NEWS

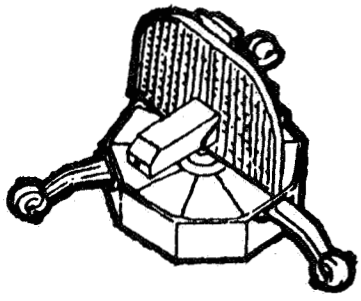
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

TELS. WO 2-4155
WO 3-6925

FOR RELEASE: MONDAY P.M.
January 20, 1969

RELEASE NO: 68-13

PRESS KIT



PROJECT: OSO-F

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SOLAR OBSERVATORY SET FOR LAUNCHING

An Orbiting Solar Observatory designed to study the Sun and its influence in the interplanetary space near the Earth is scheduled for launching no earlier than Jan. 22, from Cape Kennedy, Fla.

OSO-F, to be called OSO-V in orbit, will be launched into a 350-mile (statute) circular orbit by a three-stage Delta launch vehicle.

Designed to provide observations from space during most of an 11-year solar cycle, the OSO Program is one of the National Aeronautics and Space Administration's major efforts in solar physics.

Besides its intrinsic interest, the Sun offers unique opportunities to observe closely the star and to test stellar theories since it is the nearest star to Earth.

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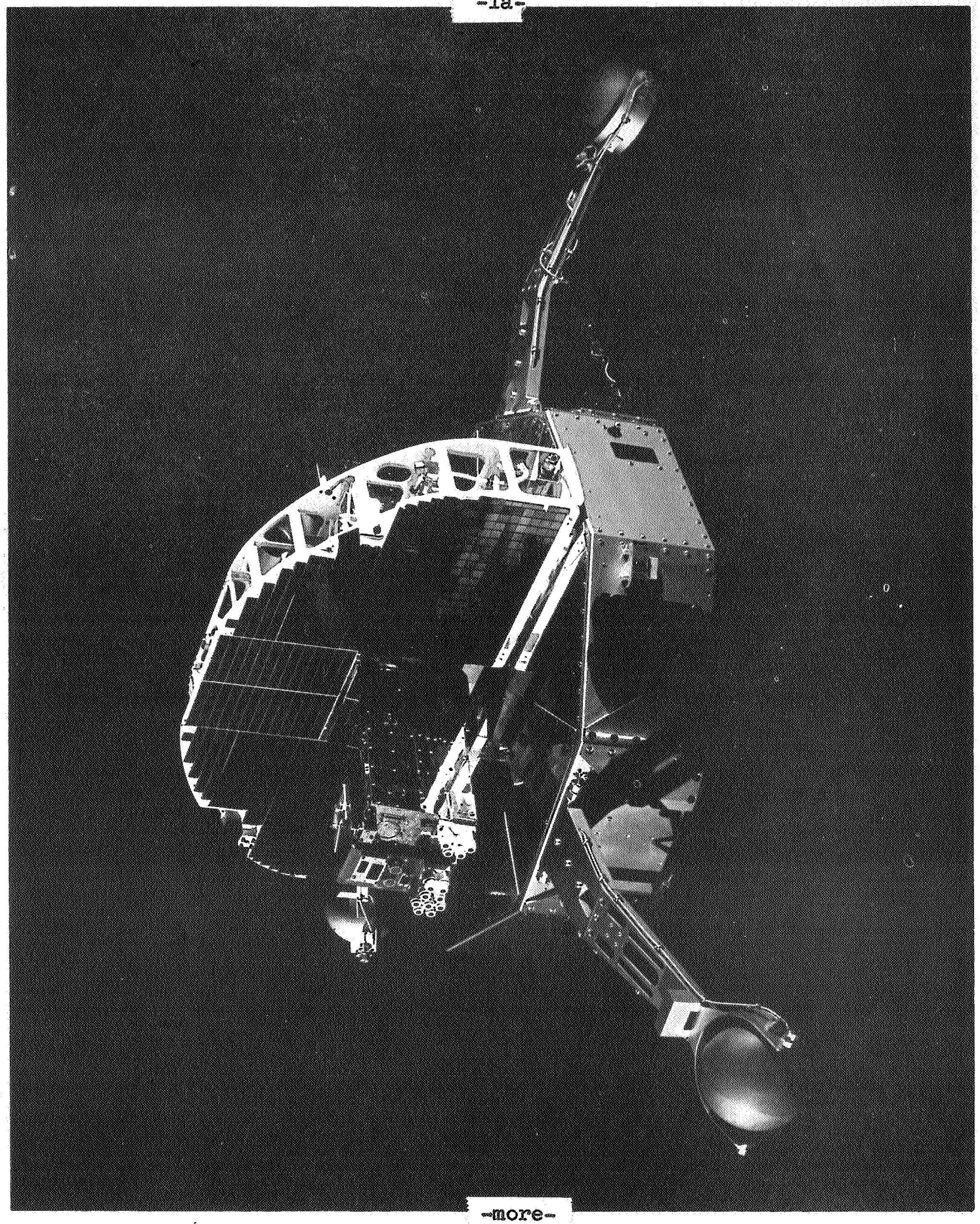


It is the only star close enough for man to observe detailed features such as spots and flares, and to permit detailed study of its X-rays, gamma rays and radio emissions.

The Sun's cycle of sunspot activity varies over an 11-year cycle. It declines from a high point during the first seven to nine years then builds back up in the remaining years. The OSO-F measurements will be taken during a period of near maximum solar activity.

Knowledge gained from OSO data will be useful in predicting solar flares and provide advance warning of intense solar activity which could affect the scheduling of manned space flights.

The Sun emits energetic particles and electromagnetic radiations of various wavelengths. Part of this solar radiation is absorbed by the Earth's upper atmosphere. The Earth's atmosphere absorbs most of the ultraviolet and X-rays below 3,000 angstroms (Å) in the electromagnetic spectrum. The solar X-ray and ultraviolet radiation produces the region of great electron concentration called the ionosphere.

The primary objective of OSO-F is to obtain high spectral resolution data (within the 1Å - 1250Å range) from onboard solar experiments pointed toward the Sun.

OSO-F continues the solar investigations begun by OSOs I, II, III and IV which were successfully orbited during the past seven years.

OSO-F carries eight experiments. They are provided by University College, London, and the University of Leicester, jointly, University of Paris, University of Colorado, University of Minnesota, the Goddard Space Flight Center, Greenbelt, Md., and the U. S. Naval Research Laboratory.

The OSO-F spacecraft weighs 641 pounds. Its eight experiments weigh 265 pounds.

The spacecraft is designed in two sections, an upper sail-like structure which carries the pointed experiments, and a nine-sided base section called the wheel.

The wheel carries experiments and support equipment such as batteries and telemetry system.

As with its predecessors, OSO-F has been designed for a lifetime of six months and a pointing accuracy of one minute of arc.

A sail control system keeps this portion of the spacecraft facing the Sun while an automatic pitch control system, using gas jets and a magnetic torque coil, maintains the spin axis of the entire spacecraft approximately perpendicular to the direction of the Sun.

The first two OSO spacecraft were launched successfully from Cape Kennedy on Mar. 7, 1962 (OSO-I) and Feb. 1965 (OSO-II). The third OSO, launched Aug. 25, 1965, failed to orbit. A fourth OSO (OSO-III) was successfully launched Mar. 8, 1967. OSO-IV was launched successfully Oct. 18, 1967.

Both OSO-I and II, surpassed their designed lifetimes of six months and, together, provided about 6,000 hours of scientific information.

OSO-III recently passed its 22d month in orbit and continues to operate well. The satellite provides seven and one-half hours of real-time data daily.

OSO-IV recently passed its 15th month of successful operation and also provides seven and one-half hours of real-time data daily.

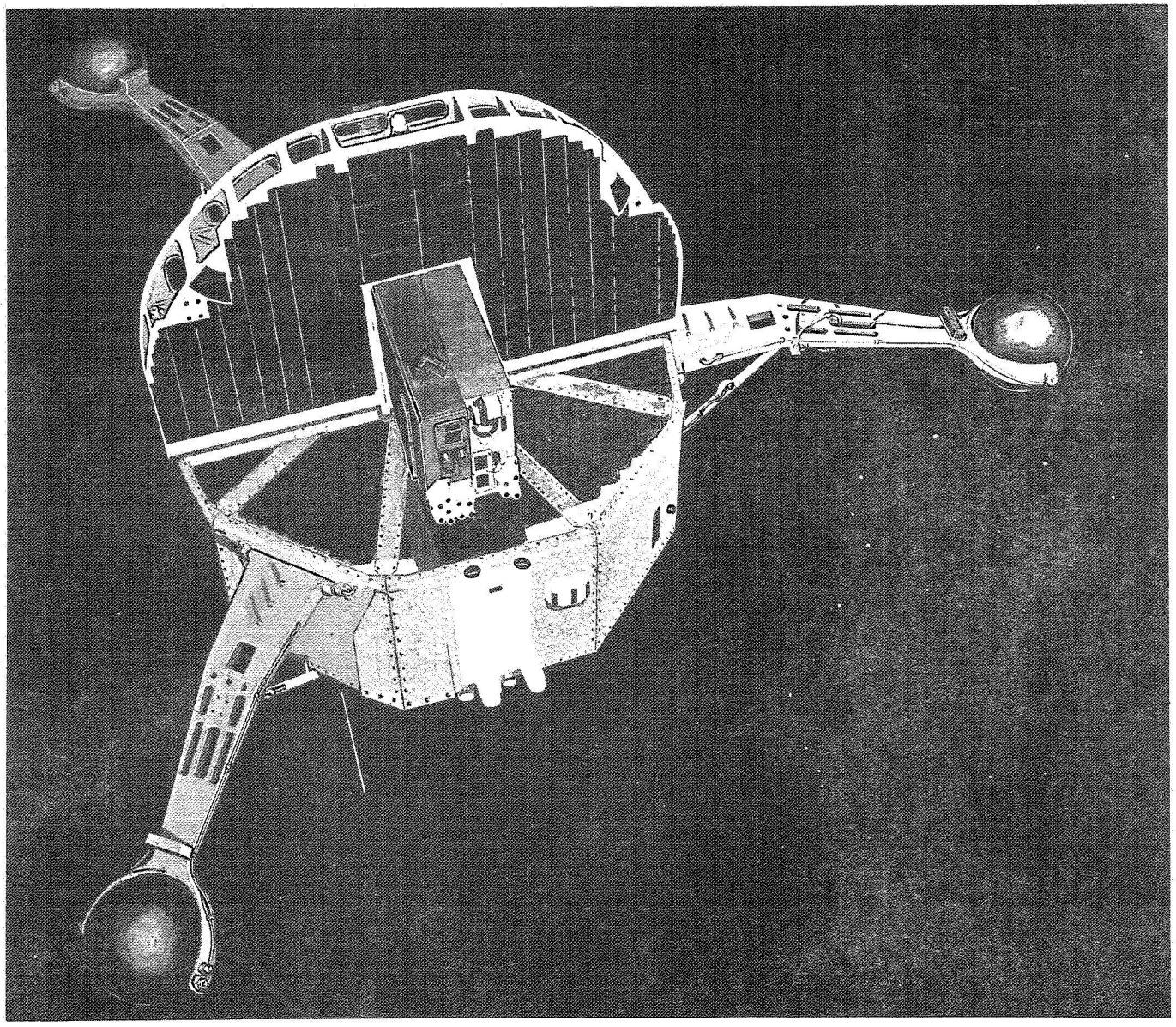
OSO-G and OSO-H remain in the program. They are scheduled for launching in 1969 and late 1970, respectively.

The OSO program is directed by Physics and Astronomy Programs, Office of Space Science and Applications, NASA Headquarters, Washington. Project management is under the Goddard Space Flight Center, which is also responsible for tracking and data acquisition and the Delta launch vehicle. Launch of the Delta is supervised by Kennedy Space Center's Unmanned Launch Operations (ULO).

The OSO spacecraft are designed and built by Ball Brothers Research Corp., Boulder, Colo., and the Delta Launch Vehicle by McDonnell-Douglas Corp., Santa Monica, Calif.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS)

OSO-F ORBITING SOLAR OBSERVATORY



PROGRAM SUMMARY

PROJECT *ORBITING SOLAR OBSERVATORY (OSO-F)*

PROJECT DIRECTION
NASA / GSFC

PRIME CONTRACTOR
BALL BROTHERS RESEARCH CORP.

EXPERIMENT ORGANIZATIONS
U.S. NAVAL RESEARCH LABORATORY (2)
GODDARD SPACE FLIGHT CENTER (2)
UNIVERSITY COLLEGE LONDON
UNIVERSITY OF MINNESOTA
UNIVERSITY OF PARIS
UNIVERSITY OF COLORADO

MAJOR OBJECTIVES
THE OSO IS A RESEARCH SPACECRAFT DESIGNED FOR MEASUREMENT OF SOLAR PHENOMENA AND SOLAR EFFECTS. THE VARIATION IN ATTITUDE OF THE OBSERVATORY DURING ITS LIFETIME WILL ALSO PERMIT OBSERVATION OF THE ENTIRE CELESTIAL SPHERE AND PORTIONS OF THE EARTH'S SURFACE

LIFETIME
ESTIMATED: SIX MONTHS

LAUNCH VEHICLE
THOR-DELTA

CIRCULAR ORBIT
300 ± 30 NAUTICAL MILES

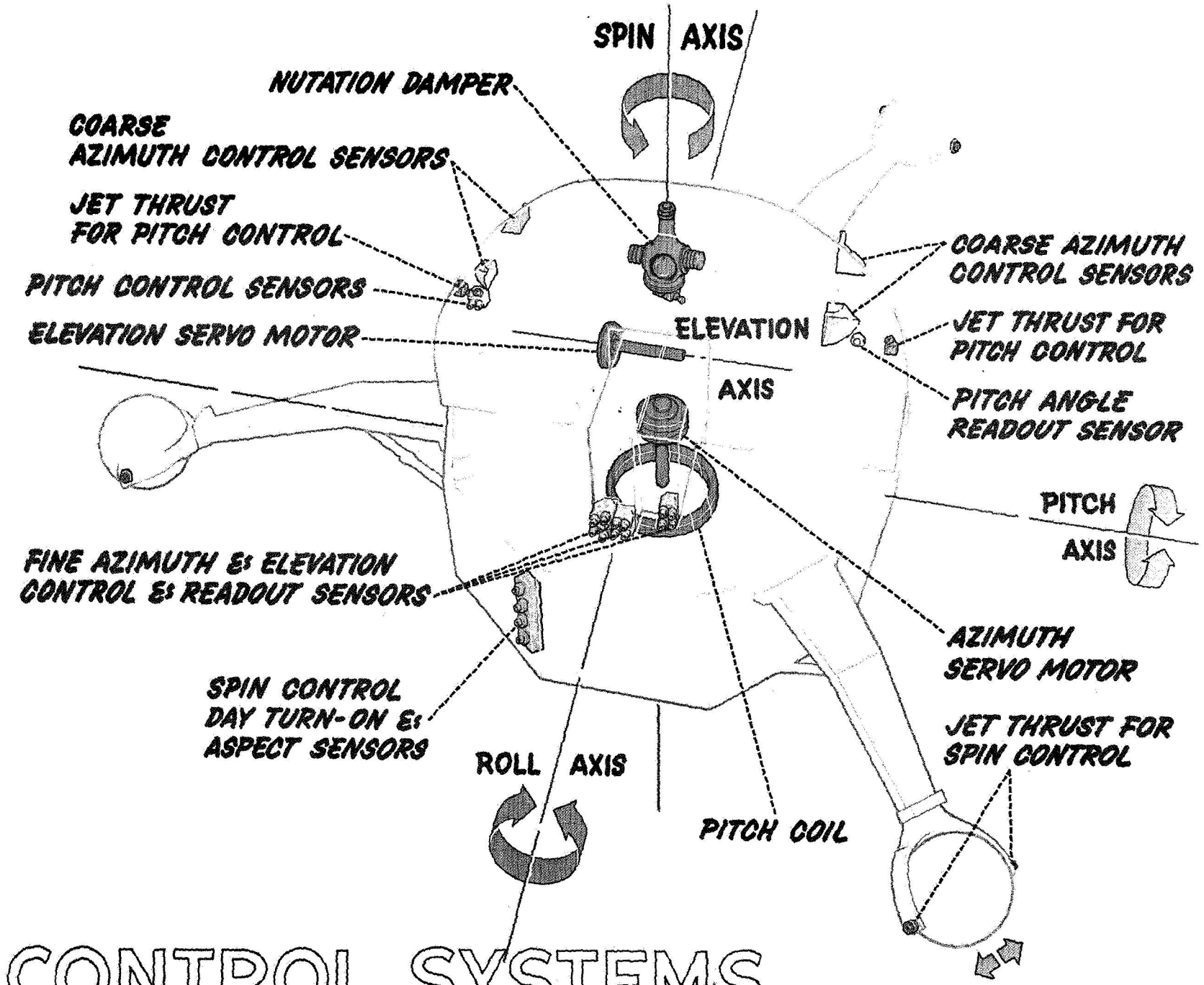
INCLINATION
33 ± 3 DEGREES

NOMINAL PERIOD
NIGHT 36 MIN.- DAY 60 MIN.
TOTAL 96 MIN.

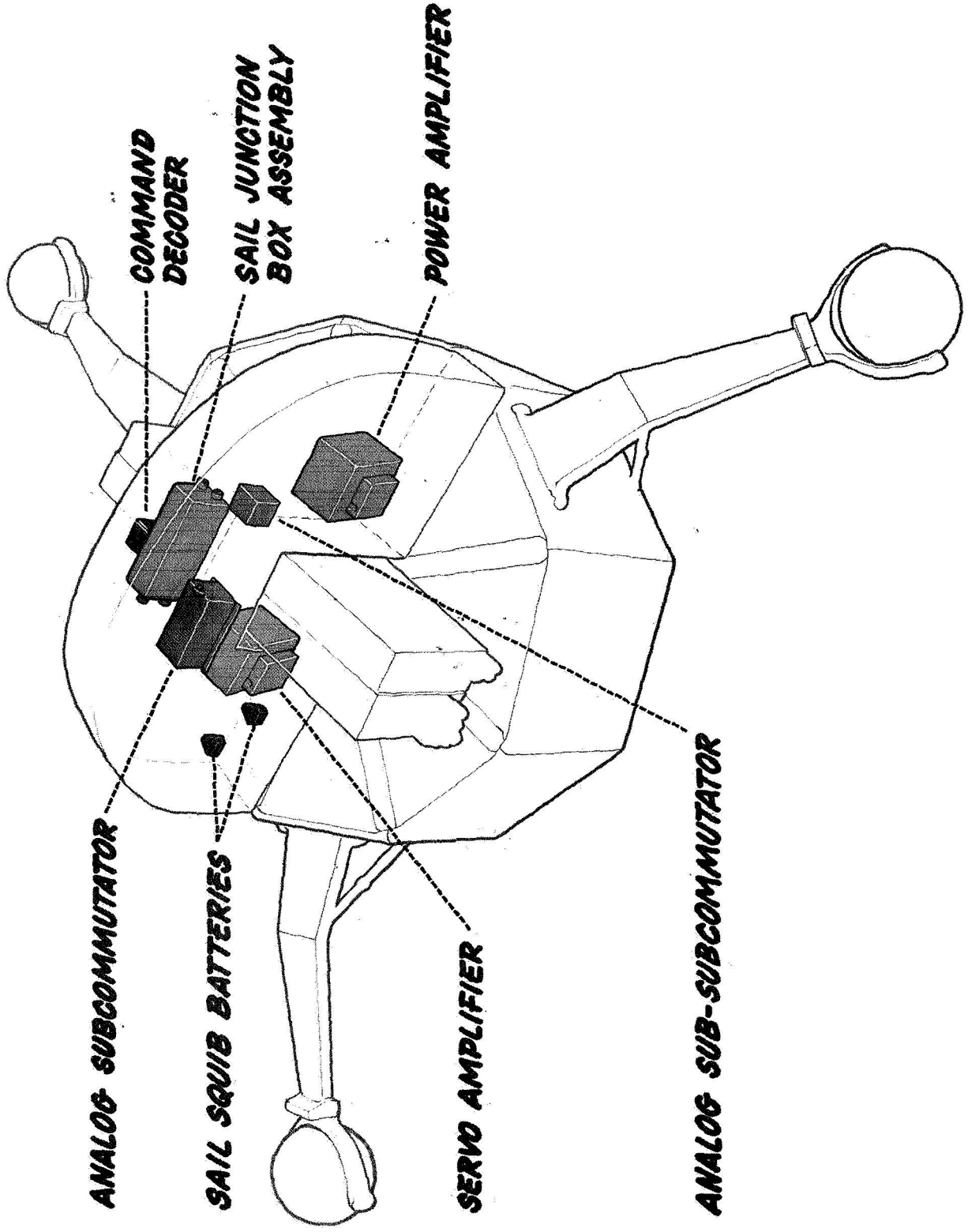
PAYLOAD WEIGHT
ESTIMATED 636 LBS.

POINTING ACCURACY
ONE MINUTE OF ARC

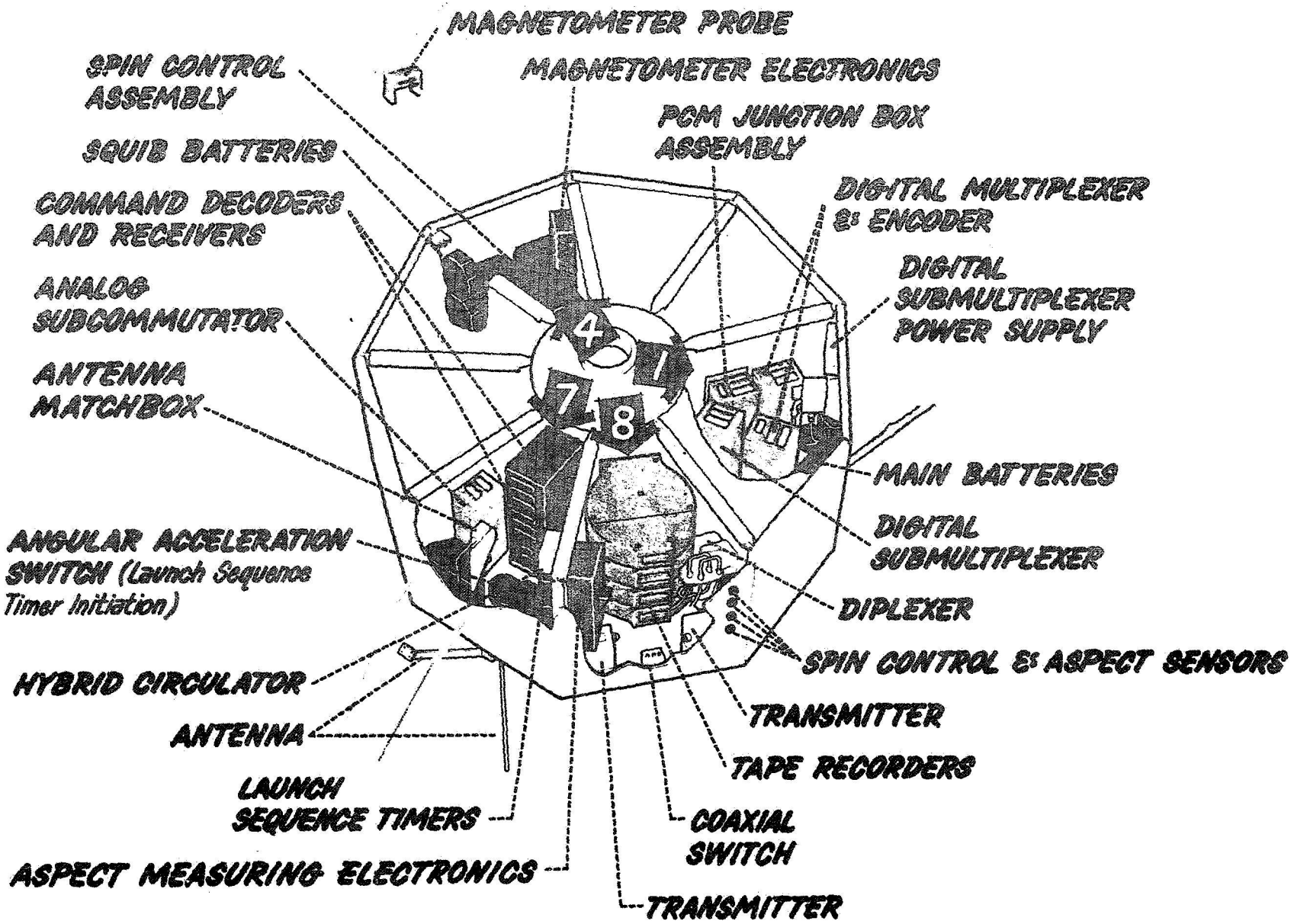
SCAN RASTER
40 BY 40 MINUTES OF ARC



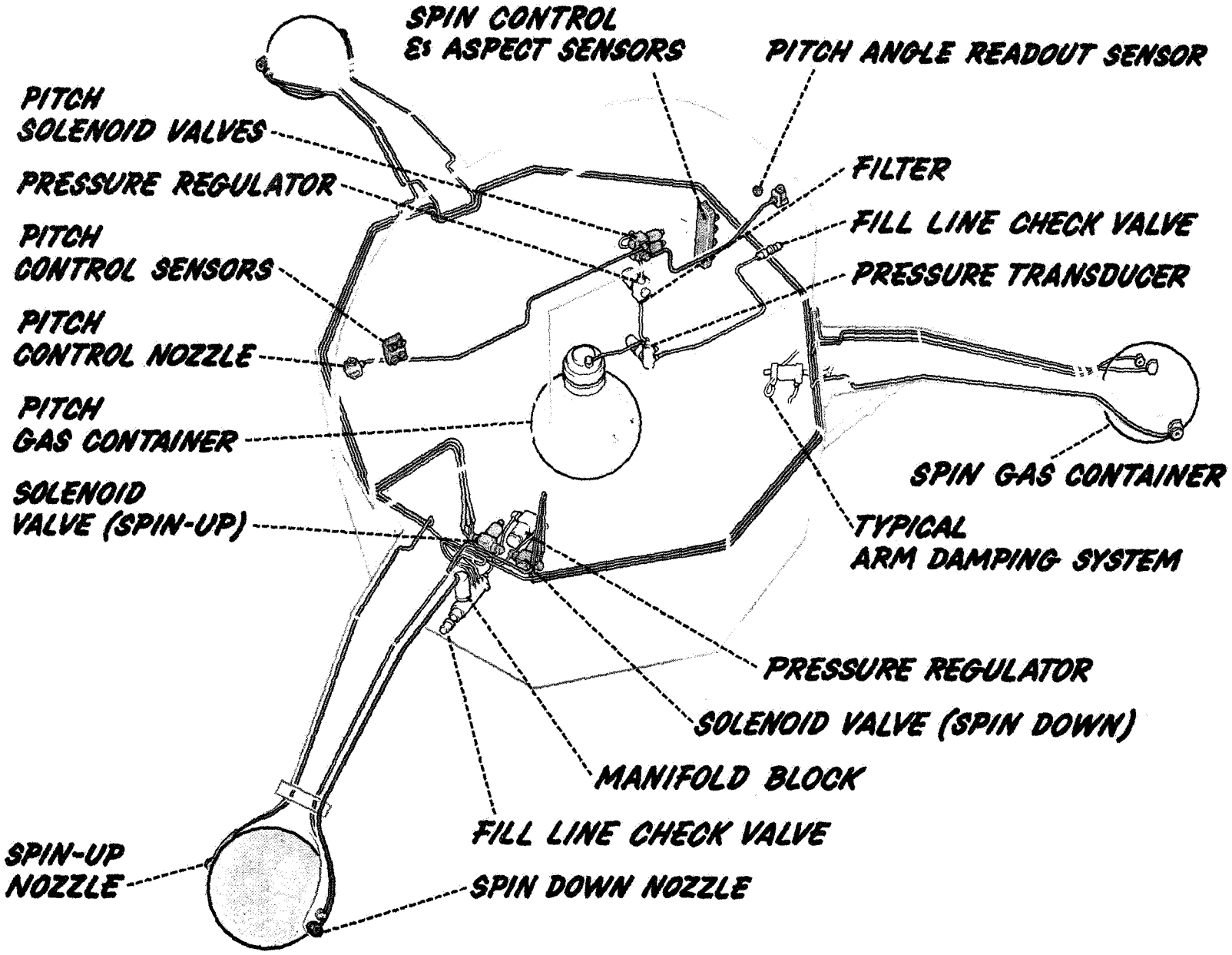
CONTROL SYSTEMS



SAIL ELECTRONIC SYSTEMS



WHEEL ELECTRONIC SYSTEMS



GAS CONTROL SYSTEMS

OSO-F FACT SHEET

Observatory

Weight:	About 641 pounds (265 pounds of scientific instruments and associated equipment).
Shape:	Base section: nine-sided wheel with three arms carrying spin control gas supply; top section: fan-shaped with pointing instrumentation.
Size:	Wheel diameter: 44 inches, increased to 92 inches with three arms extended. Over-all height: 38 inches.
Lifetime:	Designed for six month's useful lifetime.

Launch Phase

Site:	Complex 17B, Cape Kennedy, Eastern Test Range, Fla.
Date:	No earlier than Jan. 22, 1969
Vehicle:	Three-stage Delta launch vehicle
Azimuth:	108 degrees
Launch Window:	11:48 a.m. to 12:14 p.m. EST
Orbital Plan:	Circular orbit about 350 miles (statute) altitude Period: About 96 minutes Inclination: 33 degrees to the Equator

Observatory Power Subsystem

Solar power supply:	Maximum 38 watts provided by 4.0 square feet of N/P solar cells arranged in 36 parallel strings of 56 cells each on Sun-facing side of sail section.
Typical maximum load:	About 26 watts including 13 watts for experiments. About 7 watts required at night.

OSO ACCOMPLISHMENTS

OSO-I

OSO-I was successfully launched Mar. 7, 1962, from Cape Canaveral. This pioneering observatory satellite has provided valuable scientific data for over 1,000 of its orbits. As the first of its kind, it clearly established the capability to orbit successfully a complex scientific observatory containing numerous independent but complex solar and astrophysical instruments.

The contribution of OSO-I to the study of active regions is in demonstrating that Extreme Ultra-Violet (EUV) observations carried out over several solar rotations give direct evidence of changing conditions in the corona above an active region.

On OSO-I, the average atmospheric temperature and approximate density of the upper atmosphere between 124 and 248 statute miles were determined at sunrise and sunset for a period of one week each of high and low levels of solar activity. The results obtained by observing the attenuation of solar spectrum lines from 170 to 400 Å with the Goddard solar EUV spectrometer showed some disagreement with the older models of the atmosphere. For example, the difference in temperature between sunrise and sunset was not as much as obtained from the satellite drag results.

In another study, daily values of atmospheric temperature have been compared with EUV radiation data and also with indices of geomagnetic activity. The analysis of both phases and amplitudes favors the EUV rather than the solar wind effect as being principally responsible for the 27-day variations in atmospheric temperature for the months of March and April 1962.

Also on OSO-I a number of "warm" spots which lie below the lower Van Allen belt were observed by the University of California Lawrence Radiation Laboratory proton-electron experiment. These were observed at the satellite altitude of 357 statute miles between the latitudes of 33 degrees N and 33 degrees S.

OSO-II

Some of the major results are:

- There are no rapid changes in the brightness of the sky as seen from above the airglow layer. Changes in days to weeks of as much as 30 per cent are definitely ruled out.

- From the standpoint of space astronomy, OSO-II observations show that the zodiacal light will be the principal contaminant for orbiting observatories, and that it is comparable with the sky brightness from the ground, where both the airglow and zodiacal light combine to form the background.

- There is no appreciable contribution to the zodiacal light from a local (geocentric) cloud of dust.

- The majority (at least 80 per cent) of the airglow as seen in our optical bandwidth of about 4,000 to 6,000 Å arises in the 56-statute-mile layer.

- The airglow shows "meteorological" day-to-day variations in brightness and color of about one astronomical magnitude, which seem to be uncorrelated with latitude, longitude, or time of night.

- The scale of the airglow pattern is very much like the scale of a meteorological system, i.e.: of the order of 1,000 miles.

OSO-III

OSO-III, launched Mar. 8, 1967, has been an outstanding success. Both tape recorders operated satisfactorily from time of launch until they failed May 26, 1967, and June 28, 1968. All nine of the experiments operated as designed. However, two of the experiments which had met their scientific objectives have ceased operation.

The Goddard Space Flight Center pointed experiment has ion chambers which monitor the 2 to 8 Å and 10 to 20 Å regions of the solar spectrum, two spectrometers which cover the range of about 1 to 4 Å and 8 to 25 Å, and a grazing incidence spectrometer which covers the 20 to 400 Å portion of the spectrum.

The grating spectrometer can be stopped on any desired line and observations made on the changes of intensity in the selected line to give "light curves." The comparison of light curves for spectral lines of various elements and of various levels of ionization will be very important in understanding the mechanism of transport of energy through the corona generated by solar activity. In addition to its scientific value, the X-ray data are forwarded to the Flare Warning Network of Environmental Science Services Administration (ESSA). These instruments were still providing good scientific data as of June 12, 1968. Of particular interest to scientists have been the observations of the changes in the ultraviolet spectrum during the solar flares. Two moderately strong new emission lines have been observed during moderately large flares.

The pointing section also has a scanning spectrometer used as a monochromator and provided by the Air Force Cambridge Research Laboratories. This instrument operated successfully for more than six months. It scanned the solar spectrum from about 250 to 1,300 Å and provided solar spectra of the best reproducibility to date in this region, although the instrument had no spatial resolution.

In addition to obtaining solar spectra, this experiment measured the atmospheric absorption of the solar ultraviolet as a function of latitude, season and heights in the atmosphere. These data are extremely significant for aeronomy since from these absorption spectra the physical processes occurring in the upper atmosphere can be studied in detail.

The University of Michigan has, in the wheel section, an ion chamber that measures the integrated solar flux from 8 to 12 Å. Some interesting variations have been found; not all large increases in the flux correlate well with optical and radio observations of solar activity. It has been observed that all optical flares produce X-rays. On the other hand, out of 42 X-ray events observed before mid-September in the "quick look" data, only 36 were correlated with optical flares. Also, there is a large range of X-ray enhancements for a flare of given importance. In addition to its research value, this information is also provided to the Space Disturbance Laboratory of the Environmental Science Services Administration.

The University of California at San Diego has, in the wheel section, a sodium iodide scintillation counter to detect solar and celestial X-rays from about 7 to 190 kilovolts. This experiment has produced some interesting and important results for solar physics.

In this energy range the Sun is characterized by its variability -- there exists no "quiet" Sun. Studies have also been made of the rise time of solar X-ray bursts and of the correlation of the spectrum with burst activity. The latter shows that the more intense the burst, the harder the X-rays.

The Massachusetts Institute of Technology has, in the wheel section, a gamma-ray telescope for the detection of celestial gamma-ray sources with energies above 50 MeV. This experiment requires extremely long observation times as the telescope detects on the average about 1 photon per day from the sky and about 200 per day from the Earth. As a result, the interpretation of data from this experiment is just beginning. However, one extremely significant observation clearly has been made. The center of our galaxy is a source of gamma-rays of energy greater than 50 MeV. This is important for models of galactic structure and evolution, and theories on the energetics of cosmic radiation.

The University of Rochester has, in the wheel section, a particle-counting telescope to study solar and galactic high energy cosmic rays. As this experiment also has a very low counting rate, it too needs a long lifetime for good statistics. An upper limit to the isotropic flux of hard gamma-rays (energies higher than 50 MeV) has been determined and is a factor of three lower than the limit determined from earlier observations. For very high energy particles the proton (hydrogen nuclei) spectrum seems to be flatter than the alpha particle (helium nuclei) spectrum. There is an indication that the ratio of hydrogen to helium increases with increases with energy for these very energetic nuclei.

OSO-IV

OSO-IV, launched Oct. 18, 1967, carried instrumentation for nine experiments. Both tape recorders operated satisfactorily from time of launch until they failed on March 15, 1968, and May 12, 1968. All nine of the experiments operated as designed. However, one of these experiments has ceased operation.

There are three experiments in the pointing section of OSO-IV. A crystal spectrometer provided by the Naval Research Laboratory is studying solar X-rays in the 1 to 8 Å region. A scanning spectrometer provided by the Harvard College Observatory was able to scan the solar spectrum in the 300 to 1,300 Å region and to scan spatially the Sun at fixed wavelengths with spatial resolution elements of about one minute of arc. The third pointed experiment is an X-ray spectroheliograph provided by American Science and Engineering, Inc. This experiment provides "pictures" of the Sun in wavelengths from less than 8 to above 70 Angstroms.

The Harvard College Observatory ultraviolet spectroheliometer failed and was turned off about Nov. 30, 1967. Over 4,000 spectroheliograms of the solar atmosphere between 300 and 1,300 Å had been obtained. These data will permit the development and assessment of realistic models of the solar atmosphere and will provide insight into the problem of energy transport through the chromosphere and corona.

The following experiments are operative and real time data are being obtained:

Naval Research Laboratory - Pointing Bragg Crystal Spectrometer -- This experiment is obtaining moderately high resolution spectra from 1 Angstrom - 8 Angstrom. The data show differences between emissions from a "hot" corona and a relatively low temperature corona.

American Science and Engineering - Pointing X-Ray Spectroheliograph -- This experiment obtains spectroheliograms in the soft X-ray region from below 8 Angstrom to about 70 Angstrom. It is providing significant information on hot spots in the solar corona and valuable spectroheliograms on the "quiet" Sun.

American Science and Engineering - Wheel X-Ray Flux Monitor -- Data have been obtained which is being used to construct charts on the background counting rate around the world. This is necessary to establish both the general background sky flux and to ascertain point X-ray sources in the sky.

Naval Research Laboratory - Wheel Lyman-Alpha Night Sky Glow -- This experiment is providing important information on the density and scale height of the geocorona.

University College London - Wheel Total Solar X-Ray Emission Over a Wideband -- This experiment has obtained valuable data on the soft solar X-ray flux in five bands ranging from 1 Angstrom - 70 Angstrom. In particular, this experiment has made valuable observations on the distribution of X-ray flux due to flares and shows the hardening of the flux caused by solar activity.

Lawrence Radiation Laboratory - Wheel Proton/Electron Detector -- This experiment is designed to ascertain the energy distribution of charged particles in the South Atlantic anomaly. Considerable data have been obtained which must be reduced to obtain particle energy spectra for electrons and protons separately.

Naval Research Laboratory - Wheel X-Ray Ion Chambers -- This experiment is providing important data on the soft solar X-ray flux in four bands from 0.1 Angstrom to 16 Angstrom. This experiment also shows the hardening of flux produced by solar activity.

University College London - Wheel Integrated Helium II 304 Angstrom Photometer -- This experiment is designed to monitor the Helium II Lyman-Alpha 304 Angstrom line. This emission line is primarily responsible for heating of the Earth's atmosphere in the neighborhood of 124 statute miles. Study of the fluctuations in the solar emission of this Helium II line and a detailed study of the eclipse of the Sun by the atmosphere as seen by OSO-IV is providing important information to aeronomy and ionospheric physics.

Harvard College Observatory - Pointing Scanning Spectrometer -- This experiment which is no longer operating, produced spectroheliograms at numerous wavelengths from 300 Angstrom - 1,300 Angstrom. The spectroheliograms have a spatial resolution of approximately one minute by one minute of arc. It is within the capability of the experiment to select any wavelength desired by the experimenter on any given scan. To date, spectroheliograms have been made in the lines of various ionic species of oxygen, magnesium, hydrogen and in the continuum. These data represent a major step forward in solar physics. This experiment failed Nov. 30, 1967.

Pointing Device

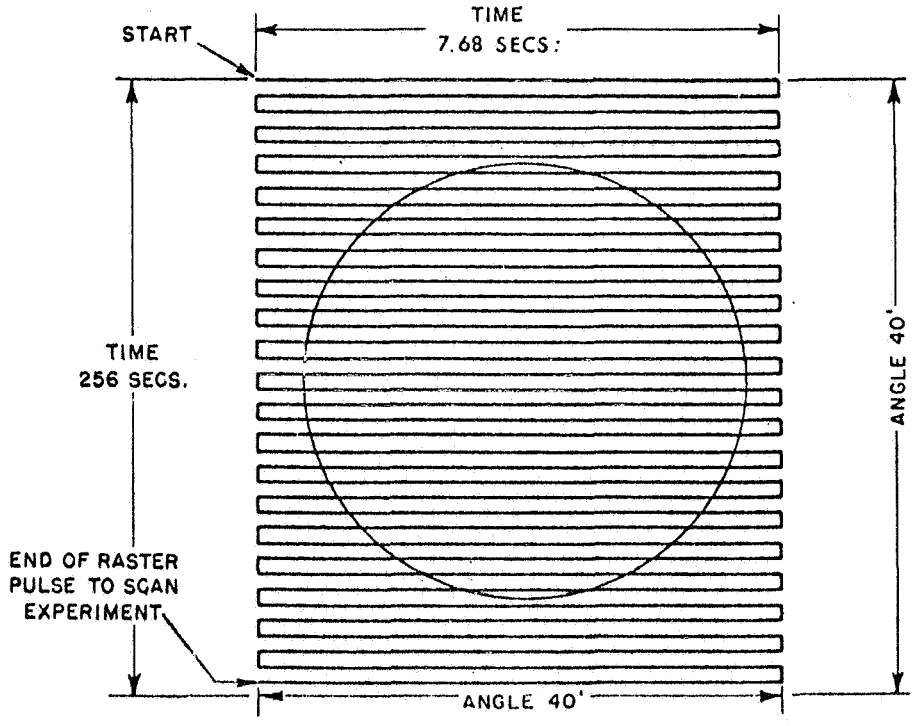
An important feature of OSO-F is that the spacecraft will have the ability to perform a scan across the solar disk similar to OSO-II and OSO-IV. OSO-I and OSO-III could only point directly at the center of the Sun. The fully oriented experiment section on the sail of the OSO-F spacecraft has two modes of operation. In the first, called the pointed or oriented mode, the experiment section is kept accurately pointed at the center of illumination of the Sun. In the second mode, called the raster mode, the oriented section is made to perform a raster scan of the entire solar disc and portions of the corona, as illustrated on page 12a. The oriented instruments scan the Sun in a square raster pattern to an azimuth angle of 40 minutes. The azimuth sweep which requires 7.68 seconds will be synchronized with the telemetry clock. One step in the elevation sweep will occur at the end of each azimuth sweep and one complete raster of the Sun will take 307.2 seconds. Scanning is initiated by ground command and is terminated automatically by a night signal.

RASTER MODE

(1) ACTUATED BY GROUND COMMAND
(2) 40 LINES: 1 ARC MINUTE APART.
(3) LINE SWEEP RATE: 40 ARC MINUTES PER 7.68 SECONDS.
(4) TOTAL RASTER TIME: 307.2 SECONDS.
(5) USED BY THE FOLLOWING EXPERIMENTS:
  (A) UNIVERSITY COLLEGE LONDON-
    X-RAY SPECTROHELIOGRAPH
  (B) NAVAL RESEARCH LABORATORY-
    SOLAR XUV SPECTROHELIOGRAPH (SELECTED WAVELENGTHS).

POINT MODE

(1) NORMAL ORIENTATION TO THE CENTER OF THE APPARENT SOLAR DISK, WITHIN ± 1 ARC MINUTE
(2) USED BY THE GODDARD SPACE FLIGHT CENTER-
  SOLAR X-RAY SPECTROMETER (SELECTED WAVELENGTH BANDS)



OSO-F EXPERIMENTS

Three of OSO-F's eight experiments are located on the sail portion of the spacecraft and will be pointing at the Sun. The remaining five experiments are located in compartments of the nine-sided rotating wheel section and scan the Sun every two seconds.

The experiments were provided by University College London and the University of Leicester jointly, University of Paris, University of Colorado, University of Minnesota, the Goddard Space Flight Center and the U.S. Naval Research Laboratory.

OSO-F Experiments

Dr. W. M. Neupert, Goddard Space Flight Center -- Pointed/X-Ray Spectrometer; Monitor the X-Ray ultraviolet Spectrum.

Prof. R. L. F. Boyd, University College, London -- Pointed/X-Ray Spectroheliograph; Study intensity and variations of X-Ray spectrum in 3 to 9 A. and 8 to 18 A.

J.D. Purcell, Naval Research Laboratory -- Pointed/Extreme Ultraviolet Spectroheliograph; Monitor the extreme ultraviolet in the 1,216A, 304A, 465A, 284A, 335A, and 299A.

Prof. E. P. Ney, University of Minnesota -- Wheel/Zodiacal Light Telescopes; Measure the intensity and polarization of the zodiacal light in blue and visual regions. Monitor the brightness of the terrestrial airglow.

Prof. J. E. Blamont, University of Paris -- Wheel/Lyman-Alpha Atomic Hydrogen cell; Monitor self-reversal of the solar Lyman alpha line.

Prof. W. A. Rense, University of Colorado -- Wheel Solar Far Ultraviolet Monitor; Monitor the total energy flux in three far-ultraviolet bands, 280, 370A, 465 to 630A and 760 to 1,030A.

K. Frost, Goddard Space Flight Center -- Wheel/Low Energy Gamma Ray Detector; Observe solar and stellar gamma radiation in the 5 to 150.

Dr. T. A. Chubb, Naval Research Laboratory -- Wheel/X-Ray Monitor; To monitor the solar flux variation from 0.5 to 3A, 2 to 8A, 8 to 16A and 0.1 to 1.6A.

DELTA LAUNCH VEHICLE

Delta is a launch vehicle program of NASA's Office of Space Science and Applications. Project management is the responsibility of the Goddard Space Flight Center. The Kennedy Space Center's Unmanned Launch Operations Directorate provides launch operations support. Delta prime contractor is the McDonnell Douglas Corp.

OSO-F will be the 64th Delta launching. If the launch sequence is successful, it will be the 60th success for the workhorse rocket.

Delta Statistics

The three-stage Delta for the OSO-F mission is the DSV-3C/FW-4 configuration. It has the following characteristics:

Height: 92 feet (including shroud)

Maximum Diameter: 8 feet

Lift-off Weight: about 75 tons

Lift-off Thrust: 172,000 pounds

First Stage: Modified Air Force Thor, produced by McDonnell Douglas Corp., engines produced by Rocketdyne Division of North American Rockwell Corp.

Diameter: 8 feet

Height: 51 feet

Propellants: RP-1 kerosene is used as the fuel and liquid oxygen (LOX) is utilized as the oxidizer.

Thrust: 172,000 pounds

Burning Time: 2 min. 29 sec.

Weight: more than 50 tons.

Second Stage: Produced by the McDonnell Douglas Corp.; utilizing the Aerojet General Corp. propulsion system; major contractors for the autopilot are Honeywell, Inc., Texas Instruments, Inc., and Electrosolids Corp.

Diameter: 2.7 feet

Height: 20.6 feet

Propellants: Liquid Unsymmetrical Dimethyl Hydrazine (UDMH) for the fuel and Inhibited Red Fuming Nitric Acid (IRFNA) for the oxidizer.

Thrust: about 7,500 pounds

Burning time: 2 min. 31 sec.

Weight: 2½ tons

Guidance: Western Electric Co.

Third Stage: United Technology Center FW 4 motor

Diameter: 1½ feet

Height: 5½ feet

Propellants: solid

Thrust: 5,600 pounds

Burning time: 23 sec.

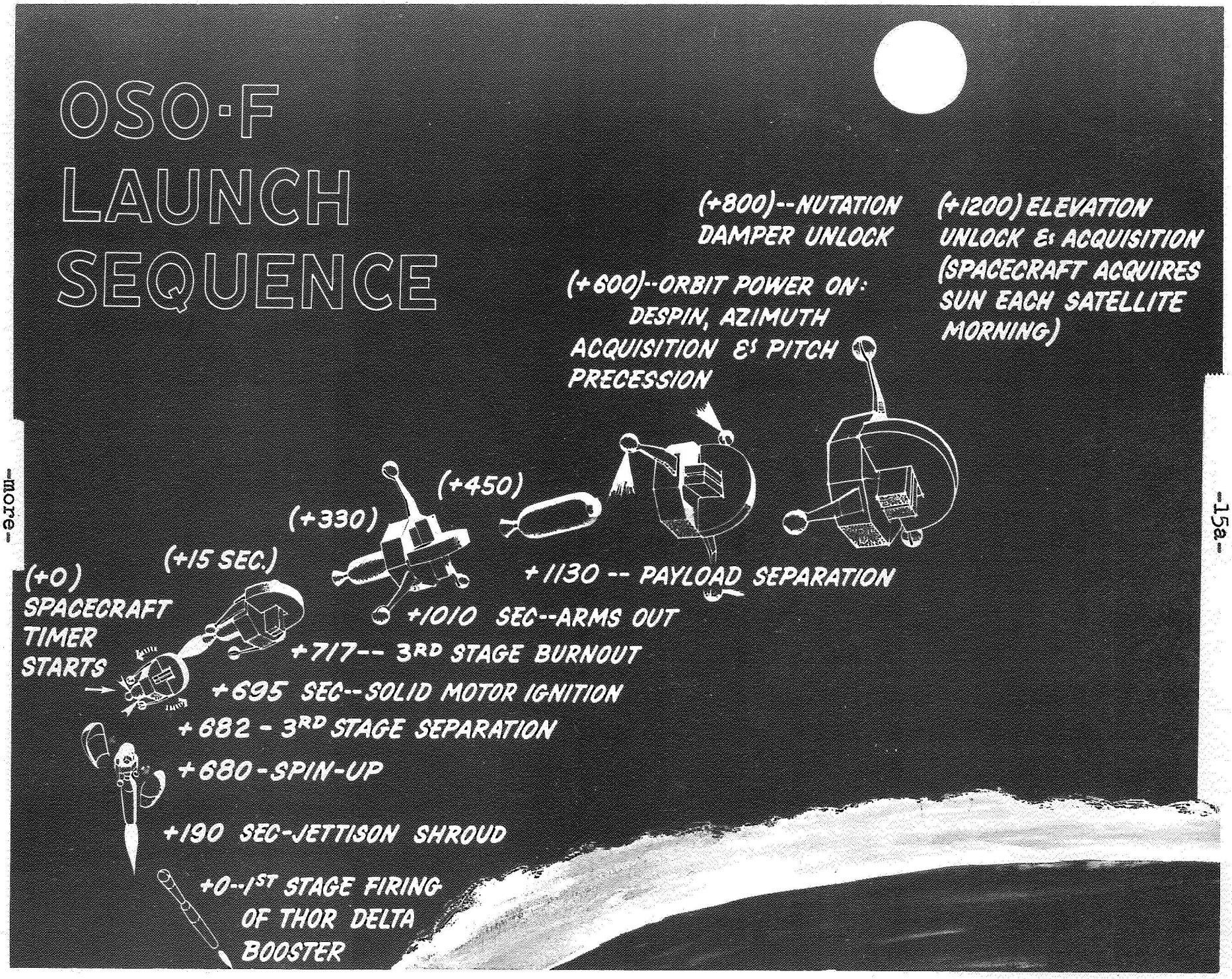
Weight: 660 pounds

Observatory Separation

Upon completion of third stage burnout, but before spacecraft separation, three arms on the OSO-F spacecraft extend.

After spacecraft separation, the de-spin system is actuated by a signal from the spacecraft timer and the spacecraft spin rate is slowed to the desired 30-40 rpm.

About 20 minutes after lift-off, OSO-F acquires the Sun.


OSO·F
LAUNCH
SEQUENCE
(+800)--NUTATION DAMPER UNLOCK
(+1200) ELEVATION UNLOCK & ACQUISITION (SPACECRAFT ACQUIRES SUN EACH SATELLITE MORNING)
(+600)--ORBIT POWER ON: DESPIN, AZIMUTH ACQUISITION & PITCH PRECESSION
(+450)
(+330)
(+15 SEC.)
(+0) SPACECRAFT TIMER STARTS
+1130 -- PAYLOAD SEPARATION
+1010 SEC--ARMS OUT
+717-- 3RD STAGE BURNOUT
+695 SEC--SOLID MOTOR IGNITION
+682 - 3RD STAGE SEPARATION
+680-SPIN-UP
+190 SEC-JETTISON SHROUD
+0--1ST STAGE FIRING OF THOR DELTA BOOSTER

NOMINAL OSO-F FLIGHT EVENTS

EVENT	TIME	ALTITUDE STATUTE MILES	SURFACE RANGE STATUTE MILES	VELOCITY MILES PER HOUR
Main Engine Cutoff	2 min. 29 sec.	56	92	9,705
Second Engine Cutoff	5 min.	199	522	13,391
Third Stage Ignition	11 min. 22 sec.	345	1,784	12,622
Third Stage Burnout	11 min. 45 sec.	345	1,867	16,022
Spacecraft Separation	18 min. 36 sec.	345	3,709	16,022

OSO TEAM

NASA HEADQUARTERS

Jesse L. Mitchell	Director, Physics and Astronomy Programs, Office of Space Science and Applications
C. D. Ashworth	Program Manager for Solar Observatories
E. B. Stubbs	OSO Program Engineer
Dr. H. Glaser	OSO Program Scientist
Joseph Mahon	Director, Launch Vehicle and Propulsion Programs
Robert Manville	Delta Program Manager

GODDARD SPACE FLIGHT CENTER

Dr. John F. Clark	Director
John M. Thole	OSO Project Manager (Acting)
Dr. William E. Behring	OSO Project Scientist (Acting)
William R. Schindler	Delta Project Manager

KENNEDY SPACE CENTER

Kurt Debus	Director
Robert H. Gray	Director, Unmanned Launch Operations
Hugh A. Weston,	Manager, Delta Operations

BALL BROTHERS RESEARCH CORP.

Dr. R. C. Mercure	Vice President
R. Marsh	OSO Program Manager

McDONNELL-DOUGLAS CORP.

Marcus F. Cooper	Director, Florida Test Center, Cape Kennedy
J. Kline	Delta Systems Engineer.

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