families of the Coast Guard Eastern Shore Group occupy 25 houses in this area, which was formerly part of the Main Base.

3. **Building F-16** - The technical services shop building contains the carpenter, paint, electric, and welding shops; the garage; and the plant operations offices.

4. **Building F-7** - Logistic branch personnel, stock control, shipping and receiving, travel office, and vehicle control are located here.

5. **"F" Buildings** - Buildings F-5 and F-4 are dormitories which house visiting experimenters and attendees of the Management Education Center programs. The Rocket Club, WEMA activities, and a conference room are located in Building F-3. Building F-2 contains the telephone switchboard and maintenance personnel and the Mail and File area. Located in Building F-1 are the print shop and graphic services.

6. **Post Office, Gymnasium/Auditorium, and Navy Offices** - A full-service United States Post Office, an employees' stress lab for physical fitness activities, and offices for the administrative staff of the Naval Surface Warfare Center detachment are found here.

7. **Cafeteria and Photo Lab (Building E-2)** - The cafeteria is open for breakfast and lunch during most regular working hours. The WFF Optical Section is in a wing of the same building. Many different kinds of optical support are provided to the various research projects.

8. **Airport and Control Tower** - Wallops Airport has three runways, ranging in length from 4,000 to nearly 9,000 feet. The Aeronautical Project Control Center is located in the tower building (A-1) just below the control tower. The D-1 hangar houses the WFF aircraft fleet.

9. **NOAA/NESDIS CDA Station** - Across the runway is the National Oceanic and Atmospheric Administration's National Environmental Satellite and Data Information Service (NESDIS), Command and Data Acquisition Station. This station provides an unlimited 24-hour per day flow of weather satellite-derived sensor data to the Nation and world. To support this operation, nine antenna systems (ranging in size from 24- to 85-feet in diameter) and associated equipment to track, monitor, and command nine weather satellites are used 24 hours per day. The facility is divided into two separate ground stations — Polar and Geostationary. The Polar-Orbiting Environmental Satellites provide operational coverage of the entire Earth four times per day. The Geostationary Operational Environmental Satellites (GOES) observe the Eastern and Western United States and the adjacent ocean areas from their vantage points 22,300 miles over the Equator, as well as having coverage zones which extend well into the Southern Hemisphere.

10. **NASA Wallops Visitor Center (VC)** - The VC houses a collection of spacecraft and flight articles, as well as exhibits about the history of manned flight, Wallops' research activities and other NASA research projects, with an emphasis on Wallops. Special movies and video presentations can also be viewed.

11. **"E" Buildings** - There are five three-story white "E" buildings which house the sounding rocket and balloon engineering and technical personnel as well as administrative personnel (procurement, financial management) and the technical library. The NASA Management Education Center, which is used by all the NASA Centers, is located in E-104.

12. **International Flagpole Array** - The flags of visiting foreign nationals are displayed at the Wallops International Court. A sizeable portion of Wallops' effort is devoted to NASA's program of international cooperation in space research.

13. **Building F-160** - The Health Unit, Personnel and Security Offices, and the Chemistry and Calibration Labs are located here.

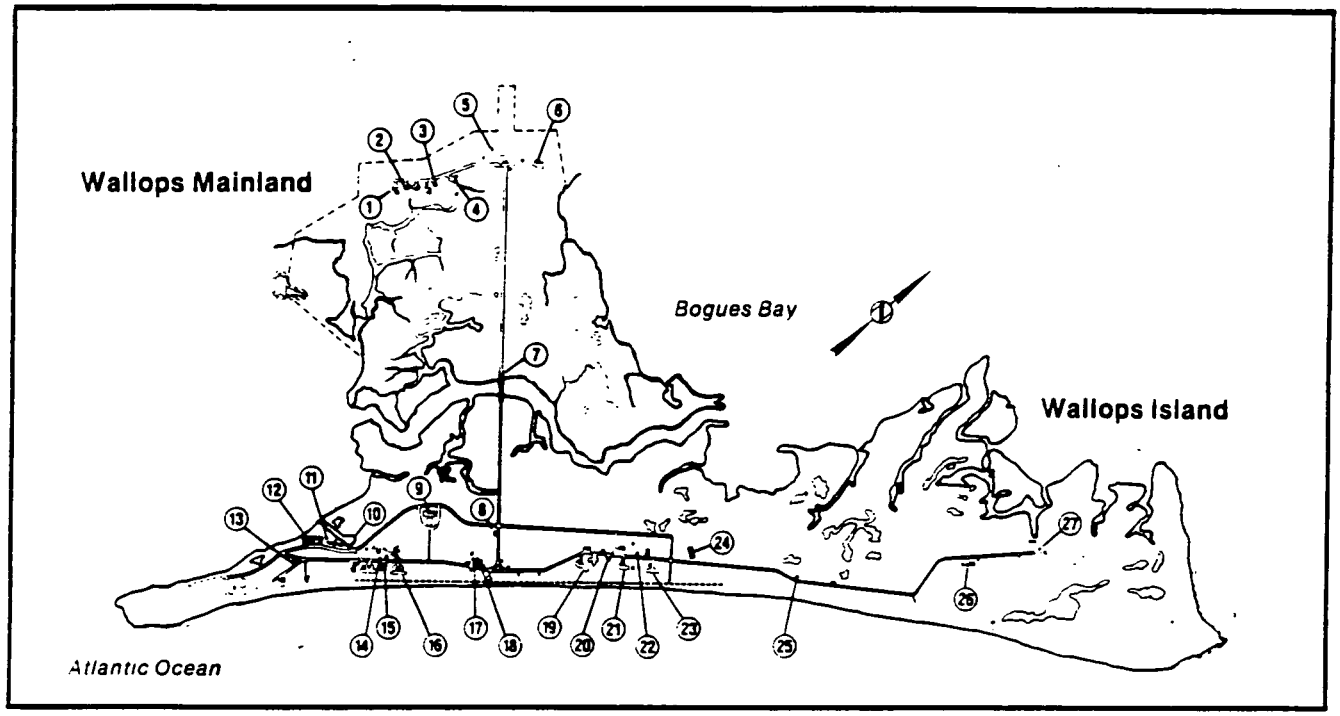
14. **Building N-159** - This large hangar houses the Wallops Range Control Center (RCC) as well as offices for range operations personnel. All rocket launchings and tracking and data acquisition operations are controlled from here. In addition, visiting aircraft conducting aeronautical research programs and visiting research teams are housed here.

15. **Building N-161** - In this main computer complex building, scientific data received from the sounding rocket, balloon, and aeronautical projects are processed to a useable form for the scientists.

16. **Building N-162** - The Wallops main Telemetry Command and Receiving Station and the Wallops Orbital Tracking Station are located here. The various antennas in this area are used to receive data from the scientific payloads launched by rockets, balloons, and research aircraft, to send commands to perform various functions, as well as to receive data from satellites. A communications receiving station and range timing and programming system also are located in this building.

17. **Navy Housing Center** - The Bachelor Officers Quarters (BOQ) building contains a total of 16 efficiency units for senior and junior officers. The Bachelor Enlisted Quarters (BEQ) dormitory has two wings, each with two stories, with an attached dining facility. It can house a maximum of 160 personnel. The family housing units provide quarters for both officers and enlisted personnel with families. Four are two-bedroom homes, and twenty-four are three-bedroom homes.

Buildings N-161 and N-162



Wallops Mainland and Island Launching Site Legend

1. **Atmospheric Sciences Research Facility (ASRF)** - The ASRF consists of instrumentation to study characteristics of the atmosphere. Two major systems are the large, powerful, ultrasensitive, research radars — the UHF and the S-Band (SPANDAR). Both radars have a 60-foot diameter antenna. Both can transmit a peak power of up to five megawatts (5,000,000 watts). SPANDAR — originally designed to track objects as far away as a quarter million miles from Earth — is sensitive enough to detect a raindrop (or an insect) 1/10 inch in diameter, seven miles away. The facility also houses several lightning detection and ranging systems. One system shows the location of almost every lightning flash that strikes the ground anywhere in the eastern one-third of the United States as they occur. Another system detects and locates all lightning within 100 miles, both cloud-to-ground and cloud-to-cloud, as well as intracloud flashes. Typical programs include the NASA Storm Hazards turbulence on airplanes; the Radio Attenuation Program, which studies the effects of rain cells on satellite communications links; and the Rocket Thunderstorm Series, which investigates the influence of electrical storms on the ionosphere.

2. **Navy Radio Transmitter Facility** - This facility contains radio transmitting equipment used to support voice and data link communications with Navy aircraft and ships.

3. **Atmospheric Physics Measurement Laboratory** - Containing photometers for determining the total amount of ozone in the atmosphere, it has the flexibility to support simultaneous experiments involving any number of instrument systems. Because of its location, it can support studies of the Earth's stratosphere and troposphere in disciplines as diverse as air pollution, synoptic weather forecasting and upper atmospheric physics.

4. **FPQ-6 Radar** - A long-range, high-precision tracking radar, it has a range capability of 32,000 miles, a measuring range with an accuracy of plus-or-minus five yards, and range-rate to an accuracy of .1 yard per second. Its peak transmitting power is three megawatts (3,000,000 watts). The antenna (parabolic reflector) is 29 feet in diameter.

5. **NSWC Operations Support Building** - The Navy's engineering staff, both permanent and transient, who support operations on the Island, are located here.

6. **WFF Radio Transmitter Building** - This building contains the radio communications transmitting equipment, both short and long-range, used to support Wallops Island activities. It also contains the radio transmitters used either to control rocket flights or destroy the rockets when necessary.

7. **Causeway and Bridge** - Almost two miles long, the Causeway was completed in 1960 at a cost of about $1.5 million. The bridge is 40 feet above mean high tide to allow clearance for water traffic on the Inland Waterway.

8. **Special Projects Building and Camera Site** - The dome on top of the building houses a tracking camera used during rocket launches. Visiting scientists and technicians also use this building as lab space for their projects being conducted on Wallops Island.

9. **Island Radar Site** - Located here are several radar systems used for tracking experiments. They have less power and range than the "big-dish radars" seen on the Mainland. They have a wider beam width and are used for "early acquisition" and range safety purposes, in addition to obtaining trajectory data.

10. **Old Dock Area** - Prior to 1960, all equipment and personnel had to be transported to the Island via boats to a dock located in this area.

11. **Liquid Propellant Storage Area** - Propellant (hydrogen peroxide) is stored here for the attitude control systems of the second and third stages of the Scout vehicle.

12. **Lagoon Sewage System** - This treatment plant (lagoon and holding pond) is part of the Island sewage treatment system. The system was installed and is operated in accordance with EPA and Virginia State requirements.

13. **NSWC Land-Based Test Site (LBTS)** - The Naval Surface Warfare Center LBTS is used to conduct research, development, test and engineering of shipboard combat systems prior to production and installation on Navy ships. Additionally, Battle Force System Engineering experiments are controlled from this facility.

14. **Assembly Shop No. 1** - All of the sounding rockets, such as the Nike, Taurus, Orion, Terrier-Malemute, and Black Brant IX and X are assembled, checked out, and prepared for launch at this location.

15. **150-Foot Meteorological Tower** - This steel tower has intruments every 50 feet for measuring low-altitude winds. Knowledge of wind direction and velocity is necessary to correct launcher angles and thus maintain proper flight paths for research vehicles. The tower occasionally is used for mounting experimental meteorological sensors or similar scientific apparatus.

16. **Launch Area No. 2 and Blockhouse No. 2** - Several types of launchers are located in this area because many types of vehicles carrying scientific experiments are launched from here. Launch Area No. 2 was the original launch site on Wallops Island. The first vehicle was fired here July 4, 1945. Since that date, thousands of experimental vehicles have been launched from this area.

17. **Launch Support Shop and Storage Area** - Located here are small shops which provide support for the launch operations and storage for miscellaneous non-hazardous material.

18. **Scout Project Office** - This was the first permanent structure erected on the Island and served as the NACA Headquarters Building. It is now used as office space for Scout support personnel. The four-stage, solid-fuel Scout vehicle has orbited 21 satellites from Wallops Island.

19. **Launch Area No. 3** - The Mark II Scout launcher is located here. It employs a horizontal type launcher which allows the vehicle to be prepared and held in the horizontal position until a short time before launch. At the proper time, the shelter building, which is mounted on steel tracks, is rolled away and the vehicle elevated to launch position. The Scout is 72 feet tall, weighs about 23 tons, and develops an average thrust of 115,000 pounds at lift-off. It is the largest vehicle currently launched at Wallops and is capable of performing a variety of missions, including the launching of satellites, space probes, and atmospheric re-entry tests. It can place a 350-pound satellite into an orbit more than 400 miles above the Earth, or loft an 80-pound scientific probe to an altitude of about 20,000 miles.

Wallops Island Launch Facilities

Near the launcher is the Scout Assembly Shop, in which the various stages, components, equipment, and payloads of the Scout launch vehicle are assembled and checked out prior to being installed on the launcher. The 21 satellites that have been launched by Wallops to date have been launched from this area.

20. **Blockhouse No. 3** - This concrete dome-shaped building north of the pad is the blockhouse from which operations on Pads 3, 4, and 5 are controlled. The walls of this building are eight feet thick reinforced concrete.

21. **Launch Area No. 4** - This area is used for special projects.

22. **315-Foot Meteorological Tower** - This steel tower also has intruments every 50 feet for measuring low-altitude winds. Information on the wind direction and its velocity is necessary to set the correct launcher angles which will maintain proper flight paths for the research vehicles. The tower is used also for mounting experimental sensors to obtain meteorological data.

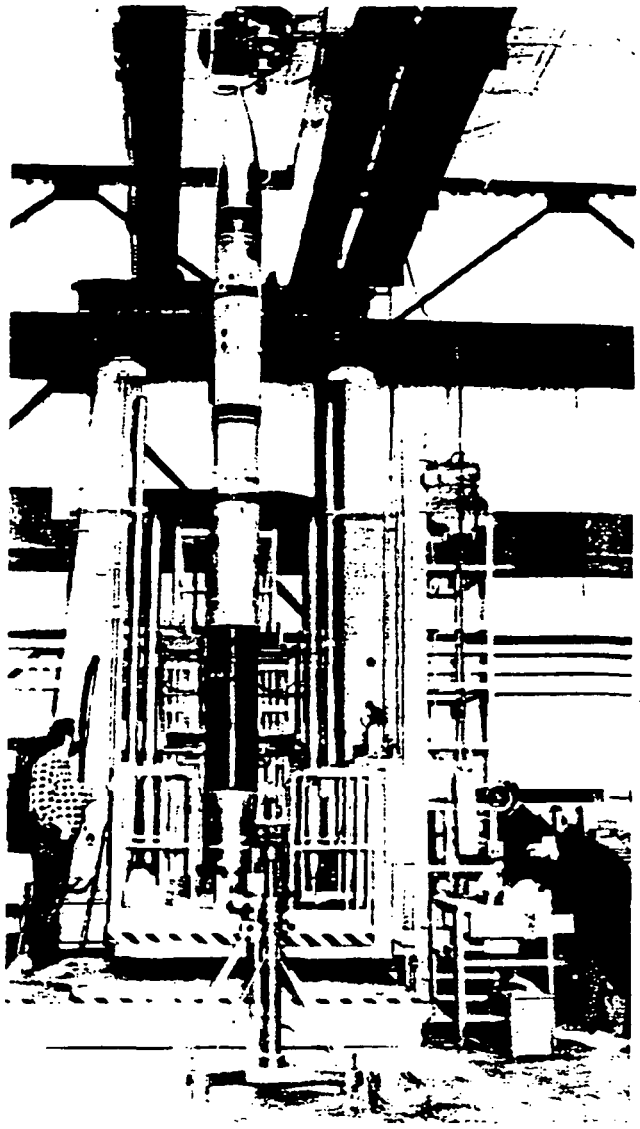
23. **Launch Area No. 5** - The Vandal target missile is launched from here. It is used as a target missile for off-shore Navy surface warship defense system tests. Vandal is a two-stage supersonic "target" about 22 feet long and 30 inches in diameter.

24. ***AEGIS* Facility** - The AEGIS Combat Systems Center (ACSC) is located here. The AEGIS system is the most modern combat system in the fleet. It consists of phased-array radars and the most integrated automatic system in use. The ACSC will be used by the Navy to engineer improvements to the existing system, to insure existing systems operate properly, and to train officers and enlisted men on the system in a realistic environment.

25. **Payload Checkout and Assembly Area** - These two buildings are used for rocket payload checkout and assembly. One is used for inert payloads and the other for "hot" payloads (payloads attached to a solid fuel rocket motor).

26. **Dynamic Balance Facility** - This structure houses equipment for vertical and horizontal spin testing and balancing of rocket motors and payloads. This operation is somewhat similar to balancing the wheels on your automobile, but far more complicated.

27. **Old Coast Guard Station** - Although no longer used by the Coast Guard, this building is used occasionally in connection with some of the experiments conducted at Wallops.



Black Brant payload ready for spin testing

NASA GSFC/WFF 1988

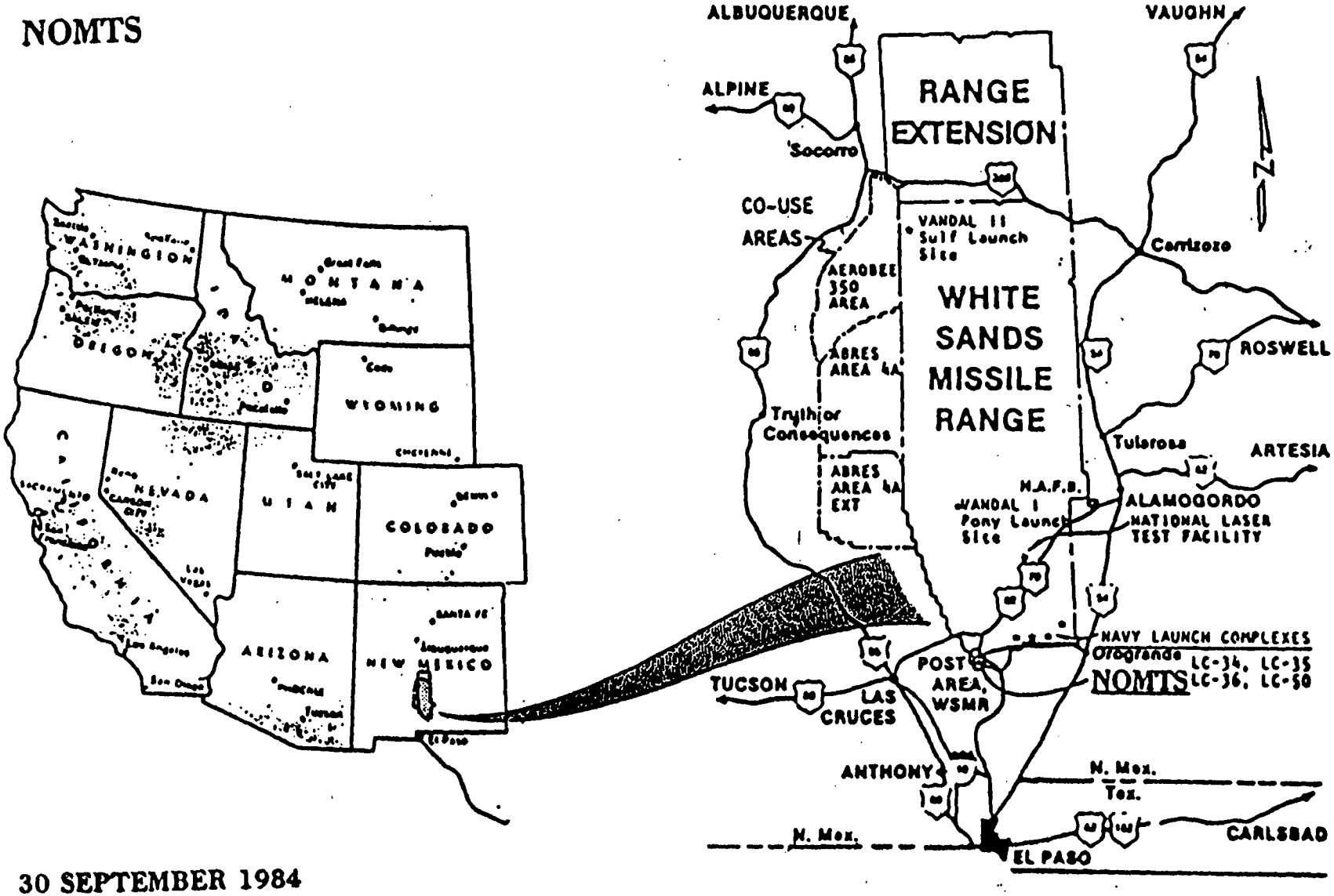
NAVAL ORDNANCE MISSILE TEST STATION

TENANT AT

WHITE SANDS MISSILE RANGE

CDR Kent Watterson
Test Officer
505-678-6121
Tom Gonzales
Research Rocket Director
505-678-5502

NOMTS



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