ENVIRONMENTAL ASSESSMENT FOR ADVANCED COMPOSITION EXPLORER (ACE) MISSION

May 1997

Prepared for and in cooperation with:

National Aeronautics and Space Administration
Explorers Project Office
Goddard Space Flight Center
Greenbelt, Maryland 20771

Environmental Assessment
for
Advanced Composition Explorer (ACE) Mission

Lead Agency:	National Aeronautics and Space Administration Goddard Space Flight Center Greenbelt, Maryland 20771
Proposed Action:	The development, integration, test, and launch from Cape Canaveral Air Station (CCAS) of the ACE spacecraft. The spacecraft will be used to study the origin and subsequent evolution of both the solar system and galactic material to answer a wide range of fundamental questions in space physics.
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Date:	May 1997

EXECUTIVE SUMMARY

This environmental assessment addresses the environmental impacts associated with the Advanced Composition Explorer (ACE) mission. The ACE mission consists of the development, integration, test and launch of the ACE spacecraft and science payload. The ACE spacecraft with nine science instruments will be launched on a Delta II 7920 launch vehicle from Cape Canaveral Air Station, Florida.

The ACE mission and No-Action Alternative were considered in this environmental assessment. The No-Action Alternative will not fulfill the need for more accurate data to better the understanding of the formation and origin of the solar system.

The environmental consequences of all aspects of the ACE mission, the development, integration, test and launch were considered. All of the activities involved in the development, integration and test of the spacecraft are within the normal scope and level of activities conducted at the various sites involved. These activities will produce no substantial adverse impacts on the existing environment at these sites.

The portion of the ACE mission which could potentially affect the environment is the launch of the ACE spacecraft on the Delta II. The National Environmental Policy Act (NEPA) process has previously been completed for the Delta II launch vehicle. Numerous environmental assessments have been prepared. These environmental assessments thoroughly addressed the existing environment at Cape Canaveral Air Station and the environmental impacts associated with the launch of the Delta II launch vehicle. These assessments evaluated consequences to air, water, threatened and endangered species, land resources, socioeconomics, noise, biotic resources, and potential launch accidents. Findings of No Significant Impacts were issued based on these environmental assessments.

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ABBREVIATIONS AND ACRONYMS

ACE	Advanced Composition Explorer
AMOC	ACE Mission Operations Center
CCAS	Cape Canaveral Air Station
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CIT	California Institute of Technology
CRIS	Cosmic Ray Isotope Spectrometer
DSN	Deep Space Network
EA	Environmental Assessment
EED	Electro-Explosive Device
ELV	Expendable Launch Vehicle
EPAM	Electron, Proton, and Alpha Monitor
GEMs	Graphite-Epoxy Motors
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HTPB	Hydroxyl-Terminated PolyButediene
JPL	Jet Propulsion Laboratory
JHU/APL	Johns Hopkins University/Applied Physics Laboratory
L_1	Earth-Sun Libration Point
LANL	Las Alamos National Laboratory
LC-17	Launch Complex-17
MAC	Maximum Allowable Concentration
MAG	Magnetic Field Monitor
MDA	McDonnell Douglas Aerospace
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
OSHA	Occupational Safety and Health Administration
PAF	Payload Attach Fitting
RP-1	Rocket Propellant 1
RTSW	Real Time Solar Wind
SAEF	Spacecraft Assembly and Encapsulation Facility
S/C	Spacecraft
S^3DPU	Data Processing Unit for SEPICA, SWICS, and SWIMS
SEPICA	Solar Energetic Particle Ionic Charge Analyzer
SIS	Solar Isotope Spectrometer
SLAM	Spacecraft Loads and Acoustic Measurement
SRM	Solid Rocket Motor
SRMU	Solid Rocket Motor Upgrades
SWEPAM	Solar Wind Electron, Proton, and Alpha Monitor
SWICS	Solar Wind Ion Composition Spectrometer
SWIMS	Solar Wind Ion Mass Spectrometer
TUB	Technical University of Braunsweig
ULEIS	Ultra Low Energy Isotope Spectrometer

1.0 PURPOSE AND NEED

This Environmental Assessment (EA) addresses the impacts to the environment associated with the implementation of the Advanced Composition Explorer (ACE) mission. The mission includes the development, integration, test, and launch of the ACE spacecraft. This EA was prepared in accordance with National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C.4321 et seq.), the Council of Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500 - 1508), NASA's NEPA regulations (14 CFR Part 1216.1 and Subpart 1216.3) and NASA's implementing procedures (NASA Handbook 8800.11).

Science has barely touched the surface in understanding the formation and evolution of the solar system, or in the understanding of the composition of matter itself. To better this understanding more and more data is needed. With new and more accurate information, obtained from Earth-based and spacecraft instruments, scientists can test current theories, uphold them, upset them, and replace them with new theories. (Reference 5)

The first step in understanding the origin of the matter in our bodies, in the earth and in the universe is to measure exactly what it is they are made of. The composition of the human body, which is a special sample of the material that originally made up the earth and solar system, can be easily measured. But, because the earth has been changed and rearranged during the billions of years since its creation measuring its complete composition is difficult. (Reference 5)

Meteorites are closer to the original makeup of the solar system, but like the earth, they are missing most of the light elements, such as hydrogen and helium. The sun has combined some of its lighter elements into heavier ones, but still retains much information about the makeup of the gas cloud that originally formed the solar system. By studying the light, energy, and types of particles coming from the sun, we can learn about both the source and evolution of this material. (Reference 5)

2.0 DESCRIPTION OF PROPOSED ACTION & ALTERNATIVES

This section provides a description of the proposed action, the ACE mission, along with a discussion of the No-Action Alternative.

2.1 Proposed Action

ACE will provide an abundance of information which will contribute to our understanding of the formation and evolution of the solar system, as well as the astrophysical processes involved. The earth is constantly bombarded with a stream of accelerated particles arriving not only from the sun, but also from interstellar and galactic sources. ACE will measure the energy and composition of these particles. ACE will sample low-energy particles of solar origin and high-energy galactic particles. (Reference 5)

The observations will span an energy range from solar wind energies to galactic cosmic ray energies and elements from hydrogen to zinc, during solar active and solar quiet periods. ACE will conduct the first direct sampling and examination of solar material. Due to the vast increase in ability to collect and more accurately label particles ACE will provide more precise and accurate information of particles. With this increased level of accuracy, the data can be compared to past and current studies to provide a much clearer picture. (Reference 5)

ACE will also provide near-real-time reporting of "space weather". ACE will be able to provide up to an hour's advance warning of geomagnetic storms that can overload power grids, disrupt communications on Earth, and present a hazard to astronauts.

The ACE project is one of four missions chosen as part of the Explorer Concept Study Program. Overall ACE mission management is the responsibility of NASA's Goddard Space Flight Center (GSFC) Explorers Project Office. While management of science payload and the ACE Science Center is the responsibility of the California Institute of Technology (CIT). The spacecraft itself is being developed, integrated and tested by the Johns Hopkins University Applied Physics Laboratory (JHU/APL). JHU/APL is also responsible for the development of two of the payload instruments and launch support operations. The other seven instruments are being developed by numerous organizations and laboratories. They include: Los Alamos National Laboratory (LANL), Washington University, University of Maryland, University of New Hampshire, Max Planck Institute, University of Bern, University of Delaware, CIT, JHU/APL, and GSFC. GSFC is also responsible for developing and managing the ground system operation center and for providing facilities and support for testing of the observatory and instruments. McDonnell Douglas Aerospace (MDA) is providing the launch vehicle. (Reference 8)

Mission Description

The ACE mission involves placing a spacecraft into a modified halo orbit around the (L_1) libration point, a point of Earth-Sun gravitational equilibrium about 1.5 million kilometers from Earth and 148.5 million kilometers from the Sun. Figure 1 shows the ACE spacecraft in orbit around L_1. ACE located at the Earth-Sun libration point will carry out in situ measurements of particles originating from the solar corona, the interplanetary medium, the local interstellar medium, and galactic matter. (Reference 8)

The ACE spacecraft will be launched in August 1997 on a Delta II 7920, Expendable Launch Vehicle (ELV) from the Cape Canaveral Air Station (CCAS). The ELV and the spacecraft propulsion system will deliver ACE to the orbit around L_1. The Delta with the spacecraft attached will be launched into a 185 km nearly circular parking orbit. When the spacecraft and second stage combination reaches a point in the parking orbit near local midnight the second stage will be reignited to put the combination on a transfer trajectory that will arch around the earth and place ACE on a path moving in a nearly straight line toward the sun. Once the transfer trajectory has been established the Delta II will spin the spacecraft to a rate of 5 rpm and initiate separation of the spacecraft from the launch vehicle. Following separation, the solar panels and magnetometer booms will be deployed and all spacecraft elements that were off during launch will be turned on and checked over a period of approximately 30 days. Once the spacecraft is found to be functioning properly, with all subsystems working normally, the activation of the instruments will begin. (Reference 8)

The observatory's transit along the transfer trajectory will take several months (4 to 5). Once ACE is delivered to the Sun-Earth libration point (L_1) the spacecraft propulsion system will place ACE in a modified halo orbit around L_1. At this location ACE will observe energetic particles within the solar system. Figure 2 shows the ACE transfer and the halo orbit. ACE has a mission life at L_1 of 2 years with a goal of 5 years. (Reference 8)

Due to the inherent instability of libration point halo/lissajous orbits, the ACE orbit at L_1 cannot be maintained without regular stationkeeping maneuvers which correct orbital energy. Thus, at the end of the ACE mission life, left uncontrolled, the ACE spacecraft can do one of two things. If the orbit has too much energy the spacecraft will escape into a heliocentric orbit of similar size and period of the Earth's. If the orbit has too little energy the spacecraft will eventually accelerate back toward the Earth and be captured into a highly elliptical geocentric orbit. In either case, chances of collision with the Earth-Moon system are remote. (Reference 10)

Mission Science Objectives

The prime objective of ACE is to determine and compare the elemental and isotopic composition of several distinct samples of matter, including the solar corona, the interplanetary medium, the local interstellar medium, and galactic matter. The

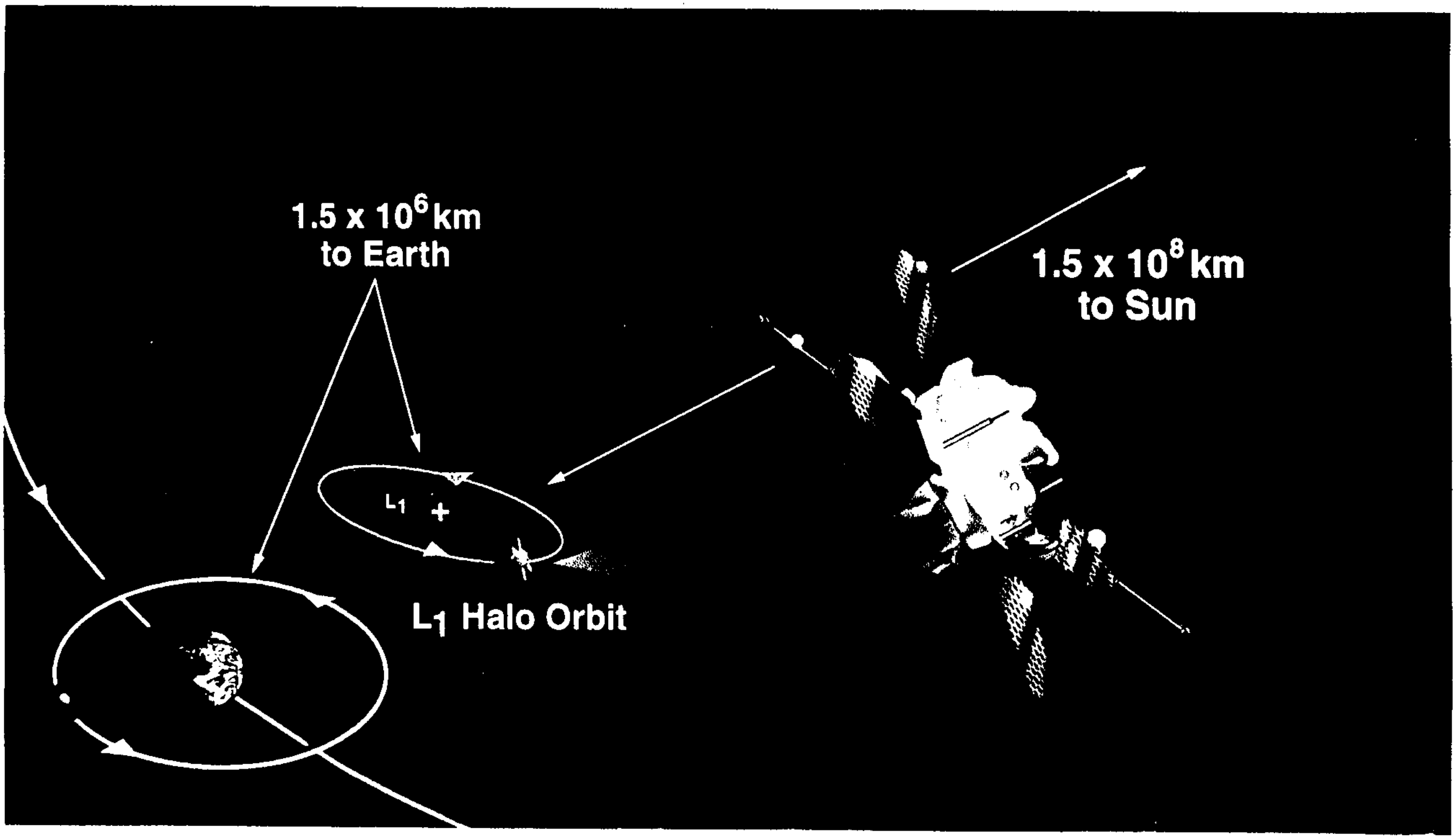


FIGURE 1 ACE IN ORBIT AROUND L1

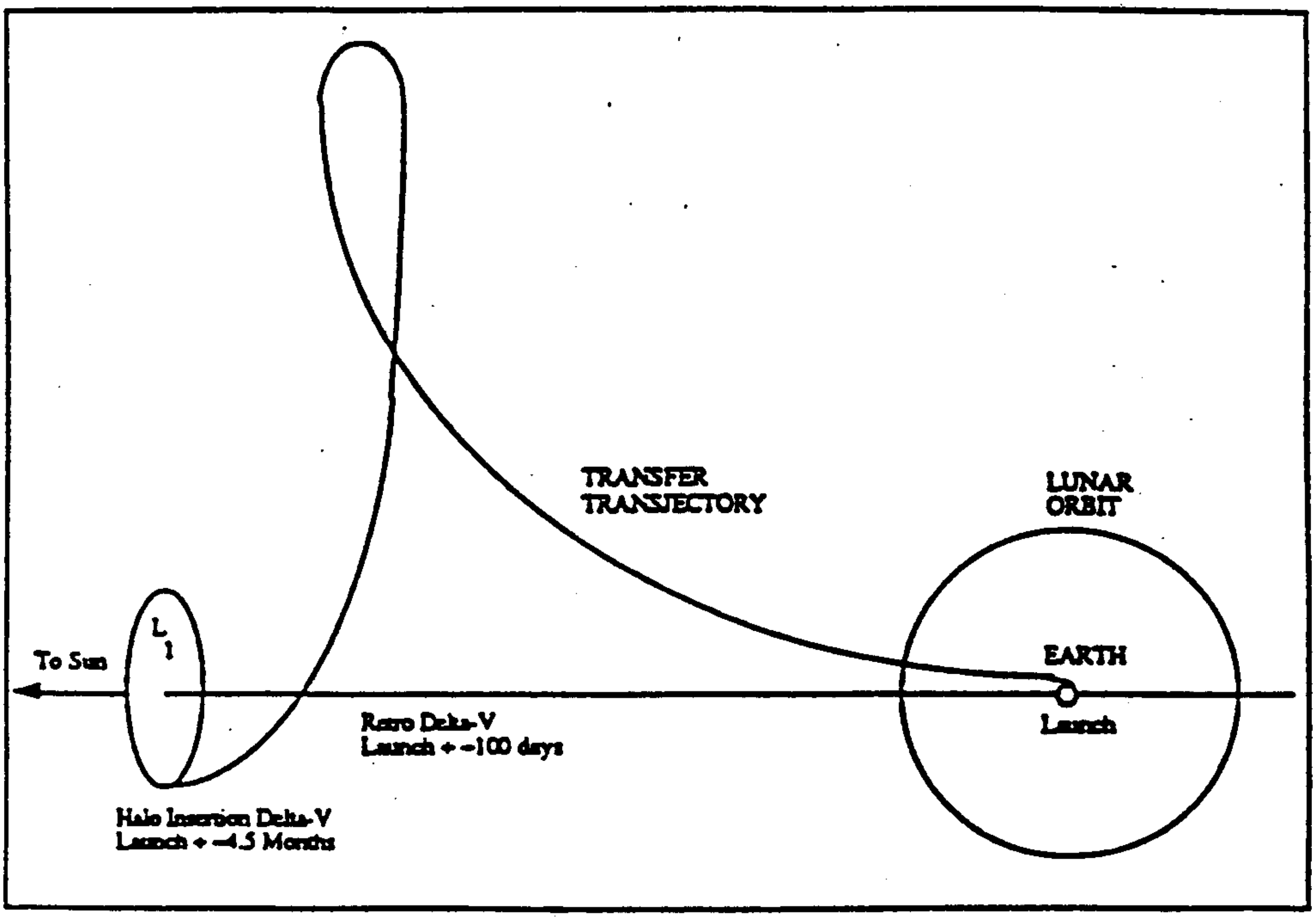


FIGURE 2 ACE TRANSFER TRAJECTORY AND HALO ORBIT

comparison of these samples of matter will be used to study the origin and subsequent evolution of both solar system and galactic material by isolating the effect of fundamental processes that include nucleosynthesis, charges and neutral-particle separation, bulk plasma acceleration and the acceleration of supra-thermal and high energy particles. The objective will be approached by performing comprehensive and coordinated determinations of the elemental and isotopic composition of energetic nuclei accelerated on the Sun, in interplanetary space and from galactic sources. Based on these observations the following will be investigated. (Reference 8)

- The Elemental and Isotopic Composition of Matter
- Origin of the Elements and Subsequent Evolutionary Processing
- Formation of the Solar Corona and Acceleration of the Solar Wind
- Particle Acceleration and Transport in Nature

Science Payload

To accomplish the science objectives nine instruments, which make-up the science payload, will be used to perform the comprehensive and coordinated in situ measurements. (Reference 9)

The nine instruments are:
Solar Isotope Spectrometer (SIS)
Cosmic Ray Isotope Spectrometer (CRIS)
Ultra Low Energy Isotope Spectrometer (ULEIS)
Solar Energetic Particle Ionic Charge Analyzer (SEPICA)
Solar Wind Electron, Proton, and Alpha Monitor (SWEPAM)
Solar Wind Ion Composition Spectrometer (SWICS)
Solar Wind Ion Mass Spectrometer (SWIMS)
Electron, Proton, and Alpha Monitor (EPAM)
Magnetic Field Monitor (MAG)

Solar Isotope Spectrometer (SIS)

SIS will be provided by CIT and GSFC. SIS will measure isotopic composition of solar energetic particles, anomalous cosmic rays, and galactic cosmic rays from He to Zn. The instrument will operate in largest solar flares using a set of silicon detectors stacked into two identical telescopes. (Reference 9)

Cosmic Ray Isotope Spectrometer (CRIS)

CRIS will be provided by CIT, Jet Propulsion Laboratory (JPL), Washington University, and GSFC. CRIS will measure galactic cosmic ray isotopic composition from Li to Zn using a set of silicon detectors stacked into a telescope. (Reference 9)

Ultra Low Energy Isotope Spectrometer (ULEIS)

ULEIS will be provided by the University of Maryland and JHU/APL. ULEIS will measure isotopic abundance with high mass resolution over a large energy range using a time-of-flight telescope, an analog electronics box, an IRIS motor and controller, and a data processing unit. ULEIS contains ionizing radiation sources for calibration of the instrument in flight. (Reference 9)

Solar Energetic Particle Ionic Charge Analyzer (SEPICA)

SEPICA will be provided by the University of New Hampshire and Max Planck Institute. SEPICA will measure the ionic charge states of solar energetic particles, particles accelerated in interplanetary space, and anomalous component of cosmic rays during solar flare. The system consists of a multi-slit collimator, 30 kV deflection plates, proportional counter, solid state detectors, and anticoincidence crystals. An isobutane gas regulating system, with 1.8 liters of isobutane is used. The isobutane is contained in a pressure vessel within the SEPICA instrument. Under nominal conditions isobutane will not be released during ground operations. SEPICA contains ionizing radiation sources used as calibration references for the gas regulation system. (Reference 9)

Solar Wind Electron, Proton, and Alpha Monitor (SWEPAM)

SWEPAM will be provided by Los Alamos National Laboratory. SWEPAM consists of two separate instruments (SWEPAM I and E) which will measure electron and ion fluxes in the low energy solar wind range. SWEPAM consists of two curved plate electrostatic analyzers (one ion and one electron). (Reference 9)

Solar Wind Ion Composition Spectrometer (SWICS)

SWICS will be provided by the University of Maryland. SWICS will measure the elemental and ionic charge composition, the temperature, and the mean speeds of all major solar winds from H through Fe. It consists of an electrostatic deflection analyzer, multi-slit collimator, 30 kV potential and solid state detectors measuring residual energy of the ions. (Reference 9)

Solar Wind Ion Mass Spectrometer (SWIMS)

SWIMS will be provided by the University of Maryland and the University of Bern. SWIMS will measure the abundance of most of the elements and a wide range of isotopes in the solar wind. It consists of a deflector system followed by a time-of-flight telescope. (Reference 9)

Electron, Proton, and Alpha Monitor (EPAM)

EPAM will be provided by JHU/APL. EPAM will measure solar and interplanetary particle fluxes. EPAM consists of 5 apertures in two telescopes. EPAM contains ionizing radiation sources for calibration of the instrument in flight. (Reference 9)

Magnetic Field Monitor (MAG)

MAG will be provided by GSFC and the University of Delaware. It will measure magnetic field strength and direction in 3 axes. MAG consists of two triaxial fluxgate magnetometers. (Reference 9)

In addition to the 9 primary instruments, two secondary payloads and a data processing unit will be on the spacecraft .

Spacecraft Loads and Acoustic Measurement (SLAM)

SLAM will be provided by GSFC. It is a self-contained autonomous environment measurement package which will measure the spacecraft response to the ELV environment during flight, using accelerometers and microphones. It will only operate during the first 5 minutes of powered flight (until the Delta II fairing separates). (Reference 9)

Real Time Solar Wind (RTSW) Monitor

RTSW Monitor will be provided by National Oceanic and Atmospheric Administration (NOAA) and developed by APL. Geomagnetic storms (magnetic storms on Earth) are a natural hazard which NOAA forecasts for the benefit of the public, as it does for hurricanes. The RTSW system on ACE will function as a "space weather station". The location of ACE at L_1 enables ACE to provide one-hour advance warning of impending magnetic storms. The RTSW will utilize a subset of data from four of the ACE instruments (SWEPAM, EPAM, MAG and SIS). For about 21 to 24 hours per day, during the time ACE is not transmitting its full telemetry, ACE will send data to NOAA-operated ground stations. NOAA will process the data at its Space Environment Services. (Reference 9)

Data Processing Unit for SEPICA, SWICS, and SWIMS (S^3DPU)

S^3DPU will be provided by Technical University of Braunsweig (TUB). It will provide collective data processing for three instruments, SEPICA, SWIMS, SWICS. S^3DPU consists of a sensor interface, dedicated hardware for fast data processing, microcomputer based 80C86 microprocessor, and S/C interface (which includes telemetry, command, spin pulses) power. (Reference 9)

Spacecraft Description

The Spacecraft will be provided by JHU/APL. The function of the spacecraft is to: 1) place the instruments in the modified halo orbit about the earth-sun Libration Point L_1, perpendicular to the ecliptic plane (earth-sun line), 2) transmit data acquired by the instruments, and 3) command the instruments from the ground. Figures 3 and 4 show the spacecraft in the launch and deployed configurations, respectively. (Reference 9)

The spacecraft is a spin stabilized observatory which incorporates six spacecraft subsystems and the nine science instruments to perform its mission. The six subsystems

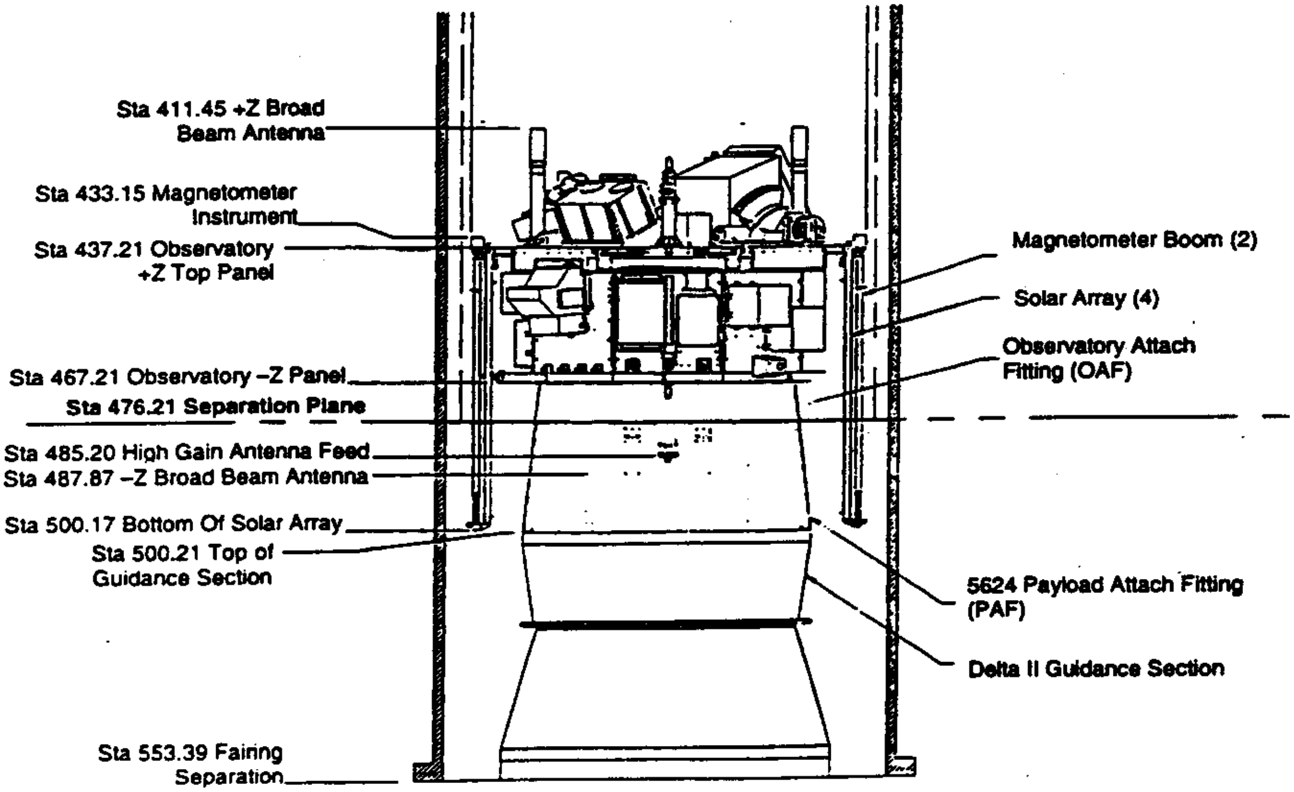
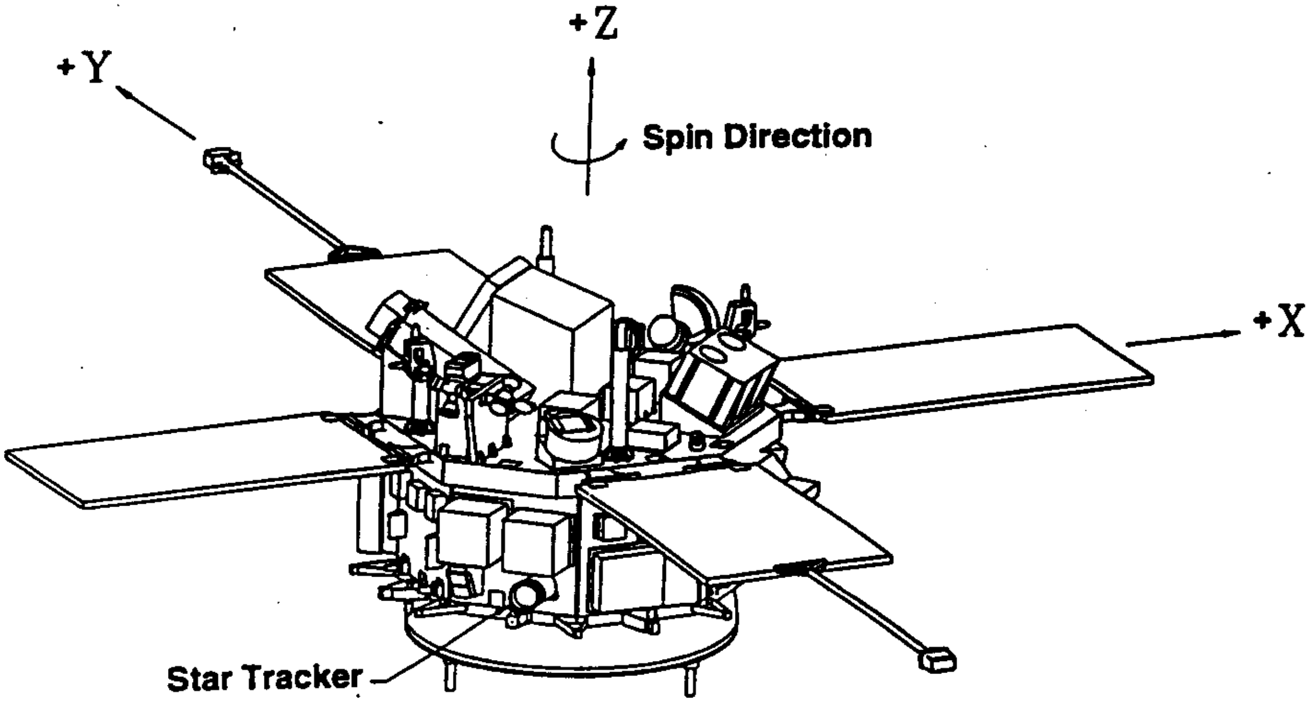


FIGURE 3 ACE SPACECRAFT LAUNCH CONFIGURATION



ACE OBSERVATORY

FIGURE 4 ACE SPACECRAFT DEPLOYED CONFIGURATION are: Propulsion, RF/Communications, Thermal, Command & Data Handling, Attitude Determination, and Power. The spacecraft structure is the main load carrying structure that supports the instrument and spacecraft hardware. The primary structure is comprised of an upper deck and a lower deck, and 8 rectangular side decks which are all supported by a frame. The spacecraft in its launch configuration is about 89 inches high with a diameter of about 83 inches. The spacecraft weighs approximately 1680 pounds. The 4 solar panels (34 inches by 59 inches) and magnetometer booms deploy via pyrotechnic devices in orbit. The solar arrays are scheduled to deploy autonomously approximately 69 minutes after launch, while the magnetometers will be deployed about 2 hours after launch. (Reference 9)

The Command and Data Handling System controls all data handling, ordnance firing, thruster firing, and power switching via a RTX 2010 processor. Power is initially supplied by a NiCd battery. The battery will be used for solar array panel deployment and to support loads from launch until solar array panel deployment. After deployment the 4 solar panels will supply power. Attitude is determined by a star scanner and digital solar attitude detectors and controlled by ground command with thruster firing. (Reference 9)

The ACE spacecraft will carry 25 electro-explosive devices (EED) all of which are classified as Category B (Class C) when installed. These devices will be used to open the instrument doors and windows and deploy the magnetometer booms and solar arrays. (Reference 9)

The spacecraft is equipped with one high gain antenna and 4 broad beam antennas. The propulsion system uses 430 pounds of monopropellant hydrazine. It is contained within 4 propellant tanks. The spacecraft has adequate fuel and power for the 5 year mission goal (2 year minimum). (Reference 9)

Launch Vehicle

The ACE spacecraft will be launched on a Delta II 7920-8 shown in Figure 5. The Delta II 7920 is a two stage expendable launch vehicle which consists of the first stage with its thrust augmentation solid rocket motors, the second stage, and the payload fairing (8 foot-diameter). (References 1, 3, 4, and 7)

The first stage consists of the engine section, oxidizer tank, (liquid oxygen (LO_2)), centerbody, and fuel tank. The first stage is powered by a liquid bipropellant main engine and two vernier engines. The engine section houses the Rocketdyne RS-27A main engine and two Rocketdyne vernier engines which provide roll and attitude control. The engines are fueled with Rocket Propellant 1 (RP-1) and liquid oxygen as an oxidizer. RP-1 is rocket grade kerosene. The fuel tank which holds approximately 66,500 pounds of RP-1 and the oxidizer tank which holds approximately 146,000 pounds of LO_2 are constructed of aluminum. (References 1, 3, 4, and 7)

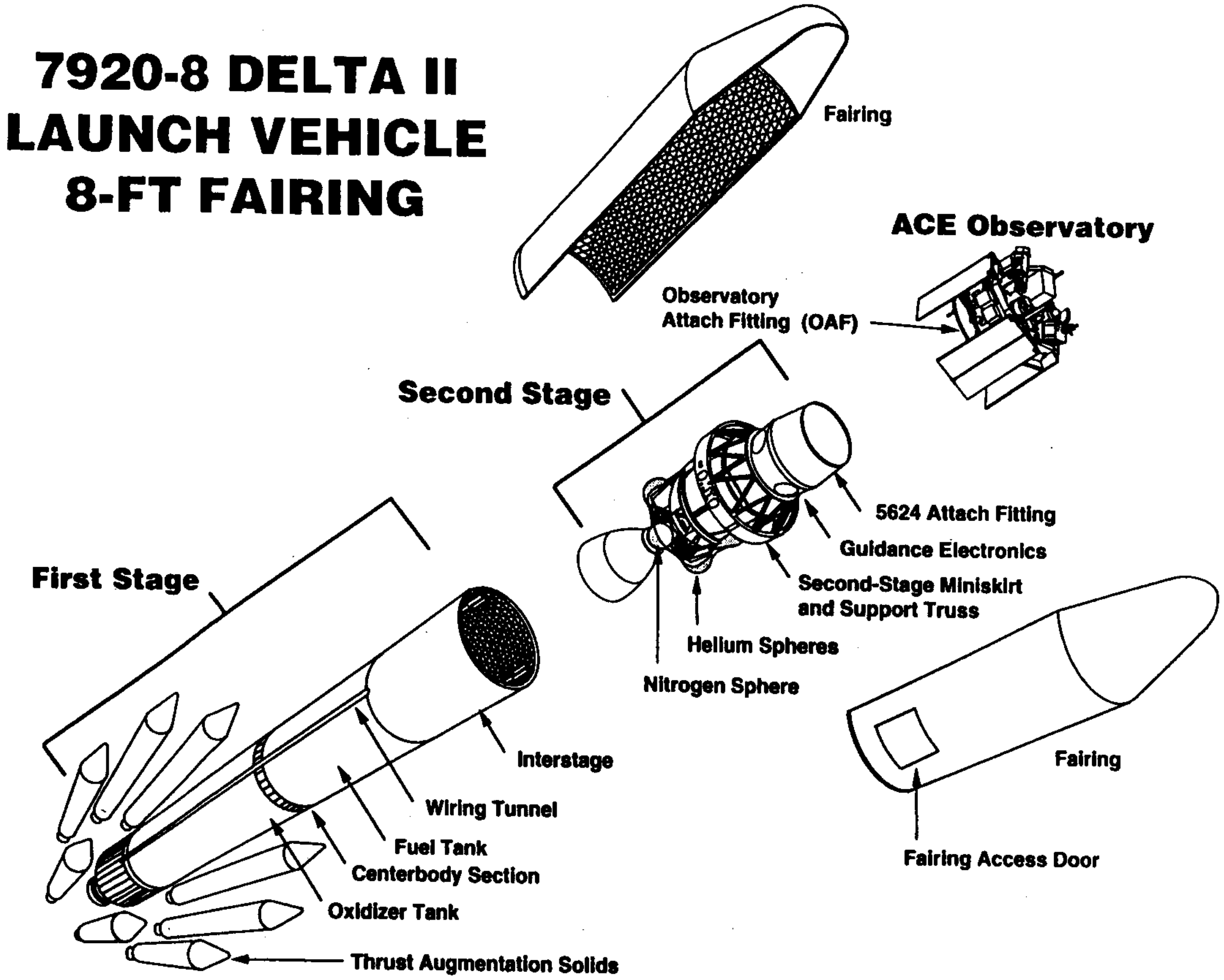


FIGURE 5 DELTA II 7920-8 LAUNCH VEHICLE

The standard vehicle configuration includes nine Alliant graphite-epoxy motors (GEMS) to augment the first-stage performance (thrust). Each GEM is fueled with 25,937 pounds of Hydroxyl-Terminated PolyButediene (HTPB) solid propellant. This fuel is composed of 71% ammonium perchlorate, 18 % aluminum powder and 11 % HTPB. The centerbody section which is between the fuel tank and LO_2 tank houses the first stage electronic components. (References 1, 3, 4, and 7)

The interstage which is located between the first stage and the second stage miniskirt carries the loads from the second stage and fairing to the first stage. It houses the second stage and contains range safety antennas, an exhaust vent for the fairing cavity, and six guided spring actuators to separate the second stage from the first stage. The interstage remains with the first stage after second stage separation. (References 1, 3, 4, and 7)

The second stage is powered by an Aerojet AJ10-118K engine that uses Aerozine 50 as fuel and nitrogen tetroxide as an oxidizer. The fuel tank which holds approximately 4,600 pounds of Aerozine fuel and the oxidizer tank which hold approximately 8,700 pounds of nitrogen tetroxide are separated by a common bulkhead. Aerozine 50 is composed of 50 % by weight unsymmetrical dimethylhydrazine and 50 % hydrazine. The guidance system is contained in the forward section of the second stage. The second stage also contains five silver-zinc alkaline batteries, three titanium spheres with pressurized helium, and one titanium sphere with pressurized nitrogen. (References 1, 3, 4, and 7)

The spacecraft is mated to the launch vehicle using a payload attach fitting (PAF) which meets the payload needs. The payload separation systems are incorporated into the PAF. The payload fairing is an aluminum structure which protects the spacecraft during flight. It is 8 feet in diameter and attached to the launch vehicle at the base of the second stage miniskirt. (References 1, 3, 4, and 7)

Prelaunch Activities

Prelaunch activities include integration, testing and fueling of the payload and launch vehicle. ACE prelaunch operations will be conducted at two major sites. The sites are Spacecraft Assembly and Encapsulation Facility Number 2 (SAEF-2) at Kennedy Space Center and the Launch Complex 17 (LC-17) located at CCAS. The spacecraft will be processed at the SAEF-2 and the launch operations will be conducted at LC-17A (Reference 6)

The spacecraft will be delivered to SAEF-2 for processing and checkout. Following successful completion of all major electrical and mechanical tasks the ordnance will be connected, the flight battery will be installed, and the hydrazine propellant will be loaded. Fueling will be performed using the propulsion fueling ground support equipment (GSE) system. This system is designed to fuel the spacecraft with a premeasured amount of fuel and does not require the handling of open drums of hydrazine. The module is self-contained in an aluminum enclosure. A vacuum tank will be used to collect residual hydrazine. When fueling is complete the GSE will be disconnected and transported back to the vendor for decontamination. (Reference 6)

Following the fueling operation the spacecraft will be weighed and spin balanced. The solar panels will be installed and the spacecraft will then be canned for transport to the pad. MDA will transport the spacecraft to the LC-17 complex. Here the spacecraft will be mated to the Delta vehicle second stage. Installation of vehicle ordnance and the fairing, and loading of first stage and second stage propellants will occur at the pad prior to launch. Abbreviated versions of ACE functional tests will be performed along with integrated tests. (Reference 6)

More detail and information concerning launch vehicle operations can be found in References 1, 2, and 7.

Launch

The ACE Spacecraft will be launched from LC-17A at Cape Canaveral Air Station (CCAS). Figure 6 shows the ACE/Delta II 7920 launch profile. At liftoff the first stage and six of the nine solid rocket motors (SRMs) or GEMS are ignited. The remaining three GEMS are ignited after burnout of the first six. The six spent GEM cases are then jettisoned. After burnout of the last three GEMS they are jettisoned. The main engine continues to burn until main engine cutoff. Following main engine cutoff, the first and second stage separate and the second stage is ignited. Separation of the payload fairing occurs early in the second stage flight. The first stage, the solid rocket motors (both burned to depletion) and the payload fairing fall into the ocean. The second stage will burn for approximately 180 seconds and then cut off. The second stage is restarted later for an additional burn until another second stage cutoff. Payload separation follows. After payload separation, the second stage is restarted to deplete the remaining propellants, a depletion burn, and/or to move the second stage to a safe distance away from the spacecraft, an evasive burn. The second stage will remain in orbit until the orbit eventually decays, with reentry normally occurring within 2 to 3 months. (References 1, 4, and 7)

Mission Operations

ACE mission operations consist of flight operations and science operations. The focal point for all ACE mission operations during the transfer and on-orbit phases will be the ACE Missions Operations Center (AMOC) at GSFC. The spacecraft will be controlled via commands and telemetry through the Deep Space Network (DSN) from this location. All commanding, processing, and displaying of downlink data for interactive control and in-depth spacecraft analysis will be accomplished in the AMOC facility. (Reference 8)

Daily stored data dumps and real-time data will be collected by the DSN, transmitted to GSFC and delivered to the ACE Science Center at CIT. Here the data will processed to higher levels, analyzed, archived and distributed to the co-investigators and the scientific

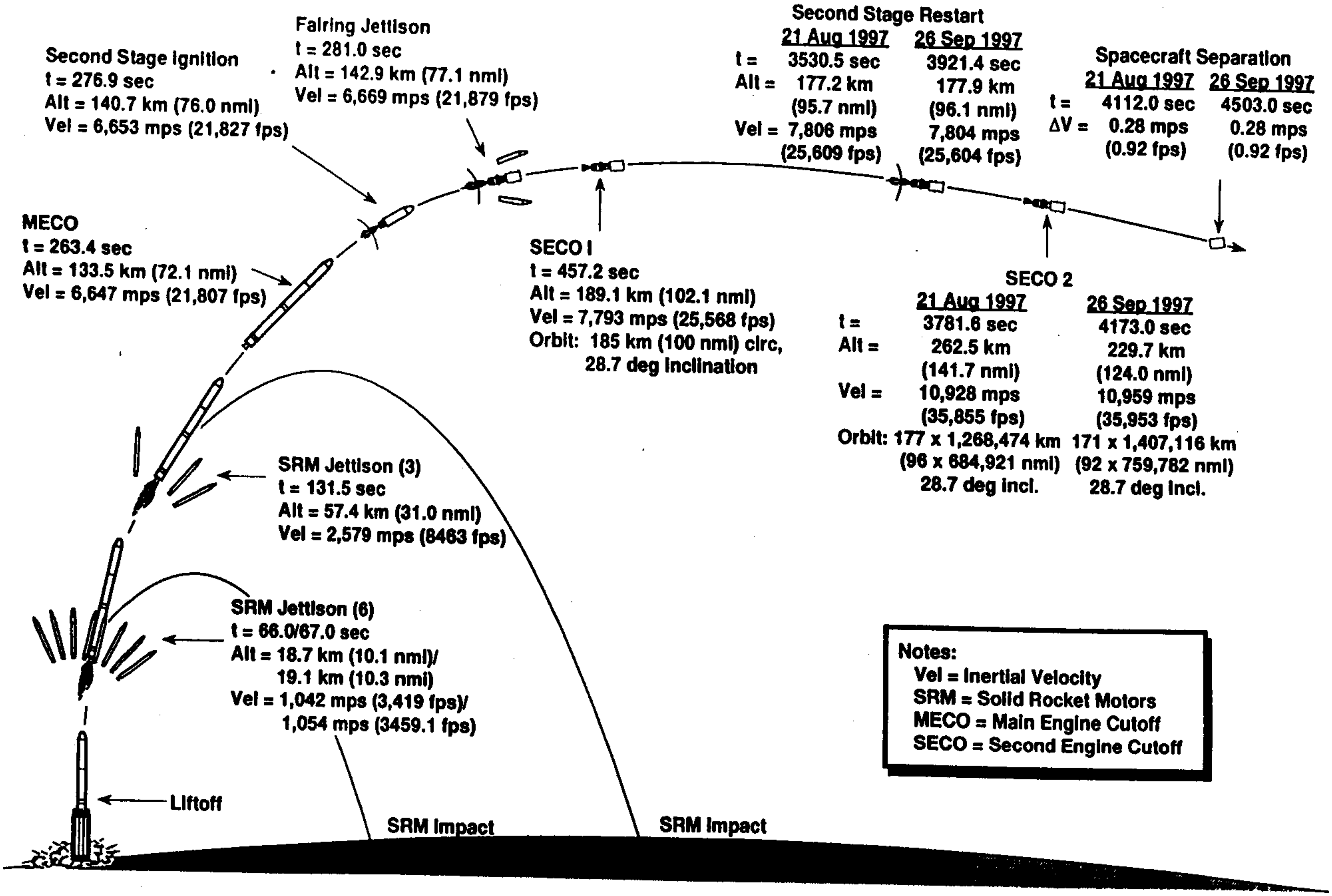


FIGURE 6 ACE LAUNCH PROFILE

community. The real-time housekeeping and ACE science data will be transmitted nominally once per 24 hours to GSFC. The RTSW data will be transmitted 21 to 24 hours per day to NOAA operated ground stations. (Reference 8)

2.2 Alternatives to the Proposed Action

The alternatives considered in this environmental assessment were the proposed action and the No-Action Alternative.

Under the No-Action Alternative there would be no ACE mission. Any potential environmental affects from the ACE mission at the CCAS launch site would be eliminated. But, the No-Action Alternative would hinder scientific progress in our understanding of the formation and evolution of the solar system as well as the astrophysical processes involved. The precision of and abundance of data which would be provided by the ACE mission is needed to better this understanding.

3.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The purpose of this section is to provide information on the existing resources of the environment which may be affected by the proposed action.

The design, fabrication, assembly and testing of the spacecraft and instruments will be performed at various locations including JHU/APL, CIT and GSFC. All of the activities involved in these processes are within the normal scope and level of activities conducted at the sites. They will not produce any substantial adverse impacts on the existing environment at these sites. The activities will be conducted in existing buildings and will not produce any significant increases in air, water, noise pollution or hazardous waste generation.

The portion of the ACE mission which could potentially affect the environment is the launch of the ACE spacecraft on the Delta II. The launch of the ACE spacecraft will take place at CCAS in Florida. The existing environment of CCAS has been thoroughly characterized and documented in several environmental assessments (Reference 1, 2 and 7) for launches of the Delta II and thus will not be reiterated here.

4.0 ENVIRONMENTAL CONSEQUENCES OF PROPOSED ACTION

The only expected environmental affects of the proposed action are associated with the launch, thus the discussion here is limited to the environmental impacts associated with the launch of the ACE spacecraft on the Delta II.

The NEPA process has previously been completed for launches of the Delta II from CCAS. These EA's thoroughly address the environmental impacts of the launch activities of the Delta II. Although the EA's referenced were prepared for projects which utilized the 7925 configuration of the Delta II, the EA's addressed, in general, the impacts of the Delta II which includes both the 7925 and 7920 configurations. The 7920 and 7925 configurations are the same except that the 7925 has an additional stage, a third stage solid rocket motor.

The section from the Mars Global Surveyor Environmental Assessment which summarizes the environmental impacts associated with normal launch and launch failure of the Delta II is included here for reference. For more detail and information concerning the environmental impacts refer to the Mars Global Surveyor EA (Reference 7), the NAVSTAR Global Positioning System (Reference 6), and the Medium Launch Vehicle Program EA (Reference 10).

Air Quality

The majority of the emissions will be produced during launch by the GEMs and the first stage. The primary products of combustion of the GEMs are aluminum oxide (Al_2O_3), carbon monoxide (CO), carbon dioxide (CO_2), hydrochloric acid (HCl)), nitrogen oxides (NO_X), and water (H_2O). The primary exhaust products of the first stage are CO, CO_2, and H_2O. (Reference 1 and 7)

In a normal launch, exhaust products from a Delta II are distributed along the launch vehicles' path. The quantities of exhaust are greatest at ground level and decrease continuously as the vehicle gains altitude. The portion of the exhaust plume that persists longer than a few minutes (i.e., the ground cloud) is emitted during the first few seconds of flight and is concentrated near the pad area. The ground cloud resulting from a normal Delta II launch is predicted to have a radius of about 20 meters or 67 feet. (Reference 7)

This cloud will rise and move downwind, dispersing with time. The primary areas of concern associated with the cloud are 1) the effects of the cloud constituents on humans, plant, and animal life and 2) the possibility of producing a localized acid rain from rain showers falling through the ground cloud. The primary constituent of concern in the launch cloud is HCl. (Reference 1 and 7)

Because of the lack of data developed for the Delta II, data from the Titan program is used for comparison. To estimate the peak ground level concentrations of ground cloud pollutants, the US Air Force has extrapolated Delta II exhaust plume diffusion data models developed for the Titan launch vehicle program. These Titan models are used to calculate peak ground level concentrations of various pollutants in ground clouds. Due to the similarity in propellant types, the Delta vehicle ground cloud would be similar in composition to that produced by the Titan. However, the size of the Delta ground cloud should be considerably smaller than that of the Titan because the Delta vehicle and solid rocket GEMs contain significantly less propellant, produce less vapor, and accelerate off the launch pad more quickly than the Titan. (Reference 7)

Hydrogen chloride (HCl) concentrations in the Delta II exhaust plume should not exceed 5 ppm beyond about 4.3 kilometers or 2.7 miles in a downward direction. The nearest uncontrolled area (i.e., general public) is about 4.8 kilometers or 3 miles from LC-17. Appropriate safety measures would be taken to ensure that the permissible exposure limits defined by the Occupational Safety and Health Administration (OSHA) (5 parts per million [ppm] for an 8-hour time-weighted exposure limit) are not exceeded for personnel in the launch area. (Reference 7)

Based upon these comparative studies and the distance to the nearest uncontrolled area, HCl concentrations are not expected to be high enough to be harmful to the general population. Although National Ambient Air Quality Standards (NAAQS) have not been adopted for HCl, the National Academy of Sciences (NAS) has developed recommended limits for short-term exposure to HCl, ranging from 20 ppm for a 60-minute exposure to 100 ppm for a 10-minute exposure. The maximum level of HCl expected to reach uncontrolled areas during preparation and launch of the Delta II would be well below the NAS recommended limits. (Reference 7)

The same predictive modeling techniques used for HCl were also applied to CO and Al_2O_3. For Titan launches, CO concentrations were predicted to be less than 9 ppm except for brief periods during actual lift-off. During launch, gases are exhausted at temperatures ranging from 2,000 to 3,000 °F. Most of the gases immediately rise to an altitude of about 2,000 feet, where they are dispersed by the prevailing winds. Carbon monoxide gas is expected to rapidly oxidize to carbon dioxide (CO_2) in the atmosphere and, therefore, CO concentrations for Titan launches are not expected to exceed the NAAQS of 35 ppm (1-hour average) beyond the immediate vicinity of the launch complex. The nine GEMS used for the Delta launch constitute less than 20 percent of the propellant loading of the two Titan IV-Type 2 Solid Rocket Motor Upgrades (SRMU) and, therefore, the CO concentration for a Delta II launch is predicted to be on the order of 2 ppm (1-hour average). (Reference 7)

Aluminum oxide exists as a crystalline dust in solid rocket motor (SRM) exhaust clouds, but is inert chemically and is not toxic. However, since many of the dust particles are small enough to be retained by lungs, it is appropriate to abide by NAAQS for particulate matter smaller than 10 microns (PM-10). The maximum 24-hour Al_2O_3 concentration beyond the distance of the nearest CCAS property boundary predicted by the model for a Titan IV-Type 2 launch was 25 ug/m^3, which is well below the 24-hour average PM-10 NAAQS for PM-10 of 150 ug/m^3. [USAF 1990] Scaling from the Titan IV predictions, based on the solid propellant mass proportion of the Delta II 7925, the Al_2O_3 peak concentrations should not exceed 5 ug/m^3. The NAAQS for continuous emitters of particulate matter should not be exceeded by a Delta II launch due to the short nature of the launch event. (Reference 7)

Nitrogen oxides (NO_X) may enter the atmosphere through propellant system venting, a procedure used to maintain proper operating pressures. Air emission control devices will be used to mitigate small and infrequent pollutant source. First stage propellants will be carefully loaded using a system with redundant spill-prevention safeguards. Aerozine 50 vapors from second stage fuel loading will be processed to a level below analytical detection by a citric acid scrubber. Likewise, N_2O_4 vapors from second stage oxidizer loading will be passed through a sodium hydroxide (NaOH) scrubber. These scrubber wastes will be disposed of by a certified hazardous waste contractor. (Reference 7)

During the last 20 years there has been an increased concern about human activities that are affecting the upper atmosphere. Space vehicles that use SRMs have been studied concerning potential contribution to stratospheric ozone depletion because of the exhaust products, with the primary depleting component being HCl. Extrapolating from estimates made using the model for the Titan IV SRMUs effects on stratospheric ozone, the net decrease in ozone resulting from launching eight Titan IV-Type 2 (SRMUs) over a twelve-month period is predicted to be on the order of 0.02 percent. [USAF 1990] A Delta II 7925 with nine GEMs is less than 20 percent of the SRMUs propellant loading. Therefore, scaling from the Titan IV-Type 2 prediction , the net stratospheric ozone depletion from nine GEMs, which are planned for use with Delta II, has been predicted to be on the order of 0.0005 percent. History shows that there have been as average of six Delta launches per year for the past eight years. Assuming this average, launching six Delta 7925s with nine GEMs in a twelve-month period is extrapolated to result in a cumulative net stratospheric ozone depletion on the order of 0.003 percent. (Reference 7)

Since the ground cloud for a Delta II launch is very small (about 20 meters or 67 feet) and concentrates around the launch pad, there should be no substantial acid rain beyond the near-pad area. (Reference 7)

Land Resources

Overall, launching a Delta II vehicle would not be expected to have significant negative effects on the land forms surrounding LC-17. However, launch activities could have some small impacts near the launch pad associated with fire and acidic depositions. Minor brush fires are infrequent by-products of Delta launches, and are contained and limited to the ruderal vegetation within the launch complexes; past singeing has not permanently affected the vegetation near the pads. Wet deposition of HCl could damage or kill vegetation, but would not be expected to occur outside the pad fence perimeter, due to the small ground cloud size and the rapid dissipation of the ground cloud and SRM exhaust plume. (Reference 7)

Local Hydrology and Water Quality

Water, supplied by municipal sources is used at LC-17 for fire suppression (deluge water), launch pad washdown, and potable water. The deluge water would be collected in the flume located directly beneath the launch vehicle and flows into a sealed concrete catchment basin, where it would then be disposed of in accordance with applicable federal and state regulations and permit programs. A concrete exhaust flume on each pad deflects exhaust gases away from the pad to reduce the noise and shock wave that results from ignition of solid rockets and the first stage of the launch vehicle. Most of the pad washdown and fire suppressant water would also be collected in a concrete catchment basin, and any propellant release would occur within sealed trenches and should not contaminate runoff. If the catchment basin meets federal discharge criteria, it would be discharged directly to grade at the launch site. If it fails to meet the criteria, it would be treated on site and disposed to grade or collected and disposed of by a certified contractor. [USAF 1988] No discharges of contaminated water are expected to result from medium launch vehicle operations at LC-17. (Reference 7)

The primary surface water impacts from a normal Delta II launch involve HCl and Al_2O_3 deposition from the exhaust plume. The ground cloud would not persist or remain over any location for more than few minutes. Depending on wind direction, most of the exhaust may drift over the Banana River or the Atlantic Ocean. A brief acidification of surface waters may result from HCl deposition. A normal Delta II launch would have no significant impacts to the local water quality due to the amount of water available for dilution. (Reference 7)

Ocean Environment

In a normal launch, the first and second stages and the SRMs would impact the ocean. The trajectories of spent stages and SRMs would be programmed to impact at a safe distance from any US coastal areas or other land mass. Toxic concentrations of metals would not be likely to occur due to the slow rate of corrosion in the deep ocean environment and the large quantity of water available for dilution. (Reference 7)

Spent stages have relatively small amounts of propellant. Concentrations in excess of the maximum allowable concentration (MAC) of these compounds for marine organisms would be limited to the immediate vicinity of the spent stage. No substantial impacts would be expected from the reentry and ocean impact of spent stages, since the amount of residual propellants is small when compared with the large volume of water available for dilution. (Reference 7)

Biotic Resources

A normal Delta II launch would not be expected to substantially impact CCAS terrestrial, wetland, or aquatic biota. The elevated noise levels of a launch are short duration and would not substantially affect wildlife populations. Wildlife encountering the launch-generated ground cloud could experience brief exposure to exhaust particles, but would not experience any substantial impacts. If the launch were to occur immediately before a rain shower, aquatic biota could experience acidified precipitation. This impact would be expected to be insignificant due to the brevity of the small ground cloud and the high buffering ability of the surrounding surface waters to rapidly neutralize excess acidity. (Reference 7)]

Threatened and Endangered Species

Any action that may affect federally listed species or their critical habitat requires consultation with US Federal Wildlife Service (FWS) under Section 7 of the Endangered Species Act of 1973. The US FWS has reviewed those actions which would be associated with the Delta II launch from LC-17 and has determined that those actions would have no effect on state or federally listed threatened (or proposed for listing as threatened) or endangered species residing on CCAS and in adjoining waters or critical habitat. (Reference 7)

Population and Socioeconomics

The ACE mission would create negligible impact on local communities, since no additional permanent personnel would be expected beyond the current CCAS staff. Launch Complex 17 has been used exclusively for space launches since the late 1950s. The ACE mission would cause no additional adverse impacts on community facilities, services, or existing land uses. (Reference 7)

Safety and Noise Pollution

Normal operations at CCAS include preventive health measures for workers such as hearing protection, respiratory protection, and exclusion zones to minimize or prevent exposure to harmful noise or hazardous areas or materials. (Reference 7)

The engine noise and sonic booms from a Delta II launch are typical of routine CCAS operations. In the history of USAF space-launch vehicle operations at CCAS, there have been no problems reported as a result of sonic booms. To the surrounding community, the noise from this activity appears to be an infrequent nuisance rather than a health hazard. (Reference 7)

Cultural Resources

Since no surface or subsurface areas would be disturbed, no archeological, historic, or other types of cultural sites would be expected to be affected by launching the ACE mission. (Reference 7)

Potential Launch Accidents

Liquid Propellant Spill

The potential for an accidental release of liquid propellants will be minimized by strict adherence to established safety procedures. Post-fueling spills from the launch vehicle will be channeled into a sealed concrete catchment basin and disposed of according to the appropriate state and federal regulations. (Reference 7)

The most severe propellant spill accident scenario would be releasing the entire launch vehicle load of nitrogen tetroxide (N_2O_4) at the launch pad while conducting propellant transfer operations. This scenario would have the greatest potential impact on local air quality. Airborne NO_X levels from this scenario are expected to be reduced to 5 ppm within about 150 meters or 500 feet and to 1 ppm within approximately 300 m or 1,000 ft. Activating the launch pad water deluge system would substantially reduce the evaporation rate, limiting exposure to concentrations that are above federally established standards to the vicinity of the spill. Propellant transfer personnel would be outfitted with protective clothing and breathing equipment. Personnel not involved in transfer operations would be excluded from the area. (Reference 7)

Launch Vehicle Destruction

In the unlikely event of a launch vehicle destruction, either on the pad or in-flight, the liquid propellant tanks and SRM cases would be ruptured. Due to their hypergolic (ignite on contact) nature, a launch failure would results in a spontaneous burning of most of the liquid propellants, and a somewhat slower burning of the SRM propellant fragments. Any such release of pollutants would have only a short-term impact on the environment near the pad. (Reference 7)

Launch failure impacts on water quality would stem from unburned liquid propellant being released into CCAS surface waters. For most launch failures, propellant release into surface waters would be substantially less than the full fuel load, primarily due to the reliability of the vehicle destruct system. However, if there were an early flight termination and failure of the vehicle destruct system, it is remotely possible that the entire Stage II propellant quantity could be released to the ocean. Impacts to ocean biota systems would be localized, transient in nature, and these systems would be expected to recover rapidly, due to the large amount of ocean water available for dilution.(Reference 7)

Ionizing Radiation

Several of the instruments (ULEIS, SEPICA, and EPAM) contain ionizing radiation sources). Ground support equipment for several instruments also includes radiation sources for instrument test and/or calibration. The ionizing radiation levels are low and are contained within the instruments. The sources for SEPICA and ULEIS are only accessible if the instruments are disassembled and the sources for EPAM are inaccessible with the aperture doors closed. As defined by the Office of Science and Technology Policy (OSTP), all sources are minor sources. The use of the radioactive sources in the ACE mission has been reviewed in accordance with Presidential Directive/National Security Council Number 25 (PD/NSC-25), "Scientific or Technological Experiments with Possible Large Scale Adverse Environmental Effects and Launch of Nuclear Systems into Space" dated December 14, 1977, as revised May 8,1996. Based on this review, which establishes a level of radiological risk, reporting to the Office of Science and Technology Policy of the planned launch is the only action required. Because the sources are of low level and have limited accessibility they pose no significant hazard to personnel or the environment. (References 9 and 11)

Environmental Justice

The ACE mission does not raise any environmental justice concerns. The ACE project is small in size and scope and will not produce any substantial environmental or human health impacts on the population as a whole. Therefore, there will be no disproportionately high or adverse impacts on minority populations or low-income populations from the implementation of the ACE mission.

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