DESCRIPTION OF THE SPACE TEST PROGRAM

P78-2 SPACECRAFT AND PAYLOADS

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INTRODUCTION

The USAF Space Test Program was designated in 1975 as the management agency for procurement of the Department of Defense spacecraft which supports the government USAF/NASA spacecraft charging at high altitude program. The spacecraft was designated the Space Test Program P78-2 spaceflight. Built by the Martin Marietta Corporation in Denver, Colorado, the spacecraft and its payloads are designed to measure the environment at near synchronous altitude and the interactions of the environment on the spacecraft.

SPACECRAFT

The P78-2 spacecraft is spin-stabilized and will be placed in a near synchronous, equatorial earth orbit from the Eastern Test Range by a Delta 2914 in January 1979. The spacecraft houses, protects, and supports several scientific and engineering payloads. It spins about an axis which lies in the orbit plane and is normal to the earth-sun line. On-orbit, the satellite will be controlled by the Air Force Satellite Control Facility (AFSCF) and will communicate directly with remote tracking stations in New Hampshire, the Indian Ocean, Guam, Hawaii, and at Vandenberg AFB. The mission is planned for a one-year duration but the spacecraft is provided with sufficient expendables for two years. Actual lifetime of the satellite will probably be limited by survival of electronic equipment in the ionizing radiation environment.

The body of the spacecraft has a cylindrical shape approximately 1.75 m in both length and diameter. Booms, antennae, and some instrument protrusions alter the basic cylindrical shape. Most of the spacecraft and payload equipment is mounted in the central portion of the cylinder. On orbit, seven experiment booms are deployed. The boom arrangement isolates sensitive instruments from spacecraft influences and provides clear fields of view for other instruments. Two solar arrays encircle the cylinder, one forward and one aft of the central portion. An apogee insertion motor is housed in the aft central portion of the spacecraft.

In addition to the usual spacecraft components, a transient pulse monitor has been incorporated as part of the spacecraft. This instrument obtains quantitative measurements of the electromagnetic pulse characteristics on the spacecraft. It measures the number of pulses, the positive and negative pulse amplitudes, and the positive and negative integral of the pulses.

Fabrication and assembly of the spacecraft have been completed. The spacecraft has been shipped from Denver to the Goddard Spaceflight Center where the magnetic and moment of inertia characteristics of the spacecraft are being measured. Next, the spacecraft will be shipped to the Eastern Test Range from which it will be launched in January 1979. The expected orbit parameters are listed below.

Apogee	42,250 km
Perigee	27,500 km
Inclination	8.5 deg

The final orbit will have an easterly drift rate of 6 deg/day for the satellite.

PAYLOADS

The payloads have been sponsored and produced by many different agencies. The attached table delineates the many participants. A brief description of each payload follows. A more detailed description of the spacecraft and its payloads was distributed as part of the registration material. Additional copies of the detailed payload descriptions entitled "Description of the Space Test Program P78-2 Spacecraft and Payloads" can be obtained by writing to:

HQ SAMSO/YCT
Attn: Lt Col J. C. Durrett
P. O. Box 92960
Worldway Postal Center
Los Angeles, CA 90009

ENGINEERING EXPERIMENTS SC1

One of the engineering experiments measures the profile of charging events on insulators, grounded insulators, and isolated conductors in conjunction with various environmental parameters measured on the same satellite. Surface potentials up to 20 kV are measured using an electrostatic voltmeter and also by measuring leakage currents.

Other experiments measure the power spectrum of very low frequency electromagnetic waves. Using a spectrum analyzer the spectrum from

400 Hz to 300,000 Hz is measured in eight frequency intervals. Spectrum measurements are also made in the RF region of the electromagnetic spectrum. Five measurements are made in the 2 to 30 MHz band. Objectives of these instruments are to measure characteristics of electromagnetic disturbances on the spacecraft and to measure the intensity and spectra of electromagnetic and electrostatic emissions caused by the energetic particles near the spacecraft.

A pulse shape analyzer measures the shape of electromagnetic pulses in the time domain from 7 nsec to 3.7 msec.

SHEATH ELECTRIC FIELDS SC2

This experiment is intended to provide the electron and ion distribution functions over a limited energy range, less than 20 keV, at three positions in the spacecraft plasma sheath. The experiment also measures the floating potential relative to the spacecraft ground of two biasable spherical probes. The aims of the experiment are to obtain insight into the characteristics of spacecraft sheath fields, to observe the effects of particles that comprise the energetic plasma near a spacecraft, and to observe the potential that a relatively simple geometrical shape attains in the plasma environment both in sunlight and in shadow.

The proton detector consists of a two-element solid-state telescope. Protons with energy between 17 and 717 keV are measured in six energy channels.

An ion detection system consists of a two-element solid-state telescope that is highly collimated and heavily shielded. Ions with energies greater than 90 keV/nucleon are detected.

HIGH ENERGY PARTICLE SPECTROMETER SC3

The instrument is a solid-state particle spectrometer consisting of four sensor elements. Various logic combinations of the four sensors in the instrument are used to determine the particle types and energy ranges. The various particle types and energy ranges are measured in several time-multiplexed modes of operation that are command-selectable. Electrons with energy between 50 keV and 5 MeV are analyzed as are protons with energy between 5 and 200 MeV.

SATELLITE ELECTRON AND ION BEAM SYSTEM SC4

The satellite electron beam system is to be used for the ejection of electrons from the P78-2 spacecraft. Instrument ground is connected by a low impedance path to the spacecraft ground, and thus ejection of electrons

from the electron gun will drive the potential of the spacecraft positive with respect to the ambient plasma. The payload will be used (1) to determine the electron current required to prevent charging of the spacecraft ground caused by in situ electrons and (2) to swing the vehicle to a positive potential relative to the ambient plasma.

The positive Ion Beam System payload is to be used on the P78-2 spacecraft for the ejection of charged particles: positive ions, electrons, or beams containing both positive ions and electrons. The payload is electrically connected to the P78-2 spacecraft ground through a low impedance path so that the ejection of charge will play a large role in determining the potential difference between spacecraft ground and the ambient plasma. The ion source is a Xenon discharge chamber. This instrument can be used to adjust the potential of the spacecraft with respect to the ambient plasma. The potential can be either negative or positive depending on how much electron neutralizer current is used.

RAPID SCAN PARTICLE DETECTOR SC5

This detector will measure the flux of electrons and ions incident to the spacecraft both perpendicular and parallel to the spin axis of the spacecraft. The number density, temperature, and bulk flow of the plasma and the relationship of these quantities to the occurrence of spacecraft charging will be determined. The instrument also monitors operation of the Electron and Ion Beam System.

The instrument consists of two sets of spectrometers mounted perpendicular and parallel to the spin axis of the satellite. Each set of spectrometers consists of eight sensors; four measure electrons and four measure ions. These sensors measure electron differential flux from 50 eV to 1.1 MeV and ion differential flux from 50 eV to 35 MeV.

THERMAL PLASMA ANALYZER SC6

This instrument is intended to measure the ambient thermal plasma and the electrostatic potential of the satellite with respect to the ambient plasma. The ion density is measured in the range 10^1 to 10^5 per cm^3. The particle temperature is measured from 0.5 eV to 100 eV. The satellite potential is measured in the range of -100 V to +100 V. In addition, the instrument mounted on the satellite body will measure the flux of photoelectrons from the satellite. The Thermal Plasma Analyzer consists of three identical planar particle traps which can be operated as retarding potential analyzers.

LIGHT ION MASS SPECTROMETER SC7

Three spectrometers are designed to measure the density, temperature, and composition of the low-energy ion plasma in the vicinity of the P78-2 spacecraft. In order to understand the complex plasma-satellite interaction, all important charged particle populations must be identified and measured. The cold plasma (E <100 eV) component is important at and near synchronous orbit altitudes and at times can be the dominant component in terms of density, exceeding 100 ions/cm^3.

This payload consists of three sensor heads and one central electronics package. Each sensor head consists of a retarding potential analyzer, ion mass spectrometer, and ion detector. The fluxes of oxygen, helium and hydrogen are measured for energies less than 100 eV.

ENERGETIC ION COMPOSITION EXPERIMENT SC8

This instrument is an energetic ion mass spectrometer containing three parallel analyzer units, each of which measures ions in a different energy region of the range from 0.1 to 32 keV. Each unit consists of a crossed electric and magnetic field velocity filter (Wein filter) in series with an electrostatic analyzer (ESA) and a channel electron multiplier sensor. Elements with mass from 1 to 160 AMU are analyzed with mass resolution of 1 to 20 AMU, respectively.

UCSD CHARGED PARTICLE EXPERIMENT SC9

The experiment measures charged particle fluxes as a function of energy, direction, and time. The charged particles that will be measured consist of environmental electrons and ions and also particles emitted from the spacecraft, such as photoelectrons, secondary electrons, and particles emitted by the Electron/Ion Beam System.

The experiment has five electrostatic charged particle detectors. Two detectors (one for negative and one for positive particles) are contained in each rotating detector assembly. Each rotating detector assembly can be rotated through a maximum of 220 deg. One rotating detector assembly rotates so that its detectors look in a plane tangent to the cylindrical side of the spacecraft. It is capable of measuring particles with energy from a few eV to 81 keV. The other rotating detector assembly looks in a plane that cuts across the forward face of the spacecraft, and is capable of measuring particles with energy from 0.2 eV to 1550 eV.

ELECTRIC FIELD DETECTOR SC10

This instrument is a double floating ensemble that will measure DC electric fields in the ambient plasma and also spacecraft charging events. The antenna is a dipole which is 100 M tip to tip. Both differential and common mode measurements can be made. The signal strength from DC to 200 Hz can be analyzed.

MAGNETIC FIELD MONITOR SC11

The instrument is a triaxial fluxgate magnetometer. Each axis has a range of approximately ±500 γ. The resolution of the magnetic field measurement is 0.3 γ. The spin axis component is analyzed through a spectrometer with a sensitivity of ~20 mγ for frequencies between 5 and 100 Hz.

SPACECRAFT CONTAMINATION ML12

This experiment is designed to determine if spacecraft charging contributes significantly to the rate of contamination arriving at exterior spacecraft surfaces. The contamination transport mode under investigation involves the ionization of molecules outgassed or released by the vehicle within the vehicle plasma sheath and their subsequent electrostatic attraction to the vehicle. One sensor is a combined retarding potential analyzer and temperature controlled quartz crystal microbalance. With it, distinction can be made between charged and uncharged arriving molecules. Information concerning the temperature dependence of contamination adsorption and desorption rates can be obtained. Another sensor, thermal control coating trays, exposes samples of different spacecraft surface materials to arriving contamination and continuously measures the temperature and hence solar absorptance of these materials.

TABLE I. PRINCIPAL INVESTIGATORS/SPONSORS

Experiment Number	Title	Principal Investigator/ Sponsor	Address
SC1	Engineering Experiments	Dr. H. C. Koons/ USAF/AFSC/SAMSO	The Aerospace Corporation P.O. Box 92957 Los Angeles, CA 90009
SC2	Spacecraft Sheath Electric Fields	Dr. J. F. Fennell/ USAF/AFSC/SAMSO	The Aerospace Corporation P.O. Box 92957 Los Angeles, CA 90009
SC3	High Energy Particle Spectrometer	Dr. J. B. Reagan Office of Naval Research	Lockheed Palo Alto Research Lab, 3251 Hanover Street Palo Alto, CA 94304
SC4	Satellite Electron and Positive Ion Beam System	Dr. H. A. Cohen/ USAF/AFSC/AFGL	Hanscom AFB/LKB Bedford, MA 01731
SC5	Rapid Scan Particle Detector	Lt. D. Hardy/ USAF/AFSC/AFGL	Hanscom AFB/PHE Bedford, MA 01731
SC6	Thermal Plasma Analyzer	Dr. R. C. Sagalyn/ USAF/AFSC/AFGL	Hanscom AFB/PHR Bedford, MA 01731
SC7	Light Ion Mass Spectrometer	Dr. D. L. Reasoner/ Office of Naval Research	NASA Marshall Space Flight Center, Code BS-23 Huntsville, AL 35815
SC8	Energetic Ion Composition Experiment	Dr. R. G. Johnson/ Office of Naval Research	Lockheed Palo Alto Research Lab, 3251 Hanover Street Palo Alto, CA 94304
SC9	UCSD Charged Particle Experiment	Dr. S. E. Deforest/ Office of Naval Research/USAF/AFSC/ SAMSO	University of California B019 Dept. of Physics La Jolla, CA 92093
SC10	Electric Field Detector	Dr. T. L. Aggson/ Office of Naval Research	NASA Goddard Space Flight Center, Code 625 Greenbelt, MD 20771
SC11	Magnetic Field Monitor	Dr. B. G. Ledley/ Office of Naval Research	NASA Goddard Space Flight Center, Code 625 Greenbelt, MD 20771
ML12	Spacecraft Contamination	Dr. D. F. Hall/ USAF/AFSC/AFML	The Aerospace Corporation P.O. Box 92957 Los Angeles, CA 90009