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National Aeronautics and
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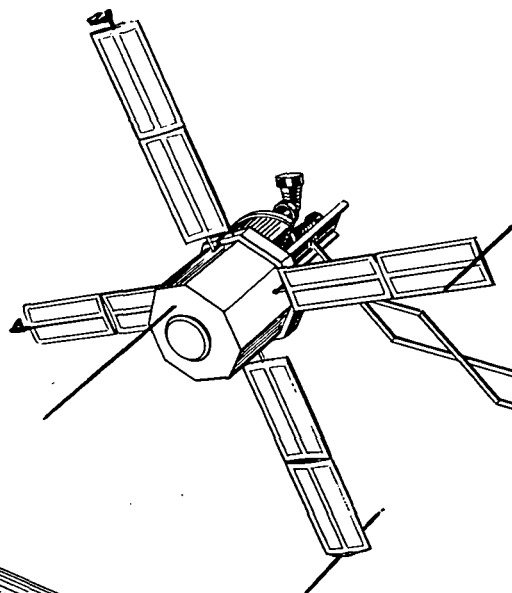For Release **TUESDAY,**
October 23, 1979

Press Kit

Project   Magsat

RELEASE NO: 79-129

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NASA News

For Release:

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Headquarters, Washington, D.C.
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TUESDAY,
October 23, 1979

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Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/344-5565)

RELEASE NO: 79-129

SATELLITE TO STUDY EARTH'S MAGNETIC FIELD

The first spacecraft specifically designed to measure
the near-Earth magnetic field and crustal anomalies is
scheduled to be launched no earlier than Oct. 29.

Called the Magnetic Field Satellite (Magsat), this NASA
experimental spacecraft will be placed in a sunlit (dawn to
dusk) Sun-synchronous, nearly polar orbit with a perigee of
350 kilometers (215 miles) and an apogee of 500 km (345 mi.).

This low orbit will provide for successive spacecraft
Earth tracks approximately 150 km (92 mi.) apart covering
the globe completely every 10 days.

-more-

October 19, 1979

The planned minimum mission life of 120 days is expected to yield at least three complete sets of global magnetic field data which will permit averaging and statistical analysis. The launch, by a NASA Scout launch vehicle, will be from the Air Force Western Space and Missile Center, Lompoc, Calif.

In addition to a scalar magnetometer to measure the magnitude of the Earth's crustal magnetic field, Magsat will be the first spacecraft in near-Earth orbit to carry a vector magnetometer which will measure magnetic field direction as well as magnitude.

Scientists hope that Magsat data will reflect important geologic features such as composition, temperature of rock formation, remanent magnetism, and geologic structure (faulting, subsidence, etc.) on a regional scale. Such knowledge will help in the understanding of large-scale variations in the geologic and geophysical characteristics of the Earth's crust and, in turn, aid in the planning of minerals exploration.

Scientists from the United States and eight foreign countries -- Australia, Brazil, Canada, France, India, Italy, Japan and the United Kingdom -- will carry on 32 investigations in six general categories: geophysics, geology, field modelling, marine studies, magnetosphere/ionosphere and core/mantle studies.

Magsat's main mission objectives are to:

● Obtain an accurate, up-to-date quantitative descrip-
   tion of the Earth's magnetic field;

● Provide data and a worldwide magnetic-field model
   suitable for U.S. Geological Survey update and
   refinement of world and regional magnetic charts;

● Compile a global two-dimensional (scalar and vector)
   crustal magnetic anomaly map. The spatial resolution
   goal of the anomaly map is to be better than 350 km
   (219 mi.).

The principal user of Magsat data, the Geological Survey
of the Department of the Interior, has cooperated closely
with NASA in setting mission objectives and will participate
in the data analysis. Magsat data will be used by the Geo-
logical Survey in its publication of updated magnetic field
charts and maps in 1980 for navigation and geological use.

Prior to the satellite era, magnetic data from many
geographic regions were acquired over periods of years through
a variety of measurement techniques. Data on many regions,
such as oceanic and polar, was either sparse or nonexistent.

Satellite measurements of the geomagnetic field began with the launch of Sputnik-3 in May 1958, and have continued sporadically in the intervening years. To date, only the three Polar Orbiting Geophysical Observatories and the Orbiting Geophysical Observatories 2, 4 and 6 have provided an accurate global geomagnetic survey. These satellites operated between October 1965 and June 1971, and provided global measurements of the field magnitude over an altitude range of 400 to 1,500 km (205 to 930 mi.).

These satellite geomagnetic field measurements were designed to map the main geopotential field originating in the Earth's core, to determine the long-term temporal or secular variations in that field, and to investigate short-term field perturbations due to ionospheric currents. Early in the polar orbiting observatory era, it was thought to be impossible to map crustal anomalies from space. However, while analyzing data from these satellites, it was discovered that the lower altitude data contains separable fields due to anomalies in the Earth's crust, thus opening the door to a new class of investigations.

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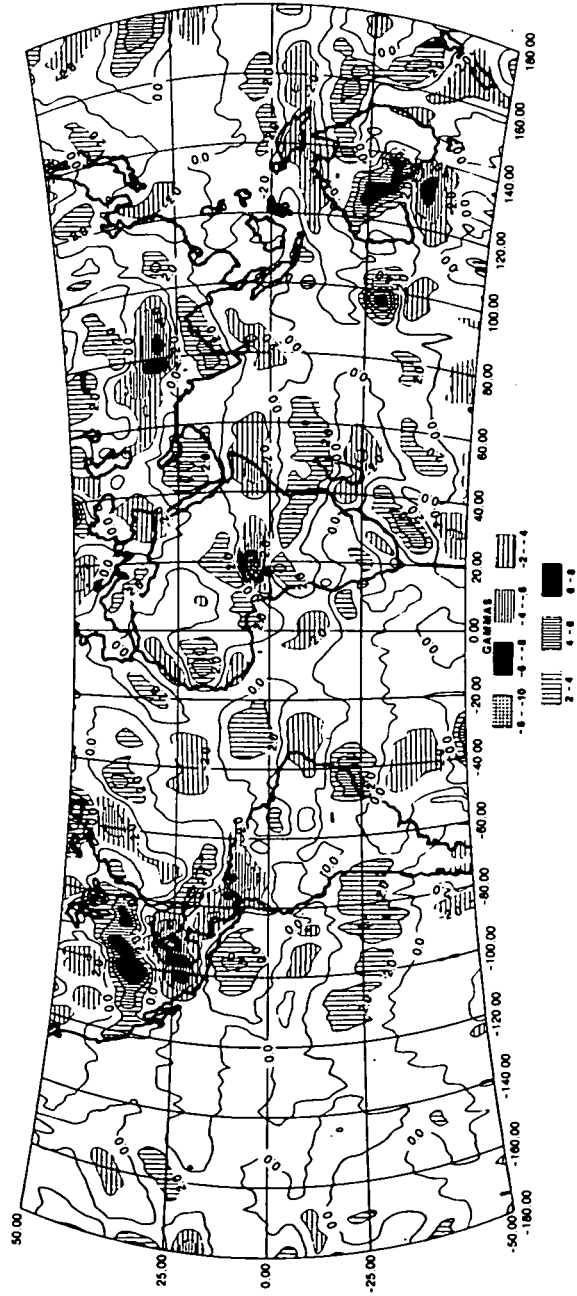
Global Magnetic Anomaly Map Based on POGO Data

Magsat data is expected to be superior to the polar orbiting observatory data in two areas:

● Vector measurements will be used to determine the directional characteristics of anomaly regions and to resolve ambiguities in their interpretation. Knowledge of the vector components will permit identification of field variations perpendicular to the main field, and thereby restrict the range of possible models which can explain the anomaly. The vertical component will provide more precise information on the boundaries of the anomalous region.

● Lower altitude data will provide increased signal strength and resolution for detailed studies of crustal anomalies. Signal strength and resolution increase rapidly with decreasing altitude. The magnitude of the anomalous field should increase nearly fivefold at 300 km (187 mi.), and the finer resolution possible will allow more detailed geological interpretations of anomalous regions.

Magsat data will be correlated with other geophysical measurements and with geological information to produce regional crustal models. For example, the highly accurate determination of the Earth's gravity field using laser tracking of satellites and satellite altimeters provides information about the density distribution within the Earth's crust.

Magsat is the third in a series of low-cost, modular design satellites, designated Applications Explorer Missions, built to be placed in special orbits to satisfy mission-unique experimental data acquisition requirements. Many of the component systems for Magsat make use of space hardware left over from the Small Astronomy Satellite which was launched in 1975. Cost of the Magsat program is $19.7 million.

The spacecraft is made up of two parts: (1) the instrument module with the optical bench, star cameras, altitude transfer system, magnetometer boom and gimbal systems, scalar and vector magnetometers and precision Sun sensor; and (2) the base module which houses the electrical power supply, telemetry, altitude control and command data handling systems.

Overall spacecraft weight is 181 kilograms (399 pounds). Its solar panels provide 160 watts of power. A three axis control of $\pm$ 5 degrees enables the satellite to maintain attitude so that the magnetometer, Sun sensors, star cameras and the solar panels are properly oriented.

NASA's Goddard Space Flight Center, Greenbelt, Md., is responsible for the design, integration and testing of the satellite and data processing.

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Magsat data will be stored on two onboard tape recorders and transmitted when the satellite is within reception range of the following NASA receiving stations: Merritt Island, Fla.; Goldstone, Calif.; Fairbanks, Alaska; Orroral, Australia; Madrid, Spain; Goddard; Kauai, Hawaii; Quito, Ecuador; Santiago, Chile; Guam; and Ascension Island.

The spacecraft's base and instrument modules were built by the Applied Physics Laboratory, Johns Hopkins University, Laurel, Md.

NASA's Langley Research Center, Hampton, Va., manages the four-stage, solid-fuel Scout-G launch vehicle which will place Magsat in orbit. Scout is built by the Vought Corp., Dallas, Texas.

The Magsat mission is a project of NASA's Office of Space and Terrestrial Applications.

The launch window is 9:09 a.m. to 9:15 a.m. EST, Oct. 29.

(END OF GENERAL RELEASE. BACKGROUND INFORMATION FOLLOWS.)

MISSION DESCRIPTION

The third Applications Explorer Mission, the Magnetic Field Satellite (Magsat) is scheduled to be launched from the Air Force Western Space and Missile Center on board a Scout-G solid-fuel launch vehicle no earlier than Oct. 29, 1979. The launch window is 9:09 a.m. to 9:15 a.m. EST. Although the minimal lifetime is four months, current predictions, based on present solar activity, imply a lifetime of nearly six months before reentry will occur.

Magsat instruments consist of a scalar and a vector magnetometer. The scalar instrument is a dual lamp cesium vapor magnetometer. The vector instrument is a three-axis fluxgate magnetometer. When uncertainties associated with orbit position, spacecraft attitude and attitude transfer between the sensor platform and the spacecraft are taken into account, the expected accuracy for the scalar measurement is +3 gamma in total field and for the vector measurement +6 gamma in each component. The spacecraft will be launched into a 350 by 550-km (215 by 345-mi.) Sun-synchronous orbit with an inclination of 97 degrees. The scientific measurements will be stored on tape recorders and telemetered to a receiving station approximately once every four orbits. The base module Magsat uses is residual hardware from the Small Astronomy Satellite.

There were 32 investigations selected in response to an Announcement of Opportunity issued Sept. 1, 1978. They included 13 foreign investigations from Australia, Brazil, Canada, France, India, Italy, Japan and the United Kingdom. The six general categories of research are geophysics, geology, field modelling, marine studies, magnetosphere/ionosphere, and core/mantle studies. Data distribution will be through the National Space Science Data Center. Goddard Space Flight Center is responsible for overall project management, data acquisition and operation of the satellite, as well as instrument development, data processing and management of the investigations program. The Applied Physics Laboratory of Johns Hopkins University is the prime spacecraft contractor.

Successive spacecraft Earth tracks will be approximately 150 km (93 mi.) apart and will provide complete global coverage in about 10 days. However, due to magnetic disturbances caused by solar activity, 50 days will be required to gather enough good data. The planned minimum mission life of 120 days is expected to yield at least three complete sets of global data which will permit averaging and statistical analysis.

Upon orbit injection, Magsat will deploy its solar array and turn 90 degrees to face the solar cells toward the Sun. The solar array will furnish 160 watts to power the spacecraft. The spacecraft will be oriented with its axis pointing towards Earth. A pitch momentum wheel and horizon scanner will maintain this attitude as Magsat travels around the Earth. The 6-meter- (20-foot)-long magnetometer boom will then be deployed aft and the magnetometers will be energized and magnetic measurements will commence. Star cameras mounted to the optical bench will be used to determine the spacecraft's attitude to within +10 arc seconds. An attitude transfer system will measure the pitch, yaw and roll angles between the vector magnetometer and the star cameras within +10 arc seconds. A direct reading precision Sun sensor mounted near the vector magnetometer will provide redundant roll angles to within +10 arc seconds.

Data will be recorded on an 8.9×10^7 bit Odetics tape recorder at 2,000 bits per second (2 kilobits per second). Every third or fourth orbit the tape recorder will be read out (dumped) at 320 kbs. Real-time data at 2 kbs may be transmitted by the spacecraft along with the tape recorder dump. Data will be provided to the Geological Survey for use in their models, charts and maps, and to the scientific community for appropriate investigations.

Program costs related to Magsat, excluding the launch vehicle and tracking and data network operations, total $19.7 million.

THE SPACECRAFT

The spacecraft is made up of two modules: the base module which houses the electrical power supply system, the telemetry system, the attitude control system and the command and data handling system; and the instrument module which comprises the optical bench, star cameras, attitude transfer system, magnetometer boom and gimbal systems, scalar and vector magnetometers and precision Sun sensor.

The base module structure is the Small Astronomy Satellite design and incorporates its salient features, i.e., central column, eight trusses, thermal control louvers, forward and aft honeycomb decks and hinged solar array.

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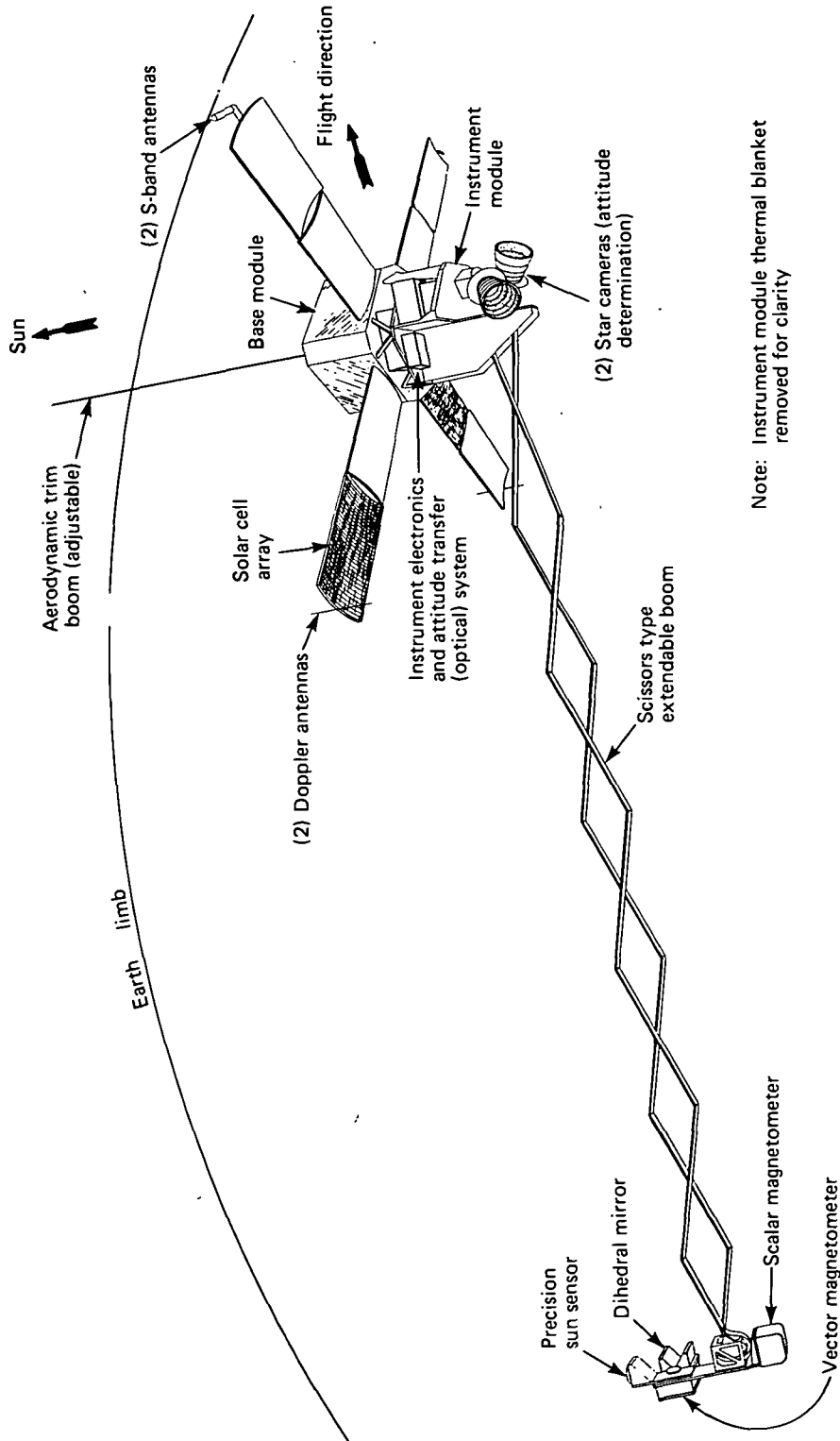
Magsat Orbital Configuration

Instrument Module

The instrument module structure is bolted to the base module and consists of four truss structures, a base plate, the optical bench and the boom drive and gimbal assembly housing. Listed below are the pertinent parameters of the spacecraft.

Height: 164 centimeters (63 inches)
8.74 cm (344 in.) with trim boom extended

Diameter: 77 cm (30 in.), solar panels and magneto-meter boom extended

Width: 340 cm (134 in.), tip to tip, solar array deployed

Length: 722 cm (284 in.), length along flight path - magnetometer boom and solar array deployed

Weight: Base Module - 115 kg (254 lb.)
Instrument Module - 66 kg (145 lb.)
Total - 181 kg (399 lb.)

Power: 160 watts

Attitude Control: Three-axis stabilization (momentum wheel and magnetic torquing)

Command and Data Handling: S-band transponder - 2282.5 MHz

Doppler Beacon: 162 and 324 MHz

The primary subsystems in the instrument module include:

● A 6-m (20-ft.) extendable boom and a sensor platform with vector and scalar magnetometers, and a precision Sun sensor.

● An optical bench with two star cameras and three attitude transfer systems components.

● Associated electronics.

Scalar Magnetometer

The scalar magnetometer measures total field magnitude. The magnetometer is a cesium (Cs 133) vapor, self-oscillating, four gas-cell, dual lamp magnetometer with active thermal control. It consists of an electronics package, a sensor assembly and a redundant radio frequency exciter package. The sensor assembly, mounted on the sensor platform, will be extended from the satellite body by a 6-m (20-ft.) scissors boom to minimize magnetic interference from the satellite. The radio frequency exciter and electronics packages are located in the instrument module.

The cesium vapor magnetometer uses optical pumping to produce an interaction of the magnetic moment and the angular momentum of the valence electrons of the cesium with the ambient magnetic field to cause an oscillation whose frequency (Larmor frequency) is directly proportional to the amplitude of the magnetic field. The frequency is 3.499 Hz/γ ($1\gamma = 10^{-5}$ gauss) for Cs 133.

The magnetometer has redundant dc/dc converters. Power consumption is 22.9 watts at 16 volts from the unregulated bus. The converters are synchronized to the main satellite converter and will free-run if the synchronizing signal is lost.

Vector Magnetometer

The vector magnetometer provides measurements of the three orthogonal components of the Earth's field. It consists of three ring-core fluxgate sensors and an electronics package. The sensors are orthogonally mounted in a ceramic block. The sensors and ceramic block are assembled together in a thermally controlled environment -- 25 degrees Celsius $\pm$ 1 degree C (77 degrees Fahrenheit $\pm$ 2 degrees F.) so that orthogonality will be maintained consistent with the accuracy goal of 3 gammas.

The sensor, mounted to the magnetometer base along with the remote attitude transfer system dihedral and plane mirrors, and the precision Sun sensor are assembled to the sensor platform. The platform will be extended 6 m (20 ft.) from the satellite body by a scissors boom so that the magnetic bias due to the satellite will be $\leq$0.5 gamma. The electronics package is located in the instrument module.

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Notes: 1. 5.8 meters (228 inches) before magnetometer-boom deployment.

2. For clarity, thermal blankets are not shown.

Sun

+B

Aerodynamic trim surface

NSDSAD

Base module

Instrument module

7.1 meters (280 inches) (See note 1)

1.64 meters (64.5 inches)

Flight Direction

6.02 meters (237 inches)

—B
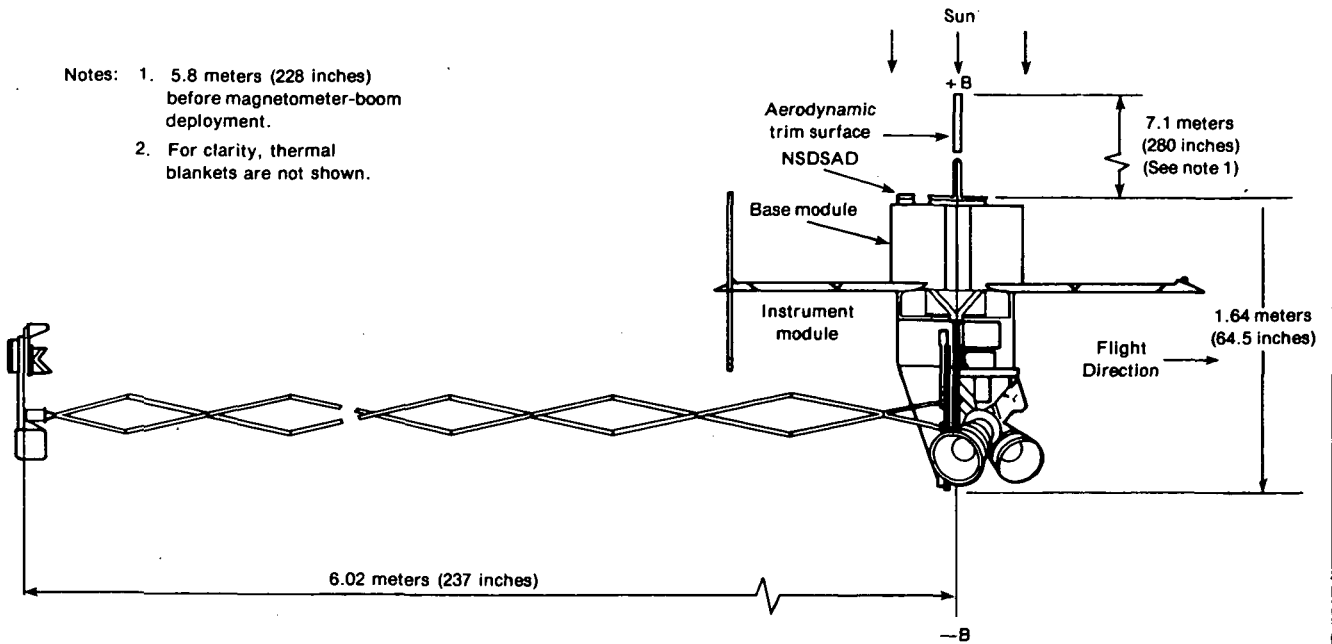
MAGSAT Orbital Configuration, Top View

Sensor platform

Sensor platform ATS dihedral mirror

Vector magnetometer

Precision Sun sensor

Scalar magnetometer

Boom sections (stowed)

Boom alignment guide

Boom drive

Z-axis

Tape recorders (2)

ATS electronics

Junction or interface

Inst. Mod. truss Structure

Sta —26.00

Sta 1.25

ATS roll head

Optical bench

Sta 19.25

Star cameras and sunshades
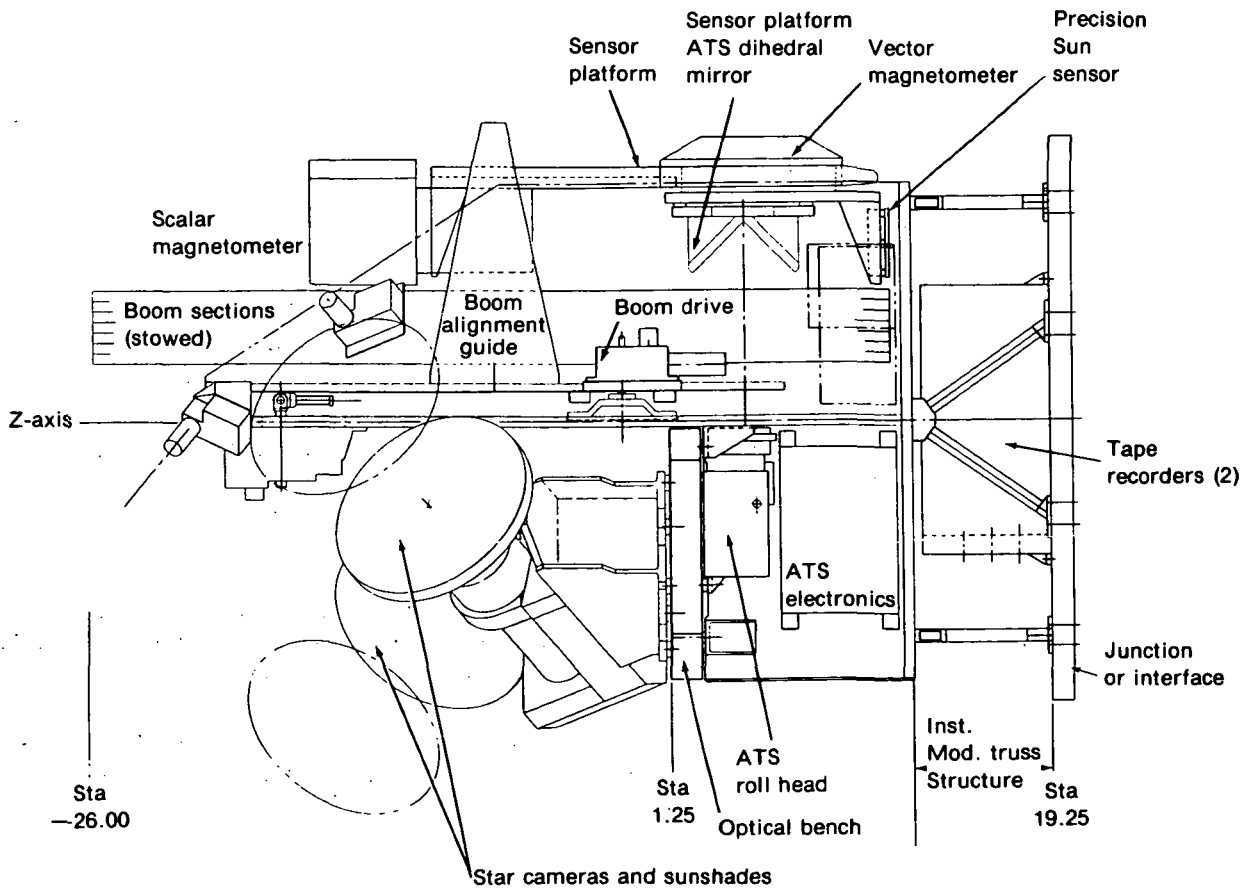
MAGSAT Instrument Module

The output signal of +8 volts corresponding to a magnetic field of +2,000 gamma will be digitized using a 12 bit A/D converter providing resolution of 0.5 gamma. The offset bias generator produces 128 automatically controlled bias steps of 1,000 gammas each to extend the range to +64,000 gammas.

The magnetometer draws approximately 1.8 watts from the unregulated bus to power the electronics. The redundant power converters are synchronized to the main satellite converter and will free-run if the synchronizing signal is lost.

Sensor Boom

The magnetometer boom must separate the sensor platform from the source of strong magnetic fields in the instrument and base modules by a distance of 6 m (20 ft.). It must also maintain the position of the sensor platform such that its angular deviation relative to the attitude transfer system optical axis never (or rarely) exceeds 3 arc minutes over a reasonable portion of the spacecraft's useful lifetime. Finally, the magnetometer boom must keep the center of the plane mirror that is attached to the vector magnetometer mounting plate confined to a square area that measures 3.81 cm (1.5 in.) on a side and whose geometric center coincides with the attitude transfer system optical axis.

The 6-m (20-ft.) boom consists of seven pairs of links. The individual links are rectangular tubes of graphite epoxy 5.08 by 1.02 cm (2 by .4 in.) with walls 0.08 (.03 in.) thick. Inner and outer surfaces are protected from moisture absorption by aluminum foil 0.018 millimeter (.0007 in.) thick. The magnetometer sensor and Sun sensor are connected to the instrument and base modules by an electrical cable that passes through the boom links. This cable consists of 128 conductors and weighs 2.72 kg (6 lb.).

Firing pyrotechnic devices release sensor platform caging and boom link caging. Preloaded springs cause the boom to extend about 0.6 m (2 ft.). An alternating current hysteresis synchronous motor drives the ends of the root-links together and with the springs produces full extension of the boom. Power to the drive motor is automatically cut off by a limit switch at full extension.

The graphite fiber/epoxy boom link material was chosen for light weight and minimum coefficient of thermal expansion. An average coefficient of approximately $+0.32 \times 10^{-6}$ cm/cm/degrees C over a temperature range of -12 degrees to 43 degrees C (54 to 109 degrees F.) has been achieved for these links. The outside of the links is covered with aluminized Kapton film with an aluminum oxide overcoat to provide the proper solar absorptivity and emissivity to minimize temperature gradients and provide an operating temperature in full Sun of 25 degrees C (77 degrees F.).

To eliminate built-in mechanical misalignments (that might go undetected during ground testing) and initial thermal bending, the boom is provided with a ground-controlled three-axis gimbal. This gimbal is located at the boom base and, upon command from the ground, tilts the boom in either pitch or yaw or rotates it in twist as necessary. It is capable of ± 2 degrees adjustment in pitch and yaw and ± 5 degrees in twist.

The boom weighs 6.781 kg (15 lb.) and the gimbal weighs 2.984 kg (6.57 lb.).

DATA COLLECTION AND PROCESSING

Data will be recorded on an 8.9×10^{7} bit Odetics tape recorder at 2,000 bits per second (2 kbs). Every third or fourth orbit the tape recorder will be read out (dumped) at 320 kbs.

Techniques developed and proven effective for scalar magnetometer data from the Polar Orbiting Geophysical Observatory satellites will be refined and utilized for Magsat. This includes extensive checking of the quality of the data prior to release for analysis. For scalar data, the goal is to have the data ready for analysis two to three months after acquisition. Insofar as possible, the scalar data will be utilized to verify and calibrate the vector data. The success of this procedure depends upon the achieved accuracy of the scalar instrument, the noise levels in the two instruments, and the stability of the fluxgate magnetometer over a period of a few hours. It is anticipated that such in-flight calibration will be possible to a 2-3 gamma level of accuracy in each component.

Vector data will first be processed and available in the magnetometer coordinate system. Any calibration of the vector instrument by the scalar instrument will be applied at this stage.

Transformation of the vector data to an Earth-oriented system requires knowledge of the attitude of the magnetometer relative to the spacecraft and knowledge of the attitude of the spacecraft. These attitude determinations will be accomplished in two stages. First, overall attitude will be determined to about 20 arc-minutes. These results will be available four to six weeks after acquisition of the data. The final definitive attitude determination will require more extensive analysis and will not be available until about eight months after acquisition of data.

Because of the time necessary to accomplish the definitive attitude determination, vector data in an Earth-oriented system will be available for analysis in two stages, corresponding to the two stages of attitude determination. Processed data will be available at 20 arc-minute accuracy about two or three months after acquisition of data and at 20 arc-second accuracy about eight months after data acquisition.

For users who require an up-to-date spherical harmonic model of the Earth's field, an initial model for the epoch of the measurements will be generated as soon as possible. Such a model could be available as early as two months after launch. It will not include secular variation. More definitive models will be developed after a substantial amount of data is acquired and the 20 arc-second attitude determination is accomplished.

Present plans call for release of the data to the National Space Science Data Center at Goddard as soon as it is ready for analysis. This data will be provided to the public at a nominal cost.

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MAGSAT INVESTIGATIONS PROGRAM

Following a NASA Announcement of Opportunity on Sept. 1, 1978, a number of investigators were selected to conduct experiments using the Magsat data. The selected investigators, both U.S. and foreign, represent government agencies, universities and industry, as indicated in the following list.

Geophysics

R. L. Coles
Geomagnetic Service
 of Canada

Reduction, Verification and Interpretation of Magsat Data Over Canada

B. N. Bhargava
Indian Institute
 of Geomagnetism

Magnetic anomaly and Magnetic Field Map Over India

W. J. Hinze
Purdue University

Processing and Interpretation of Magnetic Anomaly Data Over South America

G. R. Keller
University of Texas,
 El Paso

Synthesis of Data for Crustal Modeling of South America

P. Gasparini
University of Naples
Italy

Crustal Structures Under the Active Volcanic Areas of the Mediterranean

N. Fukushima
University of Tokyo

Regional Field Charts, Local Magnetic Anomalies, Separation of Internal and External Potentials

C. R. Bentley
University of Wisconsin

Investigation of Antarctic Crust and Upper Mantle

M. A. Mayhew
Business & Tech. Systems, Inc.
Seabrook, Md.

Magsat Anomaly Field Inversion and Interpretation for the United States

J. L. le Mouel
Institut de Physique du Globe
Toulouse, France   ·

Data Reduction, Studies of Europe, Central Africa and Secular Variation

-more-

J. C. Dooley
Bureau of Mineral Resources
Canberra, Australia

The Regional Field and
Crustal Structure of
Australia and Antarctica

B. D. Johnson
Macquarie University
Australia

Crustal Properties of
Australia and Surrounding
Regions

Geology

R. S. Carmichael
University of Iowa

Crustal Structure and
Mineral Resources in the
U.S. Midcontinent

D. H. Hall
University of Manitoba
Canada

Lithostratographic and
Structural Elements in the
Canadian Shield

I. Gill Pacca
Universidade de Sao Paulo
Brazil

Structure, Composition and
Thermal State of the Crust
in Brazil

D. A. Hastings
Michigan Technological
  University

Precambrian Shields and
Adjacent Areas of West
Africa and South America

D. W. Strangeway
University of Toronto
Canada

Analysis of Anomaly Maps
Over Portions of the
Canadian and Other Shields

I. J. Won
North Carolina State
  University, Raleigh

Compatibility Study of the
Magsat Data and Aeromagnetic
Data in the Eastern Piedmont,
United States

S. E. Haggerty
University of Massachusetts,
  Amherst

The Minerology of Global
Magnetic Anomalies

M. R. Godivier
ORSTOM
Paris, France

Magnetic Anomaly of Bangui

Field Modeling

D. R. Baraclough
Institute of Geological
  Sciences
Edinburgh, Scotland

Spherical Harmonic Repre-
sentation of the Main
Geomagnetic Field

D. P. Stern
NASA Goddard Space Flight
 Center

Study of Enhanced Errors
and of Secular Variation

M. A. Mayhew
Business & Tech. Systems, Inc.
Seabrook, Md.

Equivalent Source of
Modeling of the Main Field

B. P. Gibbs
Business & Tech. System, Inc.
Seabrook, Md.

Field Modeling by Optimal
Recursive Filtering

Marine Studies

C. G. A. Harrison
University of Miami
Florida

Investigations of Medium
Wavelength Anomalies in the
Eastern Pacific

J. L. LaBrecque
Lamont-Doherty Geological
 Observatory
Pallisades, N.Y.

Analysis of Intermediate
Wavelength Anomalies Over
the Oceans

R. F. Brammer
The Analytical Sciences Corp.
Reading, Mass.

Satellite Magnetic and
Gravity Investigation of
the Eastern Indian Ocean

Magnetosphere/Ionosphere

D. M. Klumpar
University of Texas,
 Richardson

Effects of External Current
Systems on Magsat Data
Utilizing Grid Cell Modeling

J. R. Burrows
National Research Council
 of Canada

Studies of High Latitude
Current Systems Using Magsat
Vector Data

T. A. Potemra
Johns Hopkins University

Corrective Information on
High-Latitude External Fields

R. D. Regan
Phoenix Corp.
McLean, Va.

Improved Definition of
Crustal Magnetic Anomalies
in Magsat Data

Core/Mantle Studies

E. R. Benton
University of Colorado,
 Boulder

Field Forecasting and Fluid
Dynamics of the Core

J. F. Hermance
Brown University
Providence, R.I.

Electromagnetic Deep-Probing
of the Earth's Interior:
Crustal Resource

LAUNCH VEHICLE

The Scout-G-1 launch vehicle is a basic launch vehicle designed to provide a reliable and relatively inexpensive launch system for smaller payloads. The Scout has four stages, is 22.86 m (75 ft.) long (less the spacecraft) and has a maximum diameter of 1.01 m (3.3 ft.). The Scout is the only U.S. launch vehicle which uses solid propellants exclusively.

The propulsion motors are arranged in tandem with transition sections between the stages to tie the structure together and to provide space for instrumentation.

The Scout guidance and control system consists of three miniature integrating gyroscopes, three rate gyroscopes and a pitch axis programmer. During the first-stage burn, the vehicle is controlled by a proportional control system which features a combination of jet vanes and aerodynamic tip control surfaces. The jet vanes provide most of the control force during the thrust period while the aerodynamic tip controls provide all of the control force during the coast phase following first-stage burnout. During second and third-stage burn, the vehicle attitude is controlled by sets of hydrogen peroxide reaction jets. The fourth stage, which has no active guidance or control system, receives its initial spatial orientation from the control exerted by the first three/stages, after which it is spin stabilized to 150 rpm + 20 rpm by means of four small rocket motors mounted on the skirt at the base of the fourth stage.

The guidance and control system contains a relay unit for power and ignition switching, an intervalometer to provide precise scheduling of events during flight, a programmer to provide torquing voltages to the pitch and yaw axes, an electronic signal conditioner to convert the gyro outputs to proper control signals, and a power source consisting of an inverter and dc batteries.

The launch vehicle communications system consists of a radio command destruct system, telemetry and a radar tracking beacon. The UHF radio command destruct system is provided as a means for destroying the vehicle should a malfunction occur which presents a hazard. The vehicle is equipped with two completely independent destruct systems built around a 10-channel command receiver. The destruct command requires that three channels be modulated in the proper sequence, thus reducing the possibility of an inadvertant destruct command.

The telemetry system is a standard Inter Range Instrumentation Group Pulse Amplitude Modulation frequency modulation system which is capable of handling 18 subcarrier channels. The functional and environmental conditions of the vehicle are monitored, and the data is transmitted to ground stations through a telemetry transmitter operating in the 2200- to 2300-MHz frequency range with a power output of 10 watts.

The radar tracking beacon is located in the third stage of the vehicle. The beacon has a minimum peak power output of 500 watts.
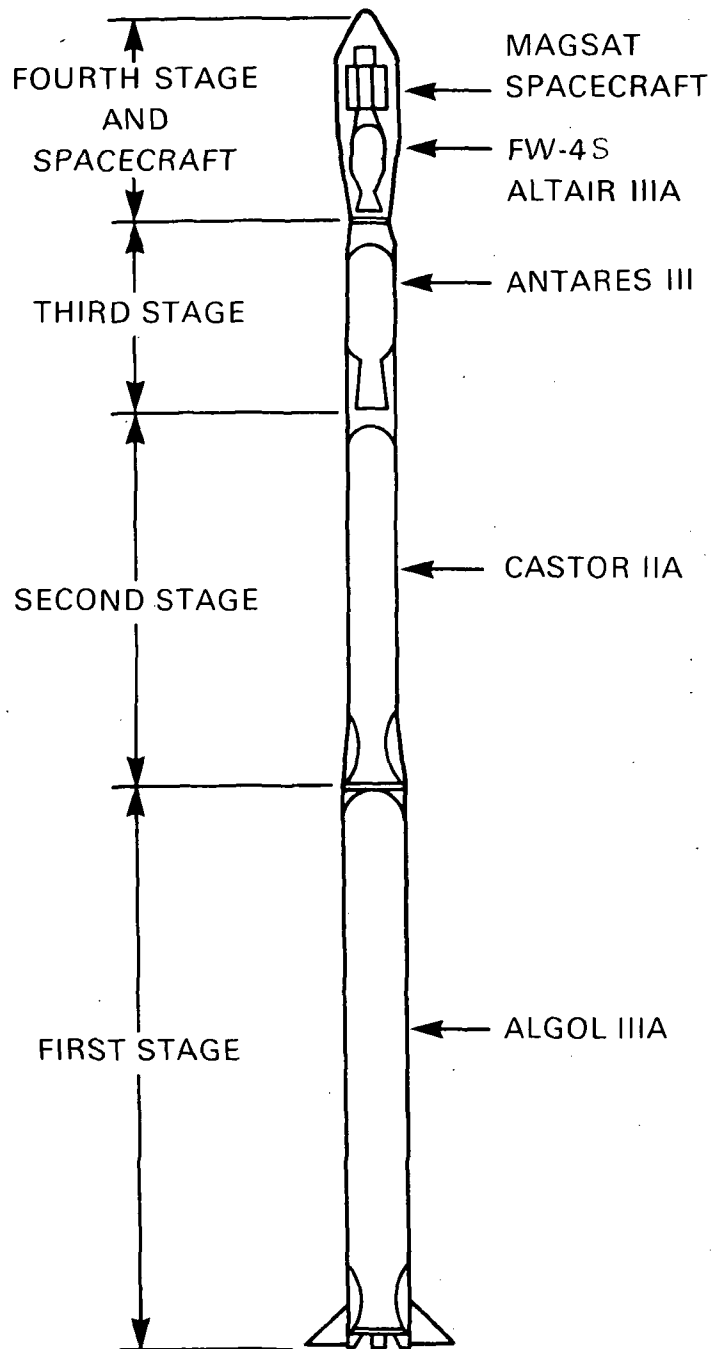
CHARACTERISTICS OF THE SCOUT LAUNCH VEHICLE

Item	First Stage	Second Stage	Third Stage	Fourth Stage
Name	Algol IIIA	Castor IIA	Antares III	FW-4S Altair IIIA
Thrust (Newtons)	481,000	281,039	83,096	26,230
Fuel Type	Solid	Solid	Solid	Solid
Fuel Weight (kg)	12,684 (27,963 lb.)	3,762 (8,294 lb.)	1,286 (2,835 lb.)	275 (606 lb.)
Gross Weight (kg)	14,185 (31,273 lb.)	4,427 (9,800 lb.)	1,396 (3,078 lb.)	301 (662 lb.)
Guidance	Strapped-down gyro sensors	Strapped-down gyro sensors	Strapped-down gyros sensors	Unguided, spin stabilized
Tracking Aids	Radar beacon*	Radar beacon*	Radar beacon*	——
Telemetry	S-band IRIG**	S-band IRIG**	S-band IRIG**	S-band IRIG**

* Tracking is available up to ignition of fourth stage using a 500-watt, single-telemetry pulse radar beacon on the third stage.

** Standard IRIG PAM/FM/FM frequency of 2200 to 2300 Mhz.

SCOUT G-1 LAUNCH VEHICLE

FOURTH STAGE
AND
SPACECRAFT

THIRD STAGE

SECOND STAGE

FIRST STAGE

MAGSAT
SPACECRAFT

FW-4S
ALTAIR IIIA

ANTARES III

CASTOR IIA

ALGOL IIIA

Detail

- Magsat
- P/L Adapter
- 4th Stage motor

HEATSHIELD

P/L ADAPTER

4TH STAGE MOTOR

"D" SECT ASSY

3RD STAGE MOTOR

UPPER "C" ASSY

LWR "C" ASSY

2ND STAGE MOTOR

UPPER "B" ASSY

LWR "B" ASSY

FIRST STAGE MOTOR

FIN INSTL

STA. -44.97

STA. 47.77

STA. 84.52

STA. 103.81

STA. 131.10

STA. 191.95

STA. 238.18

STA. 253.06

STA. 437.56

STA. 486.66

STA. 496.30

STA. 809.92

STA. 847.95

STA. 856.60

FOURTH STAGE — THIRD STAGE — SECOND STAGE — FIRST STAGE

Scout Launch Vehicle

LAUNCH TO ORBIT PHASE

The Magsat spacecraft will be launched by a four solid-rocket stage Scout vehicle. The first stage is the Algol III A; the second stage is the Castor II A; the third stage is the new (i.e. Magsat is the first user) Antares III; and the fourth stage is the Altair III A rocket. Magsat will be mounted atop the fourth stage, inside the Scout standard 86-cm (34-in.) diameter fairing.

After spearation from the spin-stabilized fourth stage, the spacecraft is despun by a yo-yo system consisting of a pair of weights, cables and release mechanisms located at diametrically opposed facets, to maintain balance torques during despin. Weight release is initiated by a separation-switch-activated timer on board the spacecraft. Despin is accomplished by the transfer of some or all of the spacecraft angular momentum into the yo-yo system weights and wires.

A series of predetermined attitude control maneuvers will be performed by stored commands to bring the satellite into alignment with the Sun. There after the satellite will be in a closed loop attitude control mode.

MAGSAT ORBIT PARAMETERS

Injection conditions:

Latitude	15.37 degrees
Longitude	-124.83 degrees
Altitude	357.57 km (222 mi.)
Injection Velocity	27,904.43 km/hr (17,339 mph)
Time of injection	525.76 sec

Elements:

Semimajor axis	6,828.82 km (4,243 mi.)
Eccentricity	.015
Inclination	97.02 degrees
Argument of perigee	165.36 degrees
Right ascension of ascending node*	
Anomalistic period	93.773 min
Height of perigee	350.1 km (218 mi.)
Height of apogee	550.3 km (342 mi.)

Changes in orbit elements:

Perigee rate	-3.62 deg. per day
Node rate	+0.95 deg. per day

* The right ascension of the ascending node will vary
depending upon the date the satellite is launched.

SEQUENCE OF INITIAL FLIGHT EVENTS

Time (sec.)	Event
-0.13	First Stage Ignition
0.00	Liftoff
84.56	First Stage Burnout
86.04	Second Stage Ignition
-	Separate First Stage
125.29	Second Stage Burnout
152.21	Separate Payload Heatshield
153.91	Third Stage Ignition
-	Separate Second Stage
199.56	Third Stage Burnout
486.10	Spin Motor Ignition
-	Fourth Stage Squib Ignition
487.60	Separation Explosive Bolt Ignition
-	Separate third Stage

Time (sec.)	Event
492.45	Fourth Stage Ignition
525.76	Fourth Stage Burnout
833 ± 30 sec	Fourth Stage/ Spacecraft Separation

POST LAUNCH SEQUENCE

Day No. 1

Event	Estimated time after liftoff
Fire all pyros except sensor platform release	17 min.
Magnetic torquing to orient the B axis to the desired direction in space	17-111 min.
Uncage nutation damper	18 min.
Extend aerotrim boom	28 min.
Turn on gyro	55 min.
Change optical bench set point from 15 C to 25 (59 to 77 F)	60 min.
Use magnetic spin/despin system to reduce spin rate to 0 ± 0.15 rpm.	12 hours
Command attitude signal processor into IR control mode with roll/yaw control and momentum dumping.	18 hours
Turn on doppler beacon	20 hours
Turn on precision vector magnetometer and scalar magnetometer (to help maintain the IM temperature)	20 hours

Day No. 2

Event	Estimated time after liftoff
Fire pyros to release sensor platform	24 hours
Extend magnetometer boom fully at apogee (by delayed command)	25 hours
Adjust aerotrim boom length immediately after magnetometer boom extension (by delayed command)	25 hours
Turn on precision Sun sensor and Attitude Transfer System	26 hours
Do pitch and yaw gimbal search for Attitude Transfer System signal if necessary	26 hours
Do a roll gimbal search for Attitude Transfer System signal if necessary	26 hours

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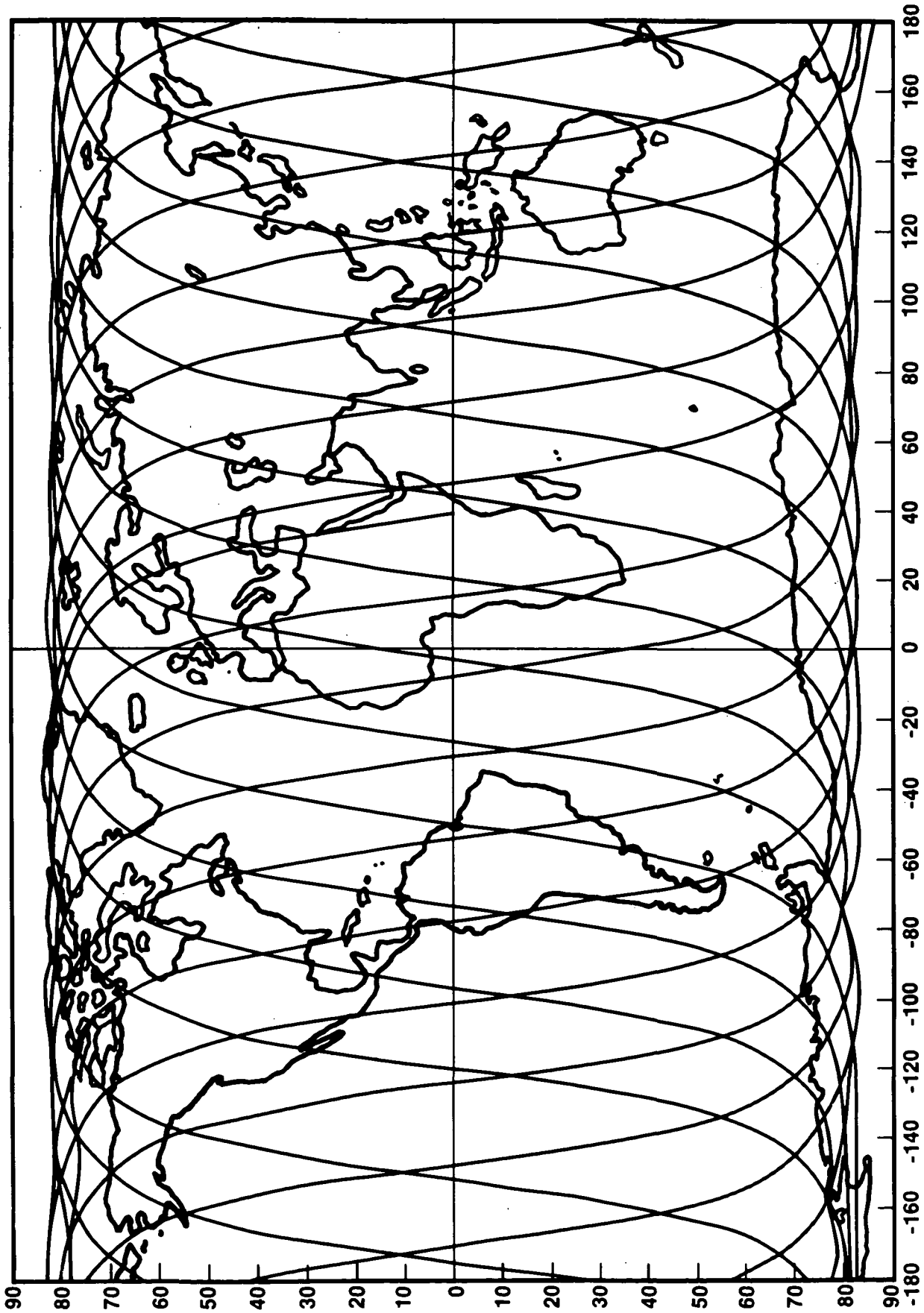
<u>Day No. 3</u>

Event	Estimated time after liftoff
Refine the attitude signal processor input data for best attitude control	50 hours

<u>Day No. 4</u>

Turn on star cameras	96 hours

MAGSAT GROUND TRACK FOR FIRST 24 HOUR

MISSION MANAGEMENT TEAM

NASA Headquarters

Dr. Anthony J. Calio	Associate Administrator for Space and Terrestrial Applications
Pitt G. Thome	Director, Resource Observation Division
James P. Murphy	Magsat Program Manager
Dr. James V. Taranik	Magsat Program Scientist
John M. Yardley	Associate Administrator for Space Transportation System Acquisition
Joseph B. Mahon	Director, Expendable Launch Vehicle Systems
Paul E. Goozh	Scout Program Manager

Goddard Space Flight Center

Robert E. Smylie	Acting Director
John H. Boeckel	Acting Director, Project Management
Gilbert W. Ousley	Magsat Project Manager
Dr. Robert A. Langel	Magsat Project Scientist
John H. Berbert	Data Manager
Charles E. White	Deputy Project Manager/ Technical
Martin D. Menton	Deputy Project Manager/ Resources
Norman J. Piterski	Mission Operations Manager
Donald L. Margolies	Spacecraft Manager

John J. O'Brien	Instrument Manager
Dr. Mario H. Acuna	Vector Magnetometer Instrument Scientist
Dr. Winfield H. Farthing	Scalar Magnetometer Technical Officer
Robert G. Sanford	Mission Support Manager
Richard H. Sclafford	Network Support Manager

Kennedy Space Center

Richard G. Smith	Director
George F. Page	Director, Expendable Launch Vehicles
H.R. Van Goey	Manager, Western Operations Office
Gene E. Schlimmer	Manager, Magsat Spacecraft Operations

Langley Research Center

Donald P. Hearth	Director
Lee R. Foster	Manager, Scout Project Office
Larry R. Tant	Magsat Coordinator Scout Project Office
Donald E. Forney	Manager, Langley Mission Support Field Office

CONTRACTORS

Applied Physics Laboratory, Johns Hopkins University - Lewis D. Eckard	Spacecraft contractor
Ball Aerospace Systems Division, Western Aerospace Laboratories - David Snyder	Scalar Magnetometer manager
Vought Corp. -- Milton Green	Program Director, Scout

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