NEWS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

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FOR RELEASE: WEDNESDAY P.M.
December 6, 1967

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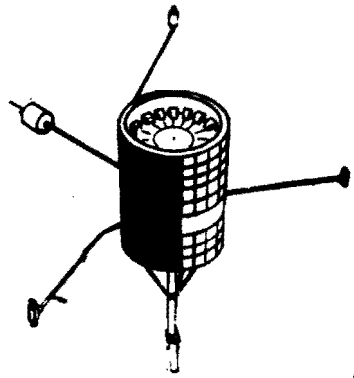

PROJECT: PIONEER C

(To be launched no earlier than Dec. 13)

PRESS KIT

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PIONEER C LAUNCH

The United States will launch Pioneer C, third in the current series of Pioneer interplanetary spacecraft, into orbit around the Sun from Cape Kennedy, Fla., no earlier than Dec. 13.

The probe will seek a clear definition of the tail of the Earth's magnetosphere, and monitor solar events as the Sun reaches the climax of its 11-year cycle in 1969. The spacecraft will be named Pioneer VIII on successful launch.

The window for the first planned launch opens at 9:08 a.m. Dec. 13 and closes at 9:43 a.m. EST. The window opens slightly later the next two days and the open time decreases to about 20 minutes. Pioneer C reports and data from Pioneers VI and VII will be important in predicting "solar weather" in Earth's protective magnetic envelope, the magnetosphere.

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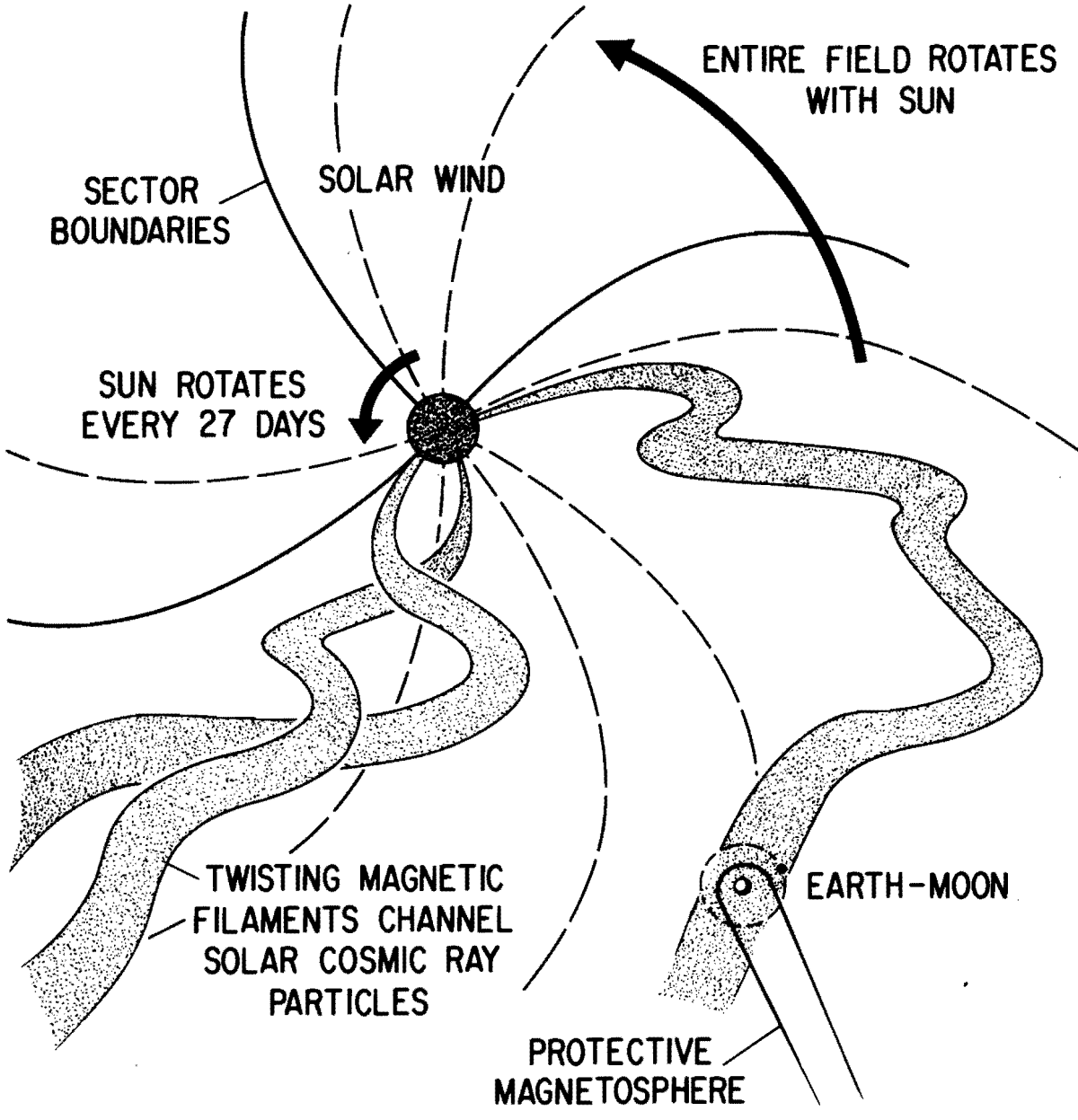
"WEATHER MAP" OF SOLAR SPACE

(VIEW LOOKING DOWN ON SUN'S "NORTH" POLE)

THE AVERAGE ANGLE OF MAGNETIC FIELD LINES TO THE EARTH-SUN LINE IS ABOUT 45° CAUSED BY SOLAR ROTATION. ONCE A MAGNETIC FILAMENT ROTATES PAST THE EARTH, THE HIGH-ENERGY PARTICLES IT CHANNELS WILL MISS THE EARTH.



The two previous probes are now 144 million and 68 million miles, respectively, away from Earth and are still returning data which will be valuable during coming manned Apollo flights.

Spectacular advances in long-distance data retrieval by NASA's Deep Space Network and unexpected long-life performance of these spacecraft make these reports possible from widely separated points in the solar system.

Pioneer C will fly an "out" mission in the plane of the Earth's orbit, crossing the Earth-Sun line about two million miles outside Earth orbit. In this location it will measure the magnetosphere to determine its exact shape. The "wagging tip" of the tail of the magnetosphere was seen in September 1966, by Pioneer VII, 3.5 million miles outside Earth's orbit.

Five of seven experiments are major improvements over those on Pioneer VII. Two new types of experiments are an interplanetary dust detector and an instrument to study electric fields in space.

The current Pioneers can "see" directions and energies (speeds) of the sub-atomic particles and magnetic fields, which they are designed to measure, better than previous interplanetary spacecraft.

The 145-pound, drum-shaped spacecraft are "spinners." They continuously scan a full circle in the plane of the Earth's orbit. They have a data rate 10 times higher than previous interplanetary spacecraft for major parts of their missions and their instruments are designed for detailed measurements.

Measurements by the Pioneers and other spacecraft, combined with earlier theoretical work, make up the beginnings of an interplanetary "weather map," which will enable scientists to predict the paths of solar high energy particles and warn of radiation hazards to spacecraft.

Pioneer reports were used this year to protect film from radiation fogging aboard the Lunar Orbiters as they photographed the Moon.

Pioneer VI, now 110 degrees around the Sun ahead of the Earth, can "see" two-thirds of the way around the Sun. It now gives warning of solar storm regions 15 to 17 days ahead of their arrival at the Earth-Moon system.

The million-mile-an-hour solar wind, which constantly blows out from the Sun, is threaded with curving magnetic filaments rooted in the Sun, carrying massive streams of high energy particles. These filaments twist around each other with kinks sometimes as sharp as 90 degrees. At the Earth, they have an average diameter of about two million miles; new ones constantly sweep past the Earth, in a co-rotation with the Sun's 27-day cycle.

Very high-energy solar storm particles can break free of the twisting field pattern and reach the Earth by a somewhat more direct path. Day-to-day observations of this magnetic structure of the space within the orbit of Mars by the Pioneers, the Sun-orbiting Mariners, the Moon-orbiting anchored IMP, and Earth-orbiting spacecraft will allow prediction of the paths of solar radiation.

Current Pioneer spacecraft are producing detailed scientific knowledge. Pioneer VI was launched Dec. 16, 1965, Pioneer VII, Aug. 17, 1966. Up to last Nov. 1, the two had received 11,000 commands and had returned 5 billion bits of data, on 5,500 miles of data tape.

These measurements have demonstrated that:

The solar wind does not flow in straight lines (deviating up to 10 per cent from a direct path);

There are an average of 5.5 electrons per cubic centimeter in the solar wind, and 30 to 40 per c.c. during solar storms;

The boundaries of the interplanetary magnetic field sector structure act like vanes of a centrifugal pump as the Sun rotates, tending to sweep the inner solar system clear of galactic cosmic ray particles;

Temperature of interplanetary electrons is 10,000 to 90,000 degrees F and varies with direction of the measurement;

The Sun produces singly-ionized helium nuclei.

Observations by Pioneer spacecraft have helped man understand the Sun, the Earth's primary source of energy. (Among the important questions still puzzling scientists are: How does the Sun's corona get so hot? and, What is the path of solar wind particles through the corona?)

Data returned by Pioneer should help man understand magnetized plasmas (very hot gas made up of positively and negatively charged particles). The promise of plasma research for producing extremely cheap commercial power, by controlling the fusion reaction or other methods, may prove of first-rank importance, scientists believe.

The Pioneers can produce this basic particle data because interplanetary space is like the inside of a cosmic particle accelerator, dwarfing the cyclotrons and other large accelerators on Earth.

Pioneer C will be launched ahead of the Earth to give it the added velocity in solar orbit to move out beyond the orbit of the Earth. The Earth in its shorter orbit will "catch" Pioneer C in 37 days, passing between the Sun and the spacecraft.

To take full advantage of the Delta launch vehicle's payload capacity, a 40-pound Test and Training Satellite (TTS-1) is being launched piggy back from the Delta second stage. TTS-1, designed and built by TRW Systems, Redondo Beach, Calif., will be used to exercise and test the Apollo tracking and communications network.

The Pioneer program is directed by NASA's Office of Space Science and Applications. Project management is by NASA's Ames Research Center, Mountain View, Calif. The Delta launch vehicle is managed by Goddard Space Flight Center, Greenbelt, Md., and is launched by Kennedy Space Center, Fla.

Communications and tracking will be by NASA's Deep Space Network (DSN), operated by the Jet Propulsion Laboratory, Pasadena, Calif.

The Pioneer spacecraft are built by TRW Systems Group, Redondo Beach, Calif. The Delta rocket is built by McDonnell Douglas Corp. at Santa Monica, Calif. The electric field experiment was developed by TRW Systems and the interplanetary dust experiment by the Goddard Center.

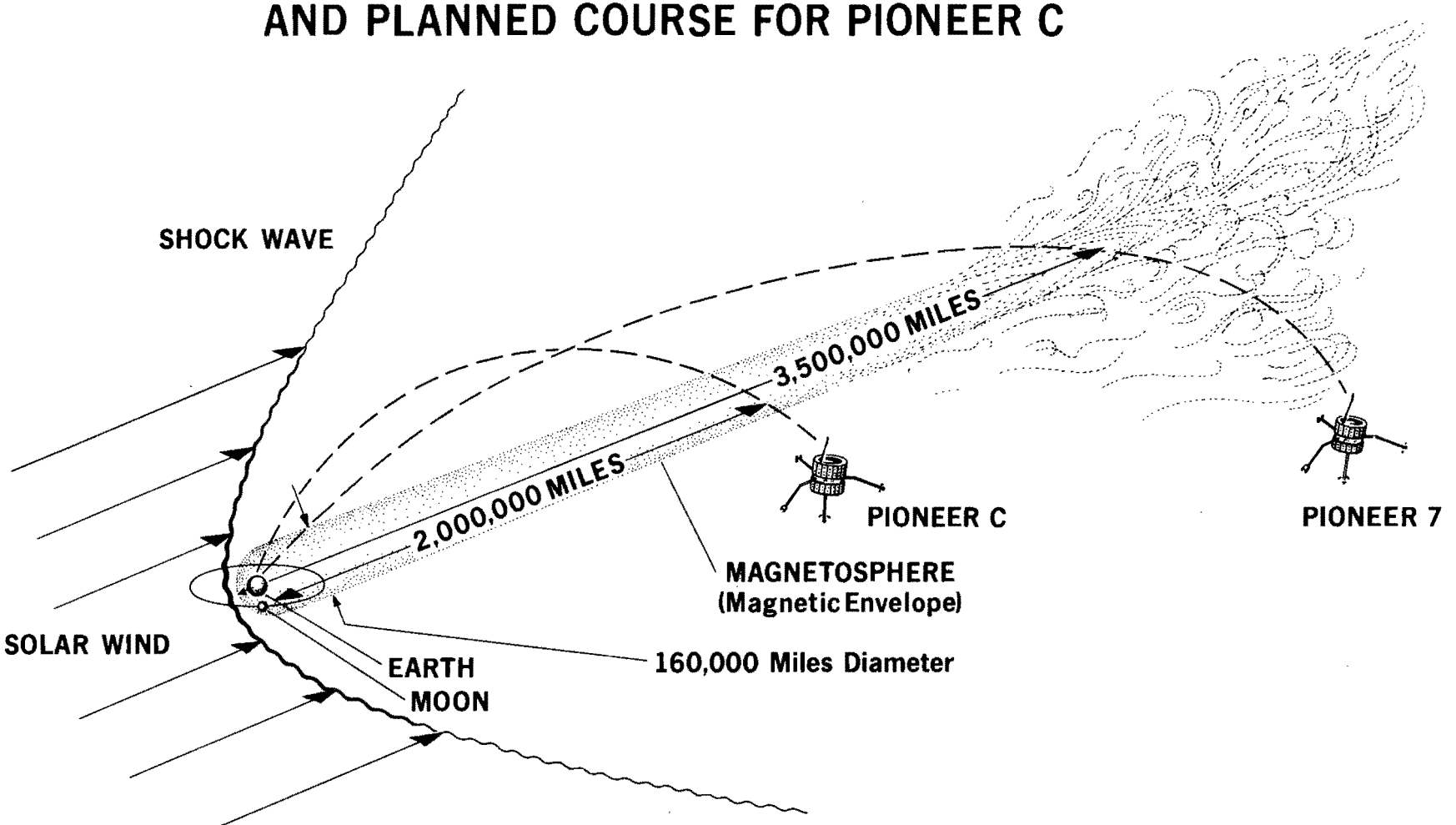
The magnetometer experiment, also developed by Goddard, can switch automatically to a high field range during solar storms. The University of Minnesota cosmic ray detector will identify for the first time chemical elements of which incoming particles are the nuclei. It can measure incoming hydrogen nuclei up to 602,640,000 mph., or 90 per cent of the speed of light. The cosmic ray detector developed at the Southwest Center for Advanced Study now can observe galactic particles arriving from above and below the plane of the Earth's orbit.

Range of the Stanford University radio propagation experiment has been increased from 110 million to 200 million miles. The Ames Center solar wind experiment now is 10 times more accurate than its predecessors.

The design life of the Pioneer C mission is six months. But if the spacecraft performs as well as Pioneer VI and VII, it could return data to DSN antennas for several years as it makes a complete circuit of the Sun.

-end-

PIONEER 7 PASSAGE THROUGH TAIL OF EARTH'S PROTECTIVE MAGNETIC ENVELOPE (THE MAGNETOSPHERE) SEPT. 1966, AND PLANNED COURSE FOR PIONEER C



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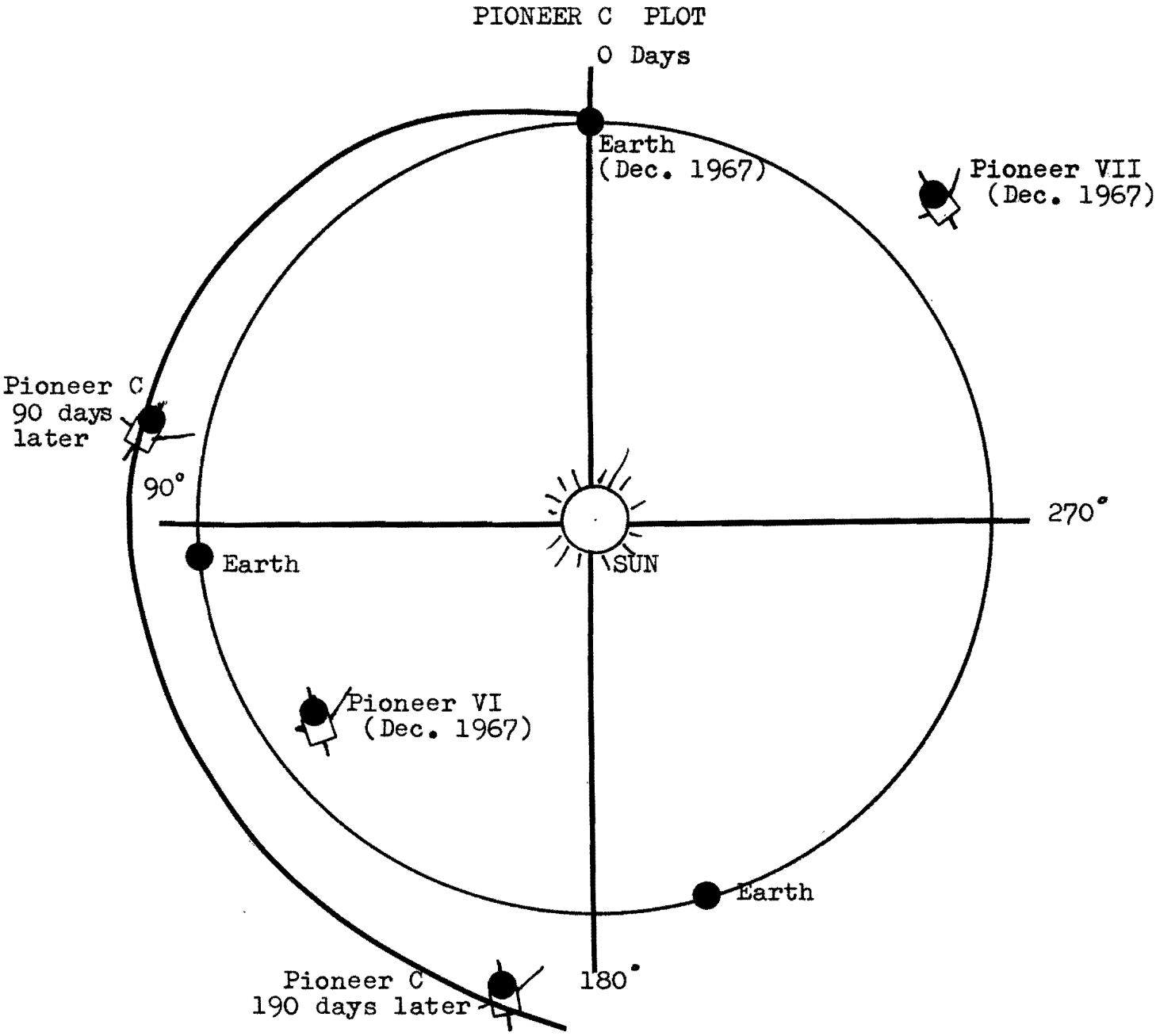


HELIOCENTRIC PLOT OF PIONEER C WITH
PIONEER VI & VII LOCATION AT TIME OF LAUNCH.

PIONEER C SPACECRAFT

Overall Configuration

The Pioneers are designed as rugged, high-performance spacecraft, able to return large amounts of data on flights of many months over distances of many millions of miles.

All spacecraft systems have been chosen for simplicity and reliability. Maneuvering, for example, is handled by a single cold-gas jet.

After Pioneer C, two more spacecraft are approved for flight.

Pioneers have the highest ratio of scientific instruments to total spacecraft weight of any interplanetary spacecraft to date. Pioneer C weighs 145 pounds and carries 38 pounds of scientific experiments. Attitude is extremely stable. After six months in space, the attitude of Pioneer VI had drifted less than 0.2 degree.

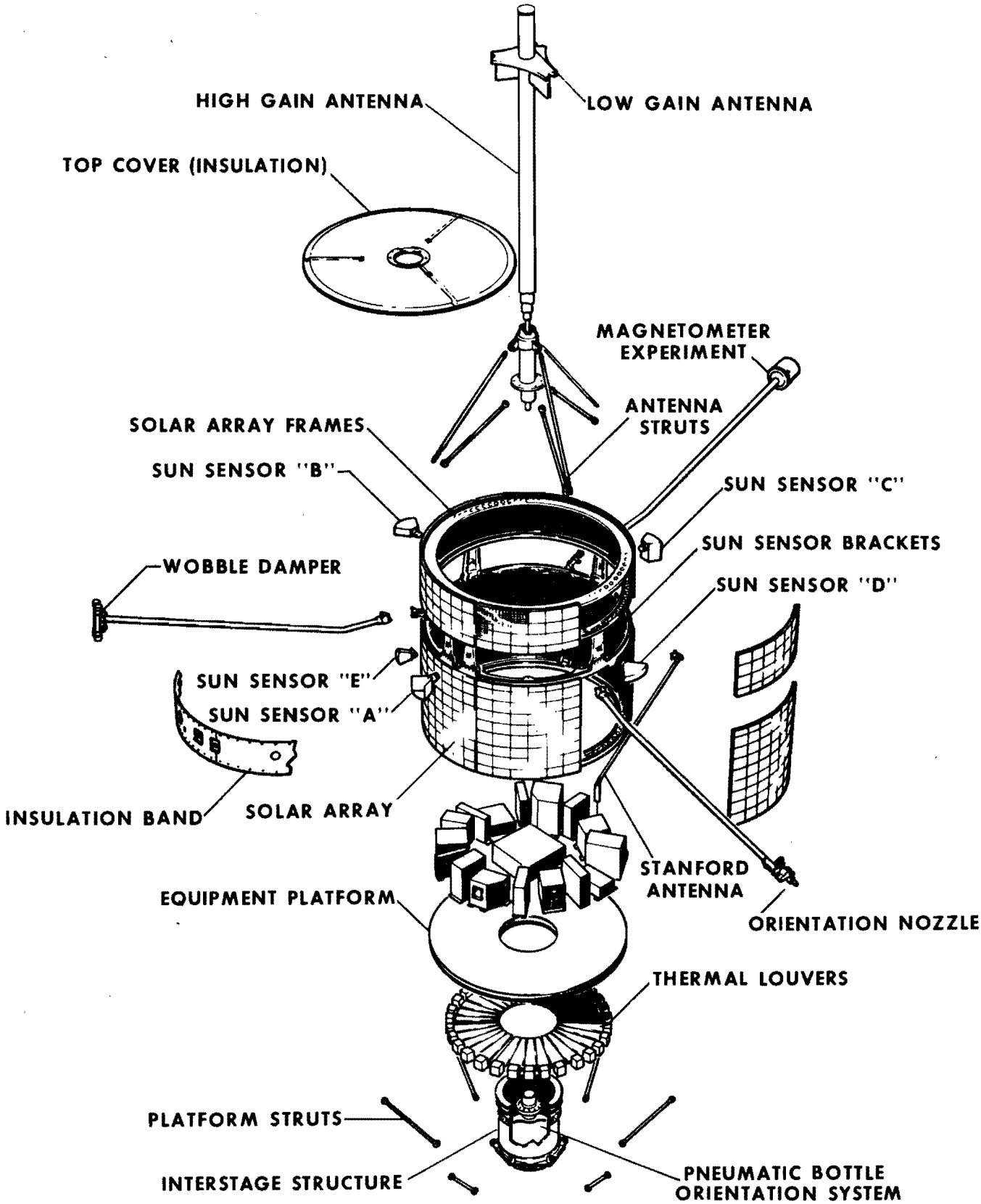
The spacecraft is a drum-shaped container, 35 inches high and 37 inches in diameter. Its sides are covered with 10,368 solar cells, and divided by a narrow circular band containing apertures for four experiments and four orientation Sun sensors. A fifth Sun sensor provides the experiments with a continuous directional reference to the Sun's position.

At 120-degree intervals around the sides of the spacecraft are three five-foot four-inch booms, deployed horizontally in flight by the spin of the spacecraft.

Within the spacecraft a circular platform carries most of the equipment. Below the platform is a pressure sphere with gas for the orientation system.

The spacecraft structure, made principally of aluminum, is lightweight and its cylindrical shape is inherently strong. There are more than 56,000 parts in Pioneer, including its scientific instruments.

PIONEER C SPACECRAFT COMPONENTS



Communication System

The 35-pound Pioneer communications, timing, and data handling system has performed well aboard Pioneers VI and VII. It has returned 5 billion data bits to Earth of 3,300 scientific measurements and 100 engineering measurements. Pioneers VI and VII have received 11,000 commands from the ground.

It maintains two-way S-band radio communication at about 2,300 megahertz.

Commands are sent to Pioneer from DSN antennas in binary code. These commands are received by spacecraft antennas and routed to one of two radio receivers. They then go to one of two command decoders. Once decoded, commands are routed by the command distribution unit to a spacecraft system or experiment, for execution. The spacecraft can receive 64 separate commands.

To send information back to Earth, the spacecraft driver puts coded data on the basic S-band carrier and routes it to one of the two spacecraft traveling wave tubes, which amplifies the signal to about eight watts.

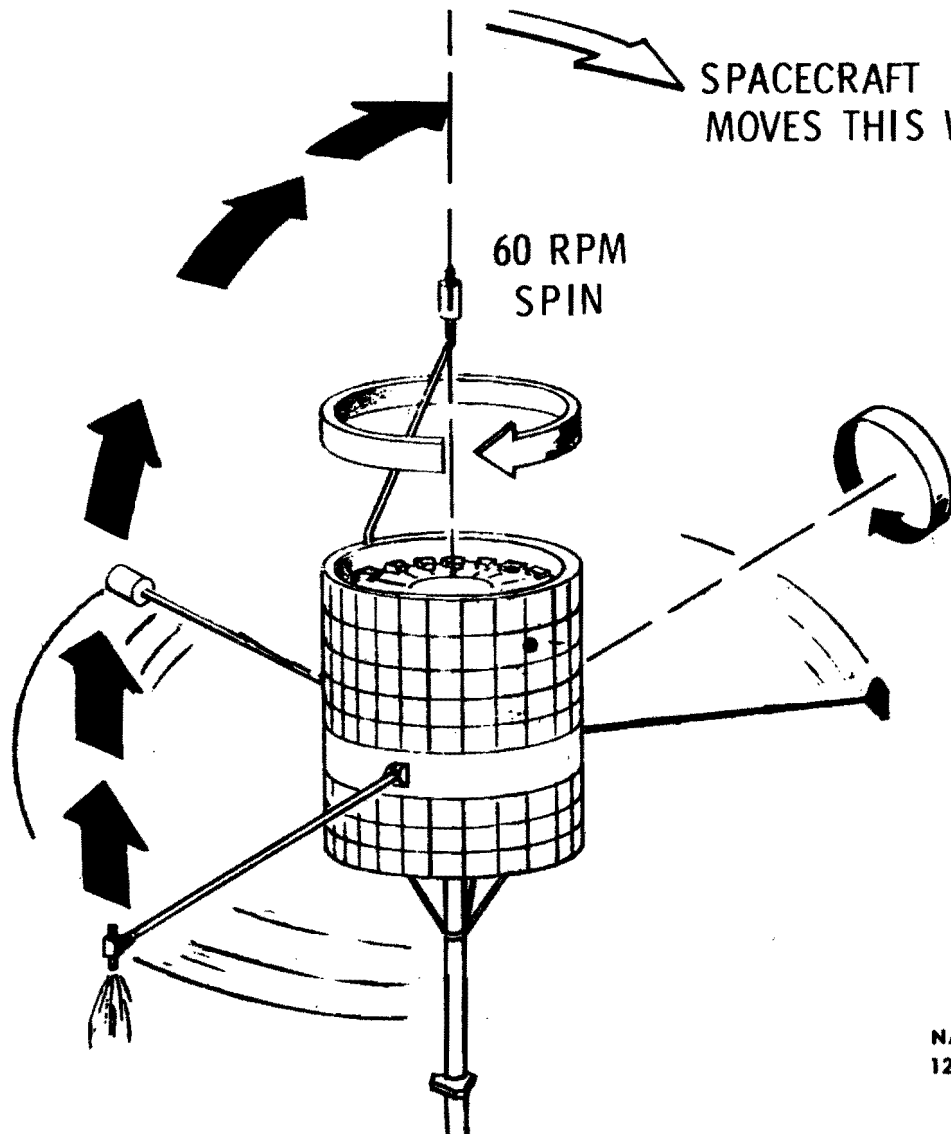
The Pioneers have the greatest data-return capacity of any interplanetary spacecraft because they match the most efficient rate of data return with the distance from the Earth. They return data at 512, 256, 64, 16 and eight bits per second. The spacecraft data storage unit can store up to 19 hours of data. The data telemetry unit converts spacecraft data into binary code for transmission to Earth.

Attitude Control

Throughout its mission, Pioneer C will use the gyroscopic effect of its 60-rpm rotation to maintain a precisely stable attitude.

Changes in attitude are achieved by turning the spacecraft about a selected axis through bursts from the nitrogen gas jet at the end of one boom. Force from the gas jet must be applied perpendicular to the desired direction of motion because the spinning craft precesses like a gyroscope.

PIONEER ORIENTATION MANEUVERING



SHORT THRUSTS AGAINST SPIN AXIS BRING FORCE TO BEAR IN A PLANE PERPENDICULAR TO DIRECTION OF THRUSTS (GYROSCOPE EFFECT) . . . .

. . . . AND TURNS SPIN AXIS (AND SPACECRAFT) ABOUT A SELECTED AXIS

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Each thrust is applied only $\frac{1}{4}$-second at one point on the circle of spacecraft rotation. Thrusts are timed by two sensors which see the Sun once each spacecraft revolution and each thrust turns the spacecraft only 3/10-degree.

The many thrusts at one point produce wobbling rotation. Wobble is eliminated by flexibility of all three booms and by a damper at the end of one boom. Two small balls are contained in two cylinders. The impacts of the balls against the ends of the cylinders change the motion energy of the wobble movement into heat which is dissipated.

To operate properly, Pioneer C must have its spin axis perpendicular to both Sun-spacecraft line and Earth-spacecraft line, so that solar cells are efficiently illuminated and the narrow beam of the high-gain antenna focuses on the Earth.

The Sun-orientation maneuver is automatic. Pioneer C uses two sensors. One sees the Sun for 80 degrees above the plane of spacecraft rotation, another for 80 degrees below this plane. When one of these two sensors sees the Sun, logic circuits order the spacecraft to turn so that the other sensor sees it, and turning stops when both sensors see the Sun.

For Earth orientation, ground commands rotate the spacecraft around the spacecraft-Sun line, until its narrow beam antenna acquires the Earth.

Power Systems

Pioneer C's 10,368 silicon crystal, n-on-p solar cells provide the spacecraft its 60-watt maximum power needs.

Auxiliary power during launch, before solar cells begin to function, is provided by a rechargeable silver-zinc battery with a lifetime of about two hours.

Temperature Control

Temperature is controlled by managing heat produced by spacecraft equipment and by heat-reflective coatings on the spacecraft exterior. Twenty louvers under the spacecraft equipment platform, actuated by bi-metallic springs, open and close automatically to release heat.

Magnetic Field

The magnetic field of the Pioneer is 1/10 gamma (1/500,000 the Earth's field). Engineers achieved this low magnetism by using non-magnetic materials, new fabrication and inspection techniques, and design innovations.

SCIENTIFIC INVESTIGATIONS

Interplanetary space is extremely tenuous, with densities hundreds of times less than the most extreme vacuums obtained on Earth. Nevertheless, space is a medium through which solar and galactic events propagate and greatly influence our terrestrial environment. They cause communications blackouts and the auroras, feed the Van Allen radiation belts, and provide the Earth its basic energy source.

Known phenomena in interplanetary space include:

Particles -- Electrons and hydrogen, helium and other nuclei carrying an electric charge which make up the "solar wind"; cosmic rays from Sun or galaxy which are extremely energetic (fast-moving) charged nuclei of many elements; cosmic dust and meteoroids.

Radiation -- The entire electromagnetic spectrum such as light, radio and x-rays.

Fields -- Magnetic, electric and gravitational.

Scientists now believe these ingredients go together as follows:

The solar wind originates when the solar atmosphere, heated by the thermonuclear reaction in the Sun's center, throws off an ionized, or electrically-charged, gas into space. The positive nuclei and negative electrons in the gas are ejected into space from the Sun's 2,000,000 degrees F. corona, perhaps heated by local shock waves. The particles reach an average speed of approximately one million miles-per-hour as solar gravity weakens.

The magnetic field on the Sun's surface is the total result of a mass of small bi-polar fields. This complex field is carried by the solar wind far beyond the Earth orbit. The field is further bent as numerous solar wind "beams" (masses of gas on separate paths) collide and change direction.

In the Sun's corona, the magnetic field divides into major radial sectors (commonly from two to seven), each with a single field direction the reverse of its neighbor.

Storms in local regions on the Sun throw out dense masses of solar wind particles and quantities of high energy particles (solar cosmic rays). The storms are accompanied by a rise in magnetic field strength on the solar surface of 100 to 1,000 times the normal of 100,000 gamma. (The Earth's surface field is 50,000 gamma, and the interplanetary field near the Earth is five gamma.)

The lower energy cosmic ray particles can cover the 93 million miles from the Sun to the Earth in one to two hours.

The higher energy particles reach the Earth in as little as 20 minutes. They break out of the twisted interplanetary field but follow its general direction. They travel in long curves from the surface of the Sun, arriving at the Earth-Sun line at an angle of about 45 degrees.

The flow of the streams of lower energy solar cosmic ray particles often lasts many hours. The Sun appears to "store" them near its surface by some unknown mechanism. The particles frequently are injected onto a number of different magnetic filaments, and particles from the same solar storm may reach the Earth in entirely separate, twisted streams.

The large, one-directional sectors (up to 100 degrees wide) in the interplanetary field are believed to be created by regions on the Sun's surface which send out very high-speed streams of solar wind continuously for months or years. When one of these regions dies, its sector disappears and new high-speed regions produce new sectors.

Normally the solar wind spirals out from the entire solar surface. The faster wind from the high-speed regions collides with the normal slower wind creating relatively dense shock areas. These radial shock fronts behave like vanes of a centrifugal pump, pushing galactic cosmic rays out of the inner solar system.

The solar wind is now believed to blow from the Sun to a distance of 900 million to nine billion miles. The location at which the solar wind stops is the end of the interplanetary field and the boundary between interplanetary and interstellar space. Pioneer's scientists have seen slight variations in direction of galactic cosmic ray particles (some of which approach the speed of light). These variations may be due to passage through this boundary.

The magnetic field of the Sun is not a simple North-South pole field like that of the Earth. It is the sum total of the many local solar surface fields. The solar field seems to disappear at the peak of each 11-year solar cycle and then reappear with its North and South poles reversed.

Experiments

Single Axis Magnetometer - Principal Investigator, Dr. Norman F. Ness, Goddard Space Flight Center

This experiment continuously charts the Sun's magnetic field.

The experiment sensor is mounted on a boom five feet from the spacecraft to minimize interference from Pioneer's tiny magnetic field.

The experiment uses a single fluxgate sensor, which is oriented about 55 degrees to the spin axis of Pioneer and takes three readings for each of the 60 rotations per minute of the spacecraft. Because the axes at the times of these three measurements are perpendicular to each other, scientists can compute the strength and direction of the magnetic field. The instrument has a sensitivity of 1/4 gamma. It normally senses magnetic field strengths from plus-32 gamma to minus-32 gamma. It automatically switches to a high range of plus- or minus-96 gamma during high solar activity.

Solar Plasma Probe -- Principal Investigator, Dr. John H. Wolfe, Ames Research Center

This experiment measures particles in the solar wind -- quantities, directions, energies, and temperatures.

The instrument employs two curved plates, one fitting over the other. A voltage across the plates is varied to select particles in a sequence and particles being measured at any moment pass between the plates and land on a collector.

Horizontal direction of the particles is measured by noting the direction in which the probe is looking out from the spinning spacecraft. Vertical direction is measured by three collector plates which look out in three directions over an arc of 160 degrees.

The experiment measures electrons with energies from 14 to 1,000 electron volts in 15 voltage ranges and positive ions with energies from 200 to 15,000 electron volts in 30 voltage ranges. It can measure 50,000 to 100 million particles per square centimeter per second, with accuracies better than one degree in particle direction and one per cent in velocity.

Radio-Propagation Detector - Principal Investigator, Dr. Von R. Eshleman, Stanford University

This experiment measures the total normal electron content in space between Pioneer and the Earth. It also measures intrusion of huge tongues of solar gas between the spacecraft and the Earth. The 150-foot dish antenna at Stanford University in Palo Alto, Calif., is used to send radio signals to a special antenna and receiver on the spacecraft.

The speed of radio transmissions is affected by the electrons of the solar plasma. Experimenters will use phase shift and delay of receipt of the signals by the spacecraft to measure electron content.

Electric Field Detector - Principal Investigator, Dr. Frederick L. Scarf, TRW Systems

The electric field detector is designed to measure the electric components of low frequency radio waves in the solar wind and waves created by density variations in the solar wind.

Unequal concentrations of positive ions and negative electrons have electric fields between them, much as do the poles of a conventional storage battery. Electric fields may be important in accelerating solar wind particles in solar storm periods.

The instrument uses an alternating current electrometer to measure the fields caused by changes of charge in space as shown by small voltage changes in the Stanford antenna. The antenna is used as an unbalanced dipole, feeding narrow bandwidth channels in the instrument to measure amplitude variations. An analysis of the wave form gives spectral information between 100 and 100,000 cps. Operation is automatic without ground commands.

Cosmic Ray Anisotropy Detector - Principal Investigator Dr. Kenneth G. McCracken, Southwest Center for Advanced Studies

This experiment measures arrival direction, mass and energy (speed) of both solar and galactic cosmic ray particles.

It consists of a crystal scintillator which produces flashes of light of varying intensity, depending on the energy, direction and type of cosmic ray particle which strikes its crystal lattice. The instrument detects particles arriving from eight directions in the plane of the Earth's orbit, and from below and above the spacecraft. The energy range measured is from three million to 360 million electron volts.

Cosmic Ray Gradient Detector - Principal Investigator, Dr. William R. Webber, University of Minnesota

This instrument is designed to measure numbers, energy and gradient of positive particles from one million to one billion electron volts. It employs two solid-state surface barrier detectors, three solid-state lithium drift detectors, one detector consisting of a synthetic sapphire window to a photomultiplier tube, and one with a plastic guard cup monitored by photomultiplier.

Selection of telescopes to be monitored is by ground command. The experiment will identify nuclei of elements up to silicon over a wide range of speeds with resolution better than any instrument to date.

Cosmic Dust Detector - Principal Investigator, Otto Berg, Goddard Space Flight Center

The instrument is designed to measure the momentum, energy and distribution in interplanetary space of minute meteoroids. It can measure particle velocities, mass and flux. It measures particles of mass greater than 50 millionths of a gram at velocities greater than 900,000 mph. An average flux rate of 10 to 100 impacts a day is expected.

The sensor consists of two sets of thin film panels behind which is a piezoelectric crystal microphone mounted on an impact plate. These elements measure particle flight time between front and rear films, determine direction by comparing front and rear penetration points, and measure impact on the microphone mounting plate.

THRUST AUGMENTED IMPROVED DELTA LAUNCH VEHICLE

The launch rocket for the Pioneer C flight is a three-stage thrust-augmented improved Delta. This will be the 55th flight for the Delta. If successful, Pioneer will be the 51st spacecraft successfully launched by the 92-foot-tall rocket. Project management for Delta is under the Goddard Space Flight Center. Launch agency is the Kennedy Space Center's Unmanned Launch Operations organization. Prime contractor for Delta is McDonnell Douglas Corp. Delta has the following general characteristics:

Height:	92 feet (includes shroud)
Maximum Diameter:	8 feet (without attached solids)
Lift-off Weight:	About 75 tons
Lift-off Thrust:	333,550 pounds (includes strap-on solids)

First Stage - kerosene-liquid oxygen engines, Rocketdyne Division, North American Rockwell Corp.

Three solid propellant strap-on rockets - Thiokol Chemical Corp.

Second Stage - UDMH-IRFNA liquid engines, AJ10-118E propulsion system, Aerojet-General Corp.; major autopilot contractors for Honeywell, Inc.; Texas Instruments, Inc.; and Electro-solids Corp. Guidance: Western Electric Co.

Third Stage - FW-4D - solid engine - United Technology Center.

PIONEER C LAUNCH WINDOW

Launch windows during December for the Pioneer C mission exist from December 13-15. The once-each-day periods are from about 20 to 35 minutes' duration. These are the times of ideal Sun angle on the spacecraft at injection to allow maximum power to be built up.

To inject Pioneer C into the desired orbit, Delta can be launched only at certain times of the day. All times are Eastern Standard Time.

Date	Opens	Closes
Dec. 13	9:08 A.M.	9:43 A.M.
Dec. 14	9:10 A.M.	9:38 A.M.
Dec. 15	9:11 A.M.	9:30 A.M.

DELTA FLIGHT EVENTS

	Time	Altitude (N.M.)	Surface Range (N.M.)	Velocity (MPH)
Strap-on Solids Burnout	1 min., 10 sec.	14	10	2,110
1st Stage Burnout	2 min., 30 sec.	54	87	8,727
2nd Stage Ignition	2 min., 34 sec.	58	96	8,727
Fairing Jettison	3 min., 6 sec.	82	158	8,860
2nd Stage Burnout	8 min., 51 sec.	205	1,069	16,320
3rd Stage Ignition	30 min., 58 sec.	308	5,864	15,832
3rd Stage Burnout	31 min., 29 sec.	309	5,992	16,880

TEST AND TRAINING SATELLITE (TTS-1)

The Delta payload will include a small, 40-pound Test and Training Satellite (TTS-1) which houses a transponder especially designed to transmit and receive the S-Band data characteristics of the Apollo spacecraft and its mission. TTS-1 will be used in S-Band system checkout and training exercises with the Manned Space Flight Network.

TTS-1 will be piggy-back launched from the Delta vehicle. It is mounted in the rear of the second stage, with a timer set to eject TTS-1 rearward at three feet per second, approximately one minute after the third stage of the Delta has ignited. The planned TTS-1 orbit is circular at an inclination of 32 to 35 degrees and altitude of about 350 miles.

PIONEER FLIGHT EVENTS

Delta No. 55 will be launched from Complex 17, Pad B, on a launch azimuth of 108°. Pioneer C's planned aphelion (greatest distance from the Sun) is 102 million miles, and perihelion (closest to Sun) is 93 million miles.

Delta will place Pioneer C into a larger solar orbit than the Earth's orbit, and the spacecraft will fall steadily behind the Earth.

Two seconds after third stage separation, spacecraft booms will deploy automatically, and the spacecraft will automatically orient perpendicular to the Sun for solar cell operation.

Without solar cell power, batteries would fail within two hours. The Sun orientation takes about five minutes.

The high power amplifier for the spacecraft transmitter turns on immediately after third-stage separation, sending out a wide beam signal via the spacecraft's low-gain antenna.

About 50 minutes after liftoff, the station at Woomera, Australia acquires the spacecraft. A key task is to check solar cell electric power output. This checkout process is completed in two hours, via incoming telemetry.

During the first six hours, the seven scientific experiments will be turned on, one at a time.

At about 14 hours after launch, the first data from the Stanford experiment will be sent from Goldstone, Calif., to Stanford University at Palo Alto, Calif.

Experimenters there will send radio signals from Stanford's 150-foot dish antenna to the Stanford radio receiver aboard the spacecraft. Data will return on the Stanford signal to Goldstone, thence to Stanford. This process continues throughout the mission. Three days after launch on the third pass over Goldstone, controllers will command the spacecraft to change its position until its high-gain antenna points precisely at the Earth to maintain a strong, two-way radio signal for the life of the mission.

About 70 days after launch, Pioneer will seek a clearer signal by shifting its rate of transmitting information down from the original 512 bits per second (bps) to 256 bps; at 90 days data will be reduced to 64 bps; at 130 days to 16 bps; and at six months, to 8 bps. At eight months and 60 million miles, tracking will shift to the 210-foot antenna at Goldstone, which will also be tracking Pioneers VI and VII.

The data rate of Pioneer C can then be raised to 64 bits per second, due to Goldstone's superior sensitivity, and the spacecraft can return data from a distance of 200 million miles, a point it will reach several years after launch.

THE DEEP SPACE NETWORK

Three 85-foot antennas of NASA's Deep Space Network (DSN), located at 120° intervals around the Earth, will track Pioneer C for the first 60 million miles.

The DSN's new 210-foot antenna at Goldstone, Calif., will receive data from Pioneer C, as well as VI and VII, all the way around the Sun (maximum distance around 200 million miles). The sensitivity of this antenna and its associated components is .000,000,000,000,000,000,5 (½ of one billionth of a billionth watt). This means the life of the Pioneers is as long as thier radio and other systems last.

The DSN is under technical direction of the Jet Propulsion Laboratory, Pasadena, Calif.

Four DSN stations will be used for Pioneer C, Echo and Mars stations at Goldstone; Woomera, Australia, and Cebreros, Madrid, Spain. The station at Johannesburg, South Africa, will track during the first four days of the mission.

For Pioneer, the DSN stations have been equipped with special command encoders and other equipment for communication with the spacecraft.

The DSN tracks the spacecraft by means of two-way Doppler. A signal is sent from the antennas at a precisely known frequency, and a transponder aboard the spacecraft returns it at a frequency increased by an exact ratio. Motion of the spacecraft away from Earth causes both frequencies to shift slightly downward. These frequency shifts can be used to calculate the velocity within a few feet per second (despite distances of millions of miles) plus exact orbit and distance from Earth.

Quick-look information is transmitted from DSN stations to the DSN Space Flight Operations Facility (SFOF) at JPL.

Within a few days after launch, command will shift to the Pioneer Control Facility at the Ames Center.

The complete tape of recorded data received from the spacecraft is mailed to the SFOF for checking and duplication and then sent to Ames. There it is processed into separate tapes and distributed to experimenters, contractors and project personnel.

PIONEER PROJECT OFFICIALS

NASA Headquarters

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SPACECRAFT SUBCONTRACTORS

Eagle Picher Joplin, Mo.	Batteries
Radio Corporation of America Mountain Top, Pa.	Solar Cells
Optical Coating Labs, Inc. Santa Rosa, Calif.	Solar Cell Cover Glasses
Rantec Calabasas, Calif.	Diplexer and Band-pass Filter
Hughes Aircraft Co. Los Angeles, Calif.	Traveling Wave Tubes
Electronic Memories, Inc. Hawthorne, Calif.	Data Storage Unit
Vitro Electronics Silver Spring, Md.	Telemetry Receiver
Solid State Products, Inc. Salem, Mass.	Photo Silicon Con-trol Rectifiers
Western Semiconductors Santa Ana, Calif.	Photo Silicon Con-trol Rectifiers
Sterer Engineering and Manufacturing Los Angeles, Calif.	Pressure Regulator and Relief Valve
Weston Hydraulics Van Nuys, Calif.	Pneumatic Solenoid Valve
Quantitron Los Angeles, Calif.	Coaxial Switch

In addition, more than 100 other firms are contributing to the Pioneer project.

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