Apr 1st, 8:00 AM

# The Scout Launch Vehicle Program

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## ABSTRACT

The NASA/DOD Scout launch vehicle was conceived in the 1950's by the NASA Langley Research Center. Their concept was to utilize solid propellant rockets developed by the DOD to provide a reliable and low cost vehicle for both scientific and applications spacecraft. The program's history indicates both objectives have been met. In addition to emphasizing mission success and low cost, the utility of Scout has been enhanced over the years by a conservative approach to increasing both its performance and usable payload volume. As part of a unique international cooperative effort, a third (in addition to NASA Wallops Flight Center and Vandenberg Air Force Base) Scout launch complex was activated in 1967 by the Italian Government off the east coast of Kenya. Scout's current launch schedule shows the program continuing under NASA management with missions planned thru CY 1985 with payloads primarily for the DOD. New roles for this proven "workhorse" are being explored by the Systems Management Contractor.

## History

### Concept

The Scout launch Vehicle Program was conceived in 1957 by personnel at the Langley Research Center of the National Aeronautics and Space Administration (NASA). Their purpose was to provide an inexpensive launch vehicle for relatively small research spacecraft. Their concept was to select from a growing inventory of rocket motors, produced for the Department of Defense (DOD), an optimum "stack" with a design objective to deliver a 45 kilogram (KG) (100 pound) payload to a 555 kilometer (KM) (300 nautical mile (n.mi.)) circular altitude launched due east from the NASA Wallops Flight Center. Another design objective was to configure the vehicle's structure and systems so that, in addition to the orbital capability, probe and reentry missions could be flown with no changes other than in mission planning. The result was a four stage all solid propellant launch vehicle. The technical soundness of the original design may be demonstrated by the fact that the following description of the current Scout G-1 configuration, except for the rocket motor designators, is also quite applicable to the initial versions.

### Vehicle Description

The Scout vehicle, shown in Fig. 1, consists of four solid propulsion rockets with interconnecting structural transition sections which provide structural continuity and also house components of various systems. Beginning at the bottom is the Base Section A. This section surrounds the Algol IIIA first stage motor nozzle and contains the hydraulically actuated first stage control system powering vanes in the exhaust and aerodynamic controls on the fin tips. Between the first stage and the Castor IIA powered second stage is Transition Section B which contains a separation diaphragm and the second stage control system, which uses hydrogen peroxide jets to provide control moments. Joining the second stage and the Antares IIIA powered third stage is Transition Section C, containing a separation diaphragm and the third stage hydrogen peroxide fueled control system. Between the third and fourth stages is Transition Section D which houses the major components of the Guidance, Ignition, Beacon, and Telemetry Systems. Mounted on the fourth stage is Transition Section E, to which the spacecraft is attached by means of a separation clamp, in addition to a payload separation ignition system and a fourth stage Telemetry System.

Surrounding the Altair IIIA fourth stage and spacecraft is a heatshield to protect them from aerodynamic heating during ascent. Versatility in trajectory design and implementation is provided thru the use of an Intervalometer and a Programmer which are pre-set for specific missions. At the pre-calculated time, the Intervalometer switches selected voltage levels from the Programmer to the Pitch Gyro torquer, causing the gyro to generate an error signal subsequently nulled out by rotation of the vehicle due to the action of the control system. Thus the vehicle is guided in the pitch plane while stabilized about all three axes. The fourth stage is not controlled by the guidance system but is spin stabilized during that portion of the flight. Total length of the vehicle is 23 meters (M) (75 feet) and its weight is 21,600 KG (47,500 pounds).

Organization and First Launch

The NASA Langley Scout Project Office (SPO) was created in 1958 to convert the concept to reality and in so doing, performed the role of systems management to insure proper integration of all the activities and designs of the many contractors involved. When the program was approaching the Operational Phase, the role of systems management was turned over to the Vought Corporation in 1960, permitting NASA to concentrate once again on their prime mission of research. Vought, under the management of the NASA/SPO, has performed this task since that time.

The first launch, whose liftoff is shown in Fig. 2, was conducted at NASA Wallops on July 1, 1960. In the next two years, it was followed by another eight Development launches, also from Wallops, the only launch site for the NASA Scout at the time. Simultaneously, the Air Force was launching the same number of a slightly different configuration from a mobile launcher at Cape Canaveral.

During the Development Phase, the shared need for the inexpensive vehicle prompted both the NASA and the DOD to form a combined Government management structure for the program, to maintain the Scout capability and to satisfy the requirements of both agencies. This management structure, defined in a formal Memorandum of Agreement, was identified at the NASA/DOD Scout Coordination Committee. It remains to this date the single Government entity responsible for Scout Program activities.

Vandenberg Air Force Base (VAFB) Launch Site

Requirements of both NASA and DOD for polar launches resulted in the establishment of a Scout launch site at VAFB in early 1962. The operational experience from the original NASA Wallops complex had a significant effect on the design of the launcher and the environmental protection for the assembled vehicle in the development for the Vandenberg site. Assembly methods for ease in handling resulted in the horizontal assembly of the vehicle on a transporter as opposed to vertical assembly on the launcher at Wallops. Vehicle processing on the launcher in an environmentally controlled shelter, with vertical erection as a complete assembly, resulted in a considerably more efficient and reliable operation. This configuration, (Fig. 3), subsequently became the standard for all Scout launch sites.

Activation of the VAFB complex brought about even greater DOD participation in the program. In addition to the U.S. Navy's Strategic Services Project Office Navigation Satellites, a number of USAF satellites - both operational and research - were launched. All of these early VAFB launches were conducted - from receiving inspection of transition sections and rocket motors to manning the Blockhouse for the Countdown - by highly skilled officers and men of the USAF 6595th ATW at VAFB. Many of these men had previous experience on Scout at Cape Canaveral with the 6555th ATW. The USAF Launch Crew was augmented by a small group of NASA and Vought personnel to provide liaison with their home organizations and with the Vought Launch Crew at Wallops.

Operational Phase

Scout, like all of the pioneering launch vehicles and missile systems, suffered a number of disappointments during the early '60's, but the program - Government and Industry - persevered. With meticulous ground testing, the institution of rigid requirements and quality and configuration controls and the following of very specific operational procedures, the vehicle's reliability was improved to the level which has been maintained over the years.

The launch of Explorer XIX, an air density experiment, on 19 December 1963, marked the entrance of Scout into the Nation's stable of Operational Launch Vehicles. Todate in the Operational Phase, 78 vehicles have been launched and have established a mission success record of 95%. Within this record, shown in Fig. 4, is included 37 consecutive successful launches. While all the members of the Government and Industry team that contributed to these launches are rightfully proud of their record, the real pride of the program stems not so much from successful vehicle launches but from the accomplishments of so many and so varied a spectrum of successful missions.

## Missions and Accomplishments

Some of Scout's missions have produced discoveries of phenomena hither to unsuspected, such as the finding of new x-ray sources, quasars, and the first "black hole" in space by the Small Astronomy Satellite series. The U.S. Navy's Transit satellites, which are used primarily to provide accurate navigation information to the Fleet are, since 1967, also used by an estimated 6,000 commercial enterprises and foreign countries for navigational assistance. In addition, they are currently in use to provide accurate location information for off-shore oil exploration as a requisite prior to drilling. Some of our early missions involved research into the problems associated with the safety of manned flight into space, investigating phenomena and evaluating materials for such subjects as micrometeoroid density and protection, and the effects of reentry heating on various materials. The output of these missions contributed to the successful Mercury, Gemini, and Apollo programs. Many other Scout missions dealt with pure research of outer space phenomena, one established test confirmation of Einstein's Gravitational and Relativity Theories. More recent missions investigated the effects of aerosol contamination of the Earth's atmosphere and mapped the Earth's magnetic field. This later mission, called MAGSAT, is expected to produce major payoffs in assisting geologists in their search for natural resources. Fig. 5 is a brief tabulation of some of the contributions of Scout launched spacecraft.

In addition to NASA and DOD missions, Scout has had 22 cooperative or reimbursable missions with foreign spacecraft. Participants have included France, Germany, Italy, the Netherlands, the United Kingdom, and the European Space Research Organization; the total spectrum of Scout users is shown in Fig. 6.

## San Marco

Another aspect of the Scout Program that emphasizes its international flavor is the Scout San Marco launch complex near the equator off the coast of Kenya. The Italian Centro Ricerche Aerospaziali (CRA) of the University of Rome had the bold concept of placing Scout launch and range facilities on two mobile platforms, shown in Fig's. 7 & 8, off the Kenya coast in Ngwana Bay. This concept, in a cooperative program between the U.S. and Italy, was brought to fruition on 26 April 1967. This successful launch of the Italian's atmospheric physics spacecraft, San Marco B, shown at liftoff in Fig. 9, demonstrated the soundness of this concept. This program is aptly named since Saint Mark is the patron saint of "risky ventures"; however, the superb effort of the Italian and American personnel involved - coupled with a Papal blessing bestowed on the program - has resulted in a 100% mission success ratio with a series of eight missions having been conducted with Italian, United Kingdom, and American spacecraft.

## Capabilities

### Payload Weight

Since the beginning of the program there has been steady improvement in the Scout vehicle as the needs of the users warranted. And from the beginning, the need for more refined measurements, more detailed investigations, additional experiments and, finally, direct applications has led to heavier and larger volume spacecraft and the subsequent demand for increased performance from the launch vehicles. A history of the increase in performance capability of Scout is illustrated by the fact that the payload weight for a 555 KM (300 n.mi.) orbit from Wallops has been increased from 59 KG (131 pounds) for the Development vehicle to the present Scout G-1 capability of 218 KG (481 pounds) with a 0.86 M (34 inch) diameter heatshield. This is 3.7 times the original capability and an increase of over 265 percent. The method used to achieve increased performance has been primarily to take advantage of improvements in the state-of-the-art of solid propulsion technology to upgrade the output of individual stage rocket motors. Fig. 10 shows this sequential performance growth along with the gains achieved. In every case, the impact of the rocket motor change on the vehicle structure and systems was, by design, held to an absolute minimum. This approach kept the risks to the minimum associated strictly with the improvement, thereby insuring no changes to other flight proven systems. It also assured minimum impact on the cost of the vehicle. In no case was a performance improvement step undertaken purely for the sake of improvement. It happened only when missions required greater performance than was then available, or when economic considerations dictated resourcing the fabrication of a particular stage rocket motor. This is not to say, however, that when greater performance was required our approach could be characterized as timid. An example of this is our latest third stage motor, the Antares IIIA, which features a high solids content HTPB, a Kevlar case, and a carbon/carbon throat insert.

This extensive upgrading of Scout was not accomplished at the expense of economy. On the contrary, a rigorous cost control program has been followed, the success of which is demonstrated by a comparison of both performance and vehicle cost from 1960 thru the program's last lot of vehicles fabricated in 1980. Fig. 11 shows that performance has increased 267% while the vehicle cost has increased only 48%. This cost increase - averaging only 2.4%/year - compares with the Cost of Living growth in the same time period of 196%.

Orbital Inclinations

The original NASA Wallops Launch site, due to its inherant range safety launch azimuth limits, is used to provide orbital inclinations only between 37.7° and 51.5°. The second Scout launch site, VAFB, is used for Polar and Sun Synchronous orbits and has a range of attainable inclinations between 75.5° and 146°. The third site, San Marco, is attractive for near-Equatorial orbits and its inclination range is between 2.9° and 38.5°. These sites are depicted in Fig. 12.

Scout is quite unique in this regard since, with its three launch sites, any orbital inclination is attainable by direct injection, except for bands between 51.5° and 75.5° and between 0° and 2.9°. Even this can be overcome, since the vehicle - with no additional hardware - can be maneuvered in the yaw plane and by so "dog legging" the trajectory, the inclination band limitations for direct injection may, and have been, penetrated.

This flexibility in providing such a wide range of inclinations, shown in Fig. 13 in earth coverage, coupled with the ability to fly orbits, probes, and reentry missions emphasize the versatility of the program. This versatility is summarized in Fig. 14. No other launch vehicle offers this coverage.

Current Scout Capability

Orbital

Today's G-1 configuration, equipped with a 42 inch diameter heatshield, can place the following weights into a 555 KM (300 n.mi) circular orbit with the inclination noted:

a. From NASA Wallops - 208 KG (458 pounds) at 38° inclination.

b. From VAFB - 167 KG (367 pounds) at 90° inclination.

c. From San Marco - 221 KG (486 pounds) at 2.9° inclination.

Parametric performance for the G-1 configuration from all three Scout launch sites is contained in the appendices.

Reentry

The G-1, from VAFB with a 270 KG (595 pound) payload, with two stages fired on ascent and the remaining two fired subsequent to apogee can achieve the following:

| Trajectory Parameter | Reentry Value at Fourth Stage Burnout | |
|---|---|---|
| Range | 1,200 KM | 7,775 KM |
| Altitude | 91 KM | 122 KM |
| Relative Velocity | 5.4 KM/Sec | 6.9 KM/Sec |
| Flight Path Angle | -20° | -20° |

Probe

From NASA Wallops, the G-1 probe capability is identified below:

| Payload Weight | Apogee | Time at Zero "g" |
|---|---|---|
| 91 KG | 14,631 KM | 4.38 hours |
| 181 KG | 3,111 KM | 1.93 hours |

Payload Volume

As the need for greater weight carrying capability grew, so did the need for greater usable volume under the heatshield grow. In fact, it grew at a larger rate than did the performance need. Usable Volume, as discussed here, means that volume which the spacecraft can take up under the heatshield with adequate clearances allowed between it and the vehicle structure and systems to account for the dynamics of flight.

The Scout heatshield has been enlarged significantly since the original 0.54 M (21 inch) diameter configuration with 0.14 cubic meters (5 cubic feet) of Usable Volume. Two different length versions of a 0.86 M (34 inch) diameter heatshield provide Usable Volumes of 0.48 cubic meters (17 cubic feet) and 0.68 cubic meters (24 cubic feet). The 1.07 M (42 inch) diameter heatshield contains 0.99 cubic meters (35 cubic feet) and is currently the most popular. Growth of Usable Volume, from 0.14 to 0.99 cubic meters, is a 600% increase or about 2.5 times the performance increase.

Mission Integration Time Spans

For a "typical" mission it takes about 24 months from its time of assignment to the Scout vehicle to launch. Invariably, it is the development, design, and testing of the spacecraft that is the pacing factor. On occasion, an existing experiment or sensor package can be synergetically matched to an existing spacecraft "bus" and the whole integration cycle reduced to a very short time. Such an example is the USAF/STP P76-5 Mission which from concept to launch required only 9 months. On other occasions, other programs knowing they will be assigned to Scout, begin their integration activities as much as 36 months before launch.

Within the 24 months for a "typical" mission, is a requirement for the flight spacecraft to be at the launch site about 25 working days prior to launch in order to be dynamically balanced with Scout's fourth stage and to undergo compatibility checks with the vehicle at the launch pad. The actual countdown for launch takes approximately 7 hours.

One unique feature about Scout in this area, is the agreement with the U.S. Navy to provide for a Transit (Navigation Satellite) launch within 30 days of their "call up". To do this, a completely checked out vehicle has been preassigned - as has a Transit spacecraft - and is in ready storage, prepared for immediate shipment to VAFB at a moments notice. Work begins immediately upon receipt of the "call", and within 30 calendar days the vehicle and spacecraft is launched on its mission.

Recent Studies of Improved Capabilities

San Marco Scout

Recently, a feasibility study for the Italian CRA to investigate the use of an advanced configuration of Scout as the launch vehicle for a series of proposed Italian communication satellites was completed.

The selected configuration consists of the basic four stage G-1 configuration with the addition of a "zero" stage of four additional Algol IIIA motors "strapped-on", i.e., a five stage vehicle. This is depicted in Fig. 15.

The feasibility study covered the stability and control aspects of the configuration, both vehicle and launcher structural loads, mods required to the major structural GSE, vehicle assembly and checkout flow. Thermal analyses due to the strap-ons on both the vehicle and launcher, separation analyses of the strap-ons, evaluation of the induced vibration and shock environments, and a reliability assessment were also covered.

The results of the study indicate the configuration is quite feasible and, with minimum change to the basic vehicle, results in a significant performance improvement.

The resultant five stage vehicle has a capability of placing a 340 KG (750 pound) payload into a 1296 KM (700 n.mi.) circular orbit at a 2.9$^{o}$ inclination. It can also be used as a four stage configuration by deleting the Altair IIIA upper stage motor and in this case performance is 590 KG (1300 pounds) at 555 KM (300 n.mi.) circular at 2.9$^{o}$.

Larger Heatshields

The need for greater Usable Volume within the heatshield envelope continues to be in demand. This fact was emphasized by the response in Europe to the San Marco Scout configuration wherein several potential users expressed a strong desire to have a larger heatshield to complement the performance gain. The major problem associated with increasing heatshield diameter is dynamic and static stability. However, studies for the San Marco Scout have shown that volumes up to 3.7 cubic meters (130 cubic feet) are attainable without change in vehicle design. Existing 0.86 and 1.07 M (34 and 42 inch) heatshields used with the G-1 configuration of Scout can be modified to yield an increase of 25% in Usable Volume without any vehicle structural redesign. Some of these growth configurations are shown in the appendices.

Individual Rocket Motors

Since our present performance resulted from improvements in individual stage motors, some are naturally closer to today's propulsion state-of-the-art than the others. The design vintage of the current "stack" ranges from 2 to 16 years old. Recent inputs from motor manufacturers indicate current potential performance gains of 8 to 10% for the Algol IIIA first stage and 6 to 8% for the Altair IIIA fourth stage. If implemented, both of these improvements could increase our current 555 KM (300 n.mi) circular performance at 38$^{o}$ from 208 to 237 KG (458 to 522 pounds).

Current Plans

At this time, there are 16 Scout launch vehicles in the inventory. Missions have been assigned to 15 of these vehicles, and the 16th is being held as a back up vehicle for the Navy's Navigational Satellite program. All of these 15 missions will be conducted between this year and 1985 as shown in Fig. 16. Included are two Italian spacecraft, SM-DL and SM-DM, for launch in '82 and '83, respectively, from the San Marco site. These are both NASA/Italian cooperative missions whose common objective is the study of relationships between solar activity and meteorological phenomena. One of the spacecraft, DL, will be investigating these relationships in the troposphere and the other in the lower altitude thermosphere. These two scientific missions are the last scheduled NASA launches. All of the others are DOD missions.

Despite the fact that current plans show the Program conducting launches well into the STS operational period at ETR and the early WTR days, the NASA has agreed to continue its overall management of the Program through 1985. Government management will be through the traditional NASA/SPO and NASA/HQ channels working in conjunction with the NASA/DOD Scout Coordination Committee. Systems management of the program will continue to be performed by Vought.

## Future Plans

With the last scheduled NASA launch in 1983, Scout will be nearing the end of its traditional role and when the last Navy navigation satellite is launched, its role will have been fulfilled. The role has been one of a very versatile launch vehicle for a wide range of uses in terms of both mission types and users.

However, despite the fact that Scout's utility to the NASA is coming to an end, some of its inherant features may make it quite attractive to other agencies that have a need for a dedicated launch vehicle. These features include such things as its low cost, its demonstrated reliability and its capability of long storage and short time to launch.

This potential of working with a dedicated program is being pursued by the Systems Management Contractor. Those of us who have spent a large portion of our professional and personal lives on Scout - the Program will be 25 years old in 1985 - are hopeful that a new, dedicated role will be established, and that Scout can continue its service to the United States.

# Major Scout Assemblies

VOUGHT

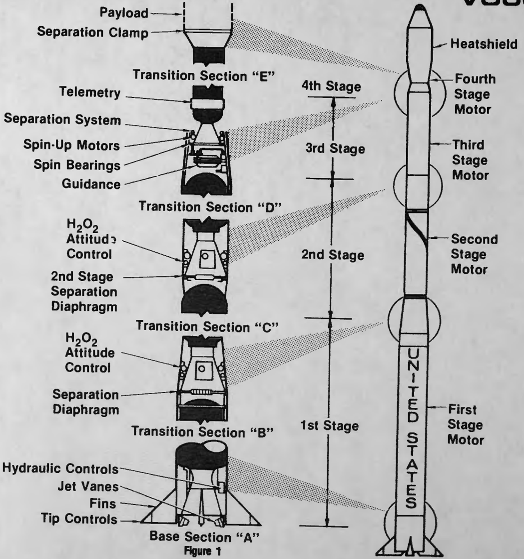


Figure 1

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Figure 2 First Scout Launch 1 July 1960

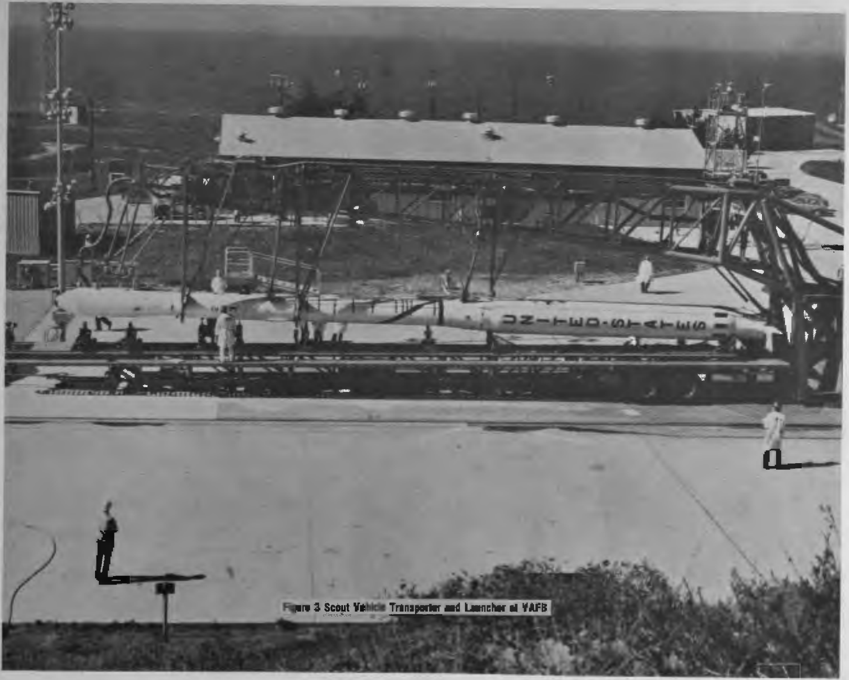


Figure 3 Scout Vehicle Transporter and Launcher at VAFB

# Operational Phase Launch Record

• 78 Operational Launches

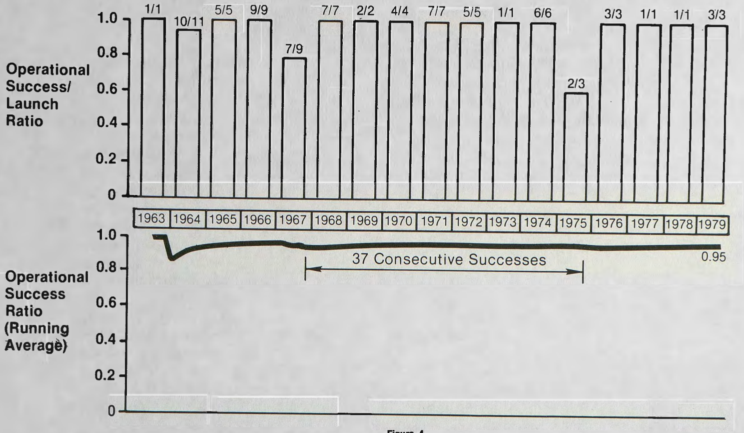


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Figure 4

# Scout Spacecraft Contributions

VOUGHT

**Astronomy**
- Astronomical Netherland Satellite
- Small Astronomy Satellite Series
- UK Series (United Kingdom)
- ESRO Series (European Space Research Organization)

**Communications Research**
- ESRO-4
- Small Scientific Satellite A
- Radiation Attenuation Measurement Series
- FR-1 (France)

**Meteorology**
- Dual Air Density
- Cooperative Applications Satellite (France)
- San Marco Series (Italy)
- Aeros Series (Germany)

**Geodesy**
- Sequential Correlation of Range (Army SECOR-5)
- Beacon Explorer Series

**Meteroid Environment**
- Micrometeoroid Measurements Satellite Series
- Meteoroid Technology Satellite

**Reentry Materials**
- Reentry Series
- RFD Series

**Biology**
- Orbiting Frog Otolith
- OV3-4
- OV3-6

**Spacecraft Technology**
- X-4 (United Kingdom)
- SERT-1
- BE-B
- P76-5
- TRANSAT

**Earth Fields and Atmospheric Sensing**
- Ionosphere Probes
- Heat Capacity Mapping Mission
- Stratospheric Aerosol and Gas Experiment
- OV3-5
- Hawkeye
- Magnetic Field Satellite
- Solar Radiation
- Gravitational Field Experiments

**Special Missions**
- U.S. Air Force

P1-623-8

Figure 5

# Scout Users

VOUGHT

| | |
|---|---|
| National Aeronautics and Space Administration | 39 |
| United States Air Force | 14 |
| United States Army | 1 |
| United States Navy | 23 |
| Atomic Energy Commission | 2 |
| ESRO (ESA) | 5 |
| France | 2 |
| Germany | 4 |
| Italy | 4 |
| Netherlands | 1 |
| United Kingdom | 6 |
| Total | 101 |

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Figure 6

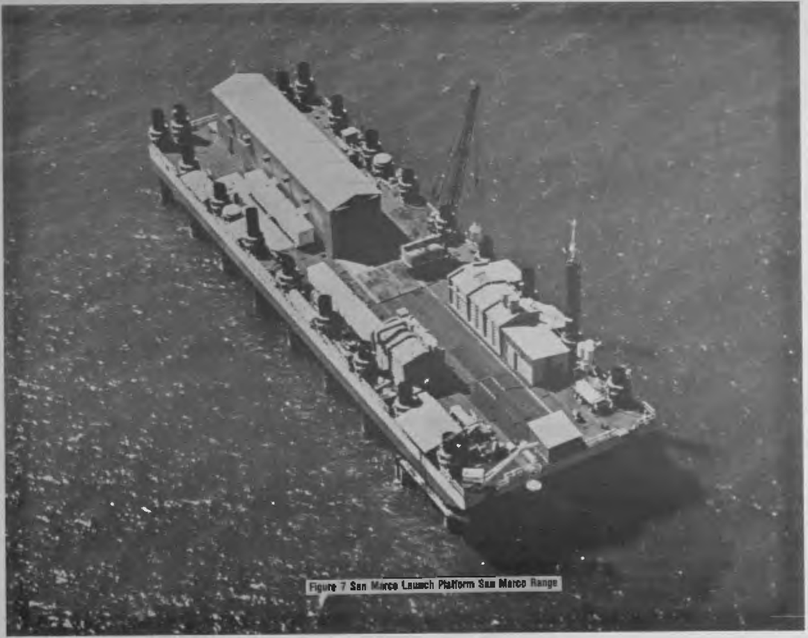


Figure 7 San Marco Launch Platform San Marco Range

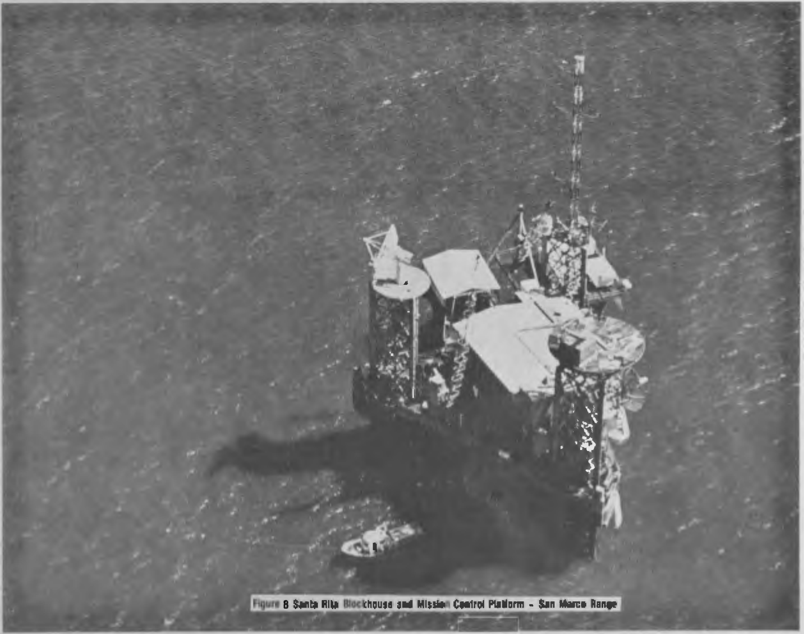


Figure 8 Santa Rita Blockhouse and Mission Control Platform - San Marco Range

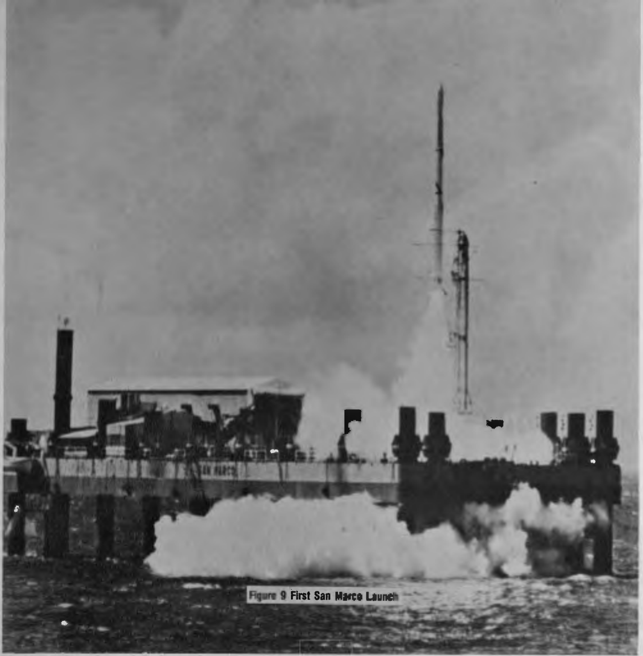
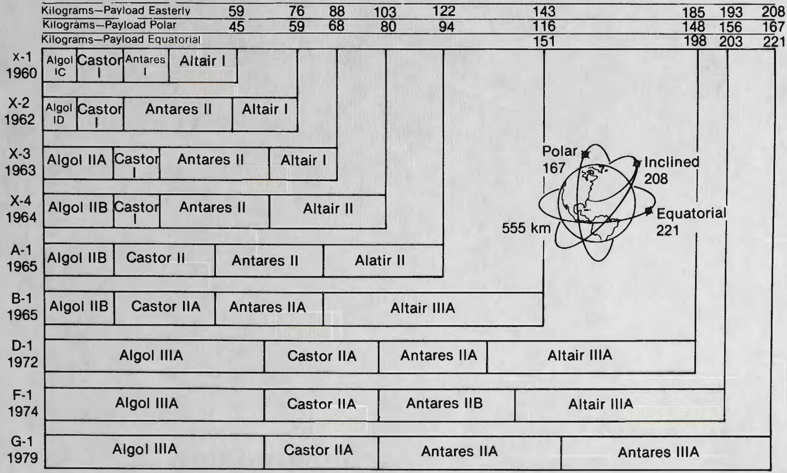


Figure 9 First San Marco Launch

# Scout Capability Growth

VOUGHT

## 555-Kilometer Circular Orbit




Scout Vehicle Growth

Figure 10

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# Cost and Performance Growth Comparison

VOUGHT

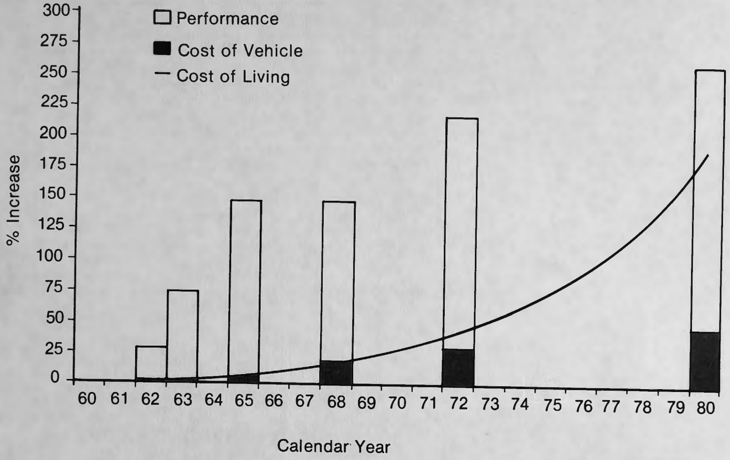


Figure 11

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# Launch Sites

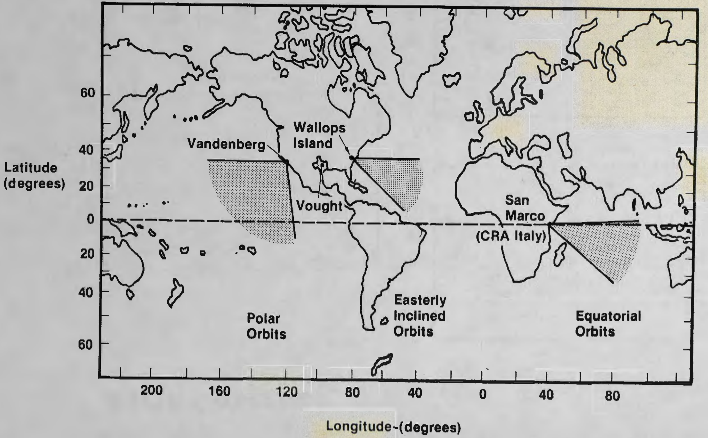


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Figure 12

# Earth Coverage

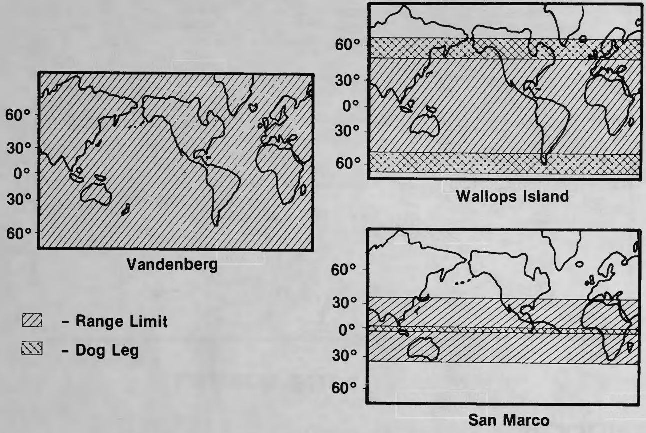




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Figure 13

# Scout Versatility

| | |
|---|---|
| **Types** | |
| Orbital | 82 |
| Reentry | 12 |
| Probe | 7 |
| | 101 |
| **Launch Site** | |
| VAFB | 54 |
| Wallops | 39 |
| San Marco | 8 |
| | 101 |
| **Customer** | |
| NASA | 41 |
| DOD | 38 |
| European | 22 |
| | 101 |

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Figure 14

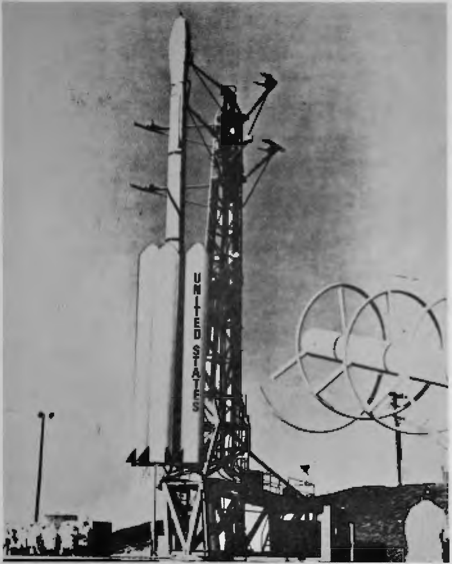


Figure 15 San Marco Scout

# Scout Launch Schedule

| 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|
| NOVA-I | Navy | AF-1 | AF-4 | Navy |
| NOVA-II | SM-DL | AF-2 | AF-5 | Navy |
| | | AF-3 | Navy | Navy |
| | | SM-DM | Navy | |

P1-623-1

Figure 16

APPENDICES

# Scout G-1 Capability

**Orbital 555-Kilometer Circular**

- From NASA Wallops – 208 kg (458 lb) at 38° Inclination
- From VAFB – 167 kg (367 lb) at 90° Inclination
- From San Marco – 221 kg (486 lb) at 2.9° Inclination

**Reentry**

- From VAFB – 270 kg (595 lb) Payload

| | | Value at 4th-Stage Burnout | |
|---|---|---|---|
| Range | – | 1,200 km (648 nmi) | 7,775 km (4,198 nmi) |
| Altitude | – | 91 km (49 nmi) | 122 km (66 nmi) |
| Relative Velocity | – | 5.4kmps (17,717 fps) | 6.9 kmps (22,639 fps) |
| Flight Path Angle | – | –20° | –20° |

**Probe**

- From NASA Wallops

| Payload Weight | Apogee | Time at Zero "g" |
|---|---|---|
| 91 kg (200 lb) | 14,631 km (7,900 nmi) | 4.38 hr |
| 181 kg (400 lb) | 3,111 km (1,680 nmi) | 1.93 hr |

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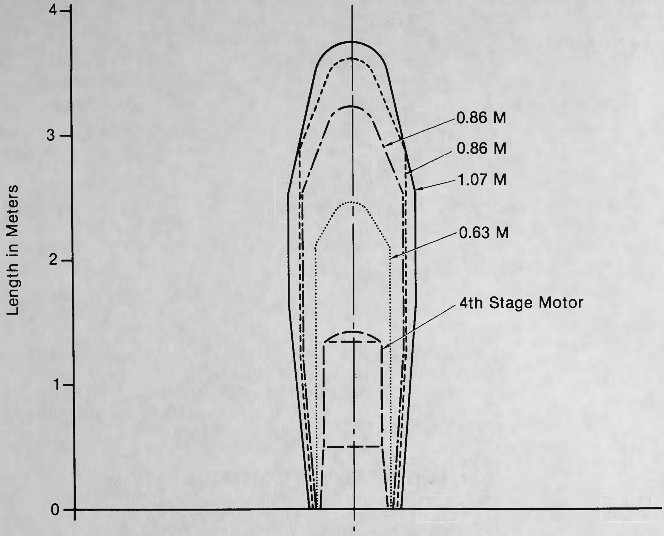
# Current Heatshield Growth

VOUGHT

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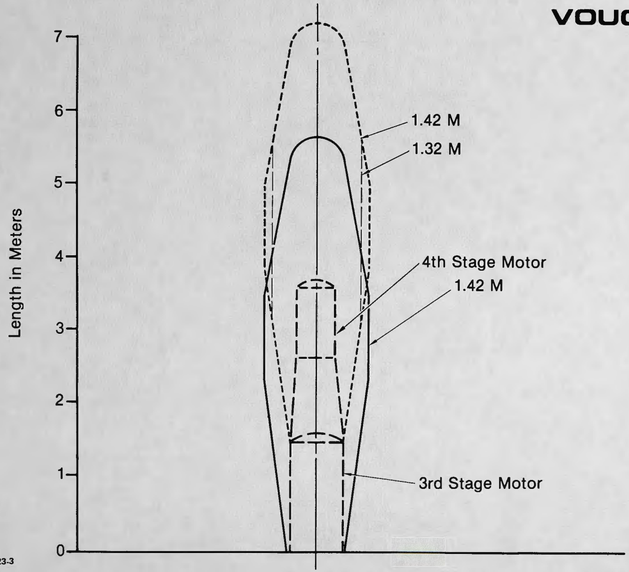
# Growth Heatshield Configurations

VOUGHT

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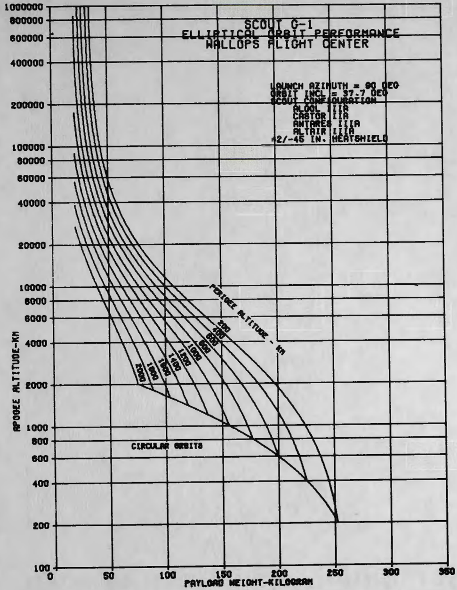
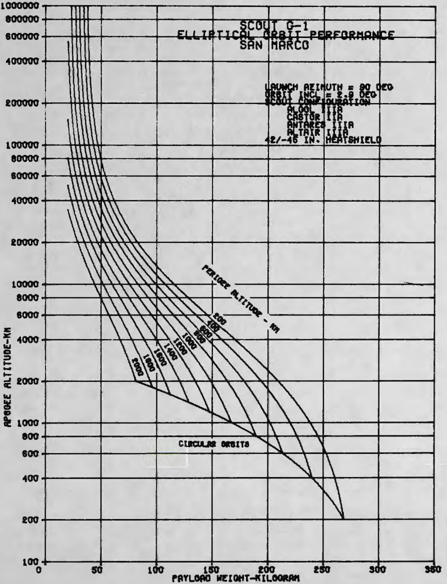
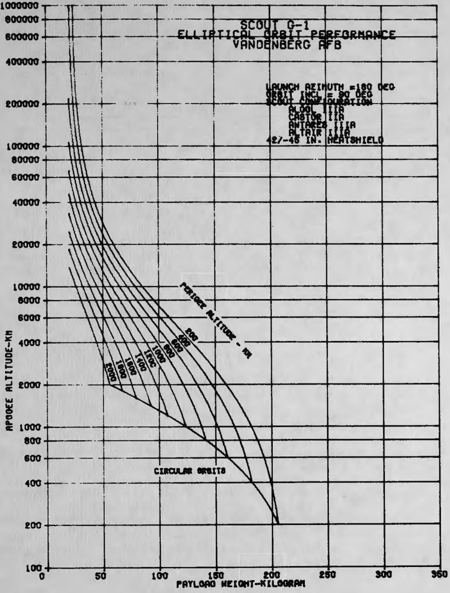

SCOUT G-1
ELLIPTICAL ORBIT PERFORMANCE
WALLOPS FLIGHT CENTER
LAUNCH AZIMUTH = 90 DEG
ORBIT INCL = 37.7 DEG
SCOUT CONFIGURATION
ALGOL IIIA
CASTOR IIA
ANTARES IIIA
ALTAIR IIIA
#2/-45 IN. HEATSHIELD
PERIGEE ALTITUDE - KM
200
400
600
800
1000
1200
1400
1600
1800
2000
CIRCULAR ORBITS
APOGEE ALTITUDE-KM
PAYLOAD WEIGHT-KILOGRAM
1000000
800000
600000
400000
200000
100000
80000
60000
40000
20000
10000
8000
6000
4000
2000
1000
800
600
400
200
100
0
50
100
150
200
250
300
350


SCOUT G-1
ELLIPTICAL ORBIT PERFORMANCE
SAN MARCO
LAUNCH AZIMUTH = 90 DEG
ORBIT INCL = 2.9 DEG
SCOUT CONFIGURATION
ALGOL IIIA
CASTOR IIA
ANTARES IIIA
ALTAIR IIIA
42/-45 IN. HEATSHIELD
PERIGEE ALTITUDE - KM
200
400
600
800
1000
1200
1400
1600
1800
2000
CIRCULAR ORBITS
APOGEE ALTITUDE-KM
PAYLOAD WEIGHT-KILOGRAM
1000000
800000
600000
400000
200000
100000
80000
60000
40000
20000
10000
8000
6000
4000
2000
1000
800
600
400
200
100
0
50
100
150
200
250
300
350


SCOUT G-1
ELLIPTICAL ORBIT PERFORMANCE
VANDENBERG AFB
LAUNCH AZIMUTH =180 DEG
ORBIT INCL = 90 DEG
SCOUT CONFIGURATION
ALGOL IIIA
CASTOR IIA
ANTARES IIIA
ALTAIR IIIA
42/-45 IN. HEATSHIELD
PERIGEE ALTITUDE - KM
200
400
600
800
1000
1200
1400
1600
1800
2000
CIRCULAR ORBITS
APOGEE ALTITUDE-KM
1000000
800000
600000
400000
200000
100000
80000
60000
40000
20000
10000
8000
6000
4000
2000
1000
800
600
400
200
100
0
50
100
150
200
250
300
350
PAYLOAD WEIGHT-KILOGRAM


UNITED STATES