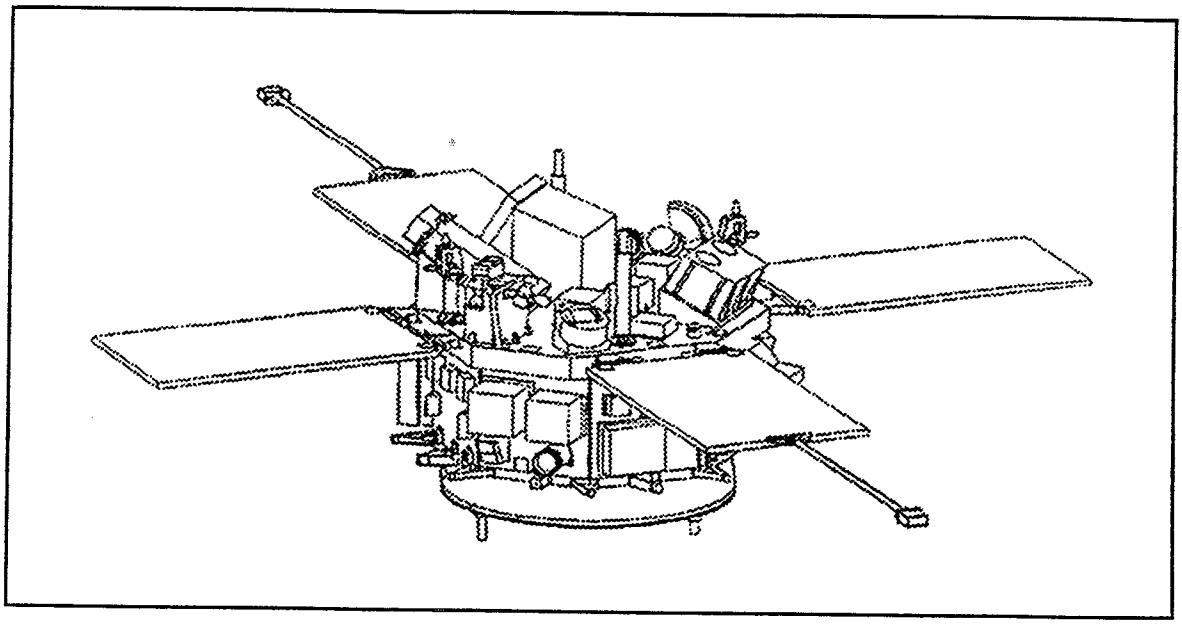
ADVANCED COMPOSITION EXPLORER

ACE

DETAILED MISSION REQUIREMENTS

GSFC-410-ACE-017



July 13, 1995

Goddard Space Flight Center

G S F C

10. REMARKS		
PROJECT CENTER(S)		LEAD CENTER
11. APPROVED BY: Frank Snow Frank Snow, Code 501 Data Systems and Operations Project Manager	DATE 8/9/95	14. APPROVED BY: Carolyn P. Dent Carolyn Dent, Code 510 ACE Implementation Manager
12. REVIEWED BY: Otto Bruegman Otto Bruegman/Omitron ACE Operations Systems Engineering	8/19/95	15. REVIEWED BY:
13. PREPARED BY: Ross Howington Ross Howington/Omitron ACE Operations Systems Engineering	8/19/95	NETWORK/RANGE 16. APPROVED BY: Norman R. Haynes Director Telecommunications & Mission Operations Directorate
		17. APPROVED BY: Allen Berman Allen Berman ACE Telecommunications & Mission Services Manager
		17a.

Revision	Page No.	Ch. No.	Revision	Page No.	Ch. No.	Revision	Page No.	Ch. No.

ACE 1032 — Change Approval

9. REV NO.	10. CH. NO.	11. CH. DATE	PROJECT CENTER(S)	LEAD CENTER
			12. APPROVED BY: Frank Snow, Code 501 Data Systems and Operations Project Manager	15. PREPARED BY:
			13. PREPARED BY: Ross Howington/Omitron ACE Operations Systems Engineering	16. APPROVED BY: Carolyn Dent, Code 510 ACE Data Systems Project Manager
			14. APPROVED BY:	NETWORK/RANGE
				17. APPROVED BY: Norman R. Haynes Director - Telecommunications & Mission Operations Directorate
			14a.	18. APPROVED BY: Allen Berman Telecommunications & Mission Services
				18a.

Page	Revision	Page	Revision	Page	Revision	Page	Revision

ACE 1030 — Revision Approval

10. REMARKS		
PROJECT CENTER(S)		LEAD CENTER
11. APPROVED BY: Frank Snow, Code 501 Data Systems and Operations Project Manager	DATE	14. APPROVED BY: Carolyn Dent, Code 510 ACE Implementation Manager
12. REVIEWED BY: Otto Bruegman/Omitron ACE Operations Systems Engineering		15. REVIEWED BY:
13. PREPARED BY: Ross Howington/Omitron ACE Operations Systems Engineering		NETWORK/RANGE 16. APPROVED BY: Norman R. Haynes Director Telecommunications & Mission Operations Directorate
		17. APPROVED BY: Allen Berman ACE Telecommunications & Mission Services Manager
		17a.

Section	Used	Title
4000	X	Introduction
4100	X	Mission Operations Systems Requirements
4110	X	External Interface Definition
4111	X	Deep Space Network
4113	X	Flight Dynamics Facility
4115	X	Science Centers
4120	X	User Interface
4121	X	Operations Interface Language
4122	X	Reports
4123	X	Display Requirements
4124	X	Event Message Requirements
4130	X	Mission Planning & Scheduling
4131	X	Planning Sources
4132	X	Planning Capabilities
4133	X	Planning Products
4140	X	Spacecraft Command and Control
4141	X	Command Source Selection
4142	X	General Commanding
4143	X	Real-time Commanding Requirements
4144	X	Command Sequence Generation
4145	X	Command Assembly
4146	X	Command Upload & Verification
4147		GSE Commands
4150	X	Spacecraft Telemetry
4151	X	Telemetry Reception
4152	X	Data Decommutation & Conversion
4153	X	Telemetry Data Routing
4154	X	Telemetry Analysis
4155	X	Memory Dump Processing
4160	X	Manage Operational Data
4161	X	Database Requirements
4162	X	User Definition Files
4163	X	History Data
4164	X	Configuration Memory Model
4165	X	File Maintenance
4166	X	Initialization & Termination
4170	X	Operational & Performance Requirements
4180		Space Craft I&T System Requirements.
4181		I&T STOL Directions
4182		I&T Telemetry Processing
4183		I&T Displays
4184		I&T RF Interface
4185		History Data
4186		I&T Miscellaneous
4300	X	Facilities Requirements
4400		Mission Operations Support

1W	One Way
2W	Two Way
ACE	Advanced Composition Explorer
ACS	Attitude Control System
ADC	Attitude Determination and Correction
AD&C	Attitude Determination and Control
AMOWG	ACE Mission Operations Working Group
APL	Applied Physics Laboratory
ASC	ACE Science Center
ASARS	ACE Science Analysis Remote Sites
ASC	ACE Science Center
ASCII	American Standard Code for Information Interchang
ATS	Absolute Time Sequence
ATTS	ACE Test and Training Simulator
BPS	Bits Per Second
C&DH	Command and Data Handling
CC	Command Controller
CCAFS	Cape Canaveral Air Force Station
CCSDS	Consultative Committee for Space Data Systems
CCTV	Closed Circuit TV
CIT	California Institute of Technology
CLCW	Command Link Control Word
CLTU	Command Link Transition Unit
CMD	Command
CMM	Configuration and Memory model
CO-I	Co-Investigator
COP-I	Command Operations Procedure, Revision 1
CP	Command Panel
CPP	Capacity Projection Plan
CPU	Central Processing Unit
CRIS	Cosmic Ray Isotope Spectrometer
CRT	Cathode Ray Tube
CTV	Compatibility Test Van
CVP	Color Video Printer
Deg	degree
DET	Direct Energy Transfer
DFCD	Data Format Control Document
DGIB	DSN-GSFC Interface Block
DMR	Detailed Mission Requirements
DPS	Data Processing System
DRIMS	Delta Redundant Measurement System
DSN	Deep Space Network

EDS	Engineering Data Set
EIV	End Item Verification
ELV	Expendable Launch Vehicle
EOM	End of Mission
EPAM	Electron, Proton, and Alpha-Particle Monitor
EPS	Electrical Power Subsystem
ER	Eastern Range
ETR	Eastern Test Range
EU	Engineering Unit
EUP	Engineering Unit Print
FARM	Frame Acceptance Relay Mechanism
FAX	Facsimile
FDF	Flight Dynamics Function
FOT	Flight Operations Team
FOV	Field of View
GATA	Ground Absolute Time Activity
GDS	Ground Data System
GFE	Government Furnished Equipment
GenSAA	Generic Spacecraft Analyst Assistant
GISE	GSFC Institutional Support Elements
GNDA	Ground Non-time Dependent Activity
GRI	Ground Reference Image
GRTA	Ground Relative Time Activity
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
GUI	Graphical User Interface
H	Hydrogen
He	Helium
HGA	High Gain Antenna
H/K	Housekeeping
HV	High Voltage
I&T	Integration and Test
ICD	Interface Control Document
ID	Identification
IDL	Interactive Display Language
IGSE	Instrument Ground Support Equipment
IM	Integration Manager
IOC	In-Orbit Checkout
IPD	Information Processing Division
IWG	Instrument Working Group
JHU	Johns Hopkins University
JPL	Jet Propulsion Laboratory
JURAP	Joint User Resource Allocation Planning - committee

kbps	Kilobits per Second
keV	Kilo-electron volt
kg	Kilogram
km	Kilometer
KSC	Kennedy Space Center
ksps	Kilo symbols per second
L1	First Sun-Earth Libration Point
LANL	Los Alamos National Laboratory
LTP	Level Two/Three Processing
LZP	Level Zero Processing
MAG	Magnetic Field Monitor (on ACE)
MAR	Mission Analysis Room
Max	Maximum
MCC	Midcourse Correction
MET	Mission Elapsed Time
MeV	Mega-electron volt
MHz	Megahertz
MILA	Merritt Island Launch Area
MLI	Multi-Layer Insulation
MMM	Max-Mean-Min
MOC	Mission Operations Center
MOM	Mission Operations Manager
MO&DA	Mission Operations and Data Analysis
MO&DSD	Mission Operations and Data Systems Directorate
MOR	Mission Operations Room
MOSA	Mission Operations Support Area
MPF	Mission Planning Function
MRD	Mission Requirements Request
MRTT	Mission Readiness Test Team
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communication Network
NCC	Network Control Center
ND	Network Director
NOCC	Network Operations Control
NRT	Near Real Time
NRZL	Non Return to Zero Level
NSSDC	National Space Science Data Center
ODB	Operational Data Base
OLS	Orbital Launch Service
ORD	Operations Requirements Document
OSC	Office of Space Communications
P/B	playback

PC	Personal Computer
PDB	Project Data Base
PDF	Programmable Data Formatter
PEDS	Processed Engineering Data Set
PRD	Program Requirements Document
RF	Radio Frequency
RFI	Radio Frequency Interference
RS or R/S	Reed Solomon
RS 232	Serial Communications Protocol
R/T	Real-time
RTDS	Real-time Data System
RTE	Relational Telemetry Expression
S3DPU	SEPICA, SWICS, SWIMS Data Processing Unit
SAA	Spacecraft Autonomous Activity
SATA	Spacecraft Absolute Time Activity
S/C	Spacecraft
SDPF	Sensor Data Processing Facility
SDVF	Software Development and Validation Facility
SEPICA	Solar Energetic particle Ionic Charge Analyzer
SEV	Sun-Earth Vector
SIS	Solar Isotope Spectrometer
SOHO	Solar & Heliospheric Observatory
SNDA	Spacecraft Non-time Dependent Activity
SOTA	Spacecraft Operations and Test Area
SPDS	Space Physics Data System
SPS	Symbols per second
SRA	Sequential Ranging Assembly
SRD	Science Requirements Document
SRTA	Spacecraft Relative Time Activity
SSR	Solid State Recorder
STDN	Spacecraft Tracking and Data Network
STOL	Systems Test and Operations Language
SWAS	Sub millimeter Wave Astronomy Satellite
SWEPAM	Solar Wind Electron, Proton, and Alpha Monitor
SWICS	Solar Wind Ion Composition Spectrometer
SWIMS	Solar Wind Ion Mass Spectrometer
TBR	To be received
TCP/IP	Transmission Control Protocol/Internet Protocol
TDM	Time Division Multiplexed
TLM	Telemetry
TPOCC	Transportable Payload Operations Control Center
T/R	Tape Recorder
TSTOL	TPOCC STOL
TTI	Transfer Trajectory Insertion
ULEIS	Ultra Low Energy Isotope Spectrometer

UNH	University of New Hampshire
UMD	University of Maryland
UTC	Universal Time Coordinated
VC	Virtual Channel
VCDU	Virtual Channel Data Unit
VDT	Video Display Terminal
Zr	Zirconium

ACE 1064 — Responsibilities for Management, Project and Operations

Organization/Title	Responsibilities
Program Office	The Associate Administrator for Space Science and Application, NASA Headquarters, is responsible for the overall direction and evaluation of the ACE Mission.
Program Manager	Mr. J. Lintott serves as the primary point of contact at NASA Headquarters for all matters relating to the Program and Project and all matters requiring Headquarters, or other Agency activities or efforts in support of Project activities.
Project Center	GSFC is responsible for overall project management.
Project Manager	Donald L. Margolies, Associate Project Manager for the ACE Project, is responsible for the observatory design, integration and test. Testing includes data flow and end to end tests with the ground system. The Project Manager is responsible for launch operations and operations of the spacecraft through the in-orbit check-out phase with the support of the DSOPM and flight operations team.
Ground Systems Manager	N/A
Data Systems and Operations Project Manager (DSOPM)	Frank Snow, Data Systems and Project Operations Manager, is responsible for the development and implementation of mission operations concepts and requirements for both the space and ground segments. As a member of the ACE Ground System and Operations Project staff, the DSOPM is responsible for the total operational ground system integrity, including defining project requirements and overseeing the development of the complete operational ground system. Prior to launch of the ACE Observatory, the DSOPM is responsible for ensuring that operational requirements are achievable, including the conduct of all necessary tests and validations of the operational system. After launch, the DSOPM is responsible for the operation of the Observatory to fulfill the mission objectives. The DSOPM receives support from the Mission Operations and Data Systems Directorate (MO&DSD) through the Implementation Manager (IM)
Launch Vehicle Manager	TBS
Implementation Manager	Carolyn Dent, Implementation Manager of the Mission Operations and Data Systems Directorate, is responsible for the acceptance and implementation of mission requirements, the commitment of ground system resources and the integrity of the ground system support for the mission.
Lead Range/Range Manager	Eastern Range/TBS
Lead Support Center	JPL is the Lead Support Center, and supplies ACE Network Support through the Deep Space Network. Norman R. Haynes, Director, Telecommunications and Mission Operations Directorate, has overall responsibility for the DSN. JPL Point of Contact - Allen Berman is the ACE Telecommunications and Mission Services Manager and is responsible for all DSN support provided specifically to the ACE Project.

ACE 1065 — Technical References

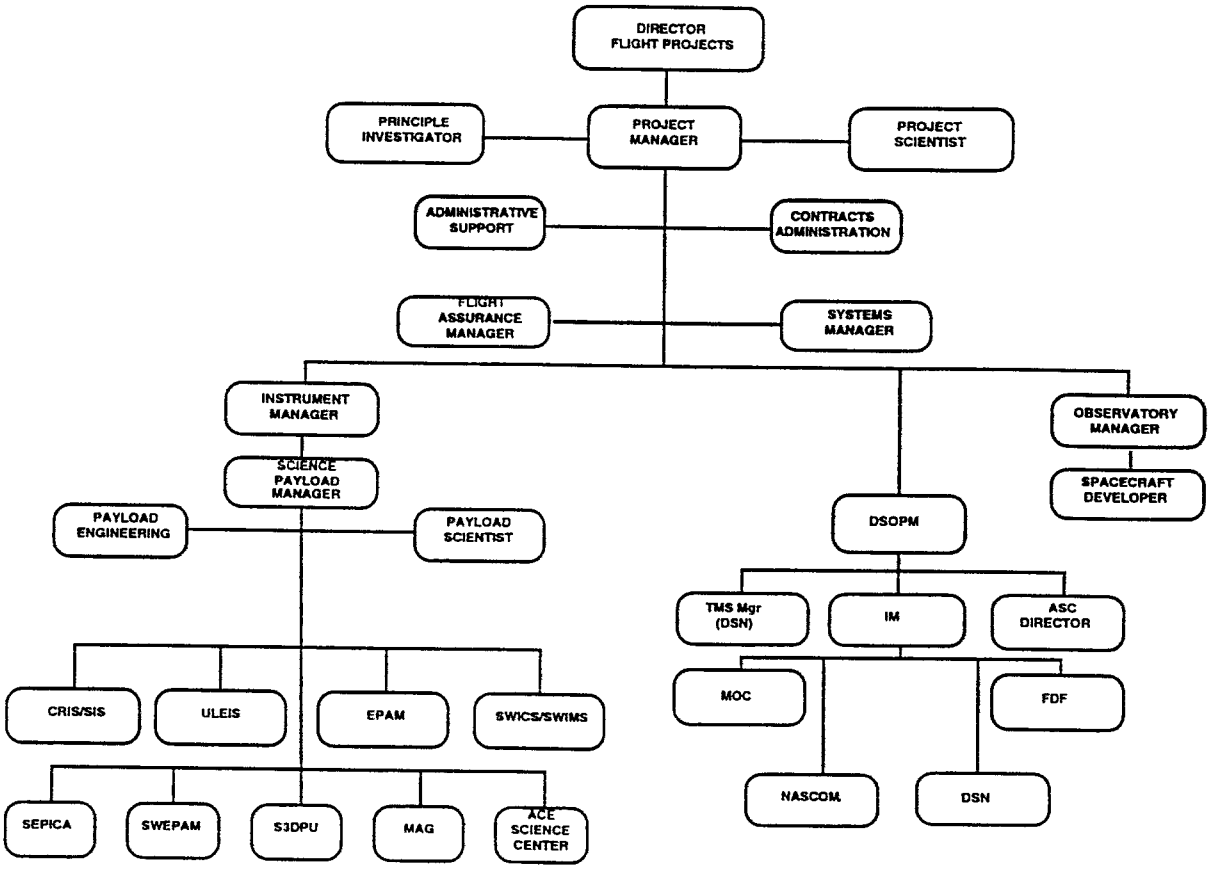
DOCUMENT TITLE	DOCUMENT NUMBER	DATE
Advanced Composition Explorer (ACE) Operations Concept Document	GSFC Code 501	October 1992
Advanced Composition Explorer (ACE) Science Requirements Document	GSFC-410-ACE-002	April 1994 Rev. A, Change N[illegible]ce 1
Advanced Composition Explorer (ACE) Mission Requirements Document	GSFC-410-ACE-003	October 1994 Rev. A, Change Notice 1
Advanced Composition Explorer (ACE) Mission Requirements Request		October 1993
Performance Assurance Requirements (PAR) for the ACE	GSFC-410-ACE-005	January 1994 (Rev. A)
ACE Configuration Management Procedure	GSFC-410-ACE-004 Rev. A	January 1994
Performance Assurance Requirements for the Science Payload of the ACE Mission	GSFC-410-ACE-008	April 1993
Execution Phase Project Plan for the ACE		October 1994 Rev. A
ACE Project Data Management Plan (PDMP)	GSFC-410-ACE-012	December 1993
ACE Spacecraft System Specification	APL-7345-9001	
Spacecraft Subsystem Specifications	APL 7345-9020 thru 9049	
Technical Proposal for Implementation of a Science Payload for the ACE Mission - Appendices A thru J	Proposal Responding to RGS5-10957/503	June 1993
Delta II Commercial Spacecraft User's Manual, McDonnell Douglas Astronautics C0.	MDCH 3224	July 1987
Network Operations Support for the Delta Launch Vehicle, STDN No. 601/Delta		
Preliminary Design Review Materials		November 1993
C&DH Subsystem Specification	APL 9030	June 1995

STANDARD	SYSTEM/COMPLIANCE	DEVIATIONS	WAIVERS/REMARKS
1. JPL-GSFC ICD (502-ICD-JPL/GSFC)			
2. CCSDS			
a. RF and Modulation System (401.0-B-1/Blue Book), January 1989			
b. Telemetry Blue Book (101.0-B-2), January 1987			
c. Telemetry Channel Coding Blue Book (201.0-B 1, 203.0-B-1), January 1987, January 1989		Non-standard CLCW Format	
d. Radiometric and Orbit Data Blue Book (707.0-B-1), October 1989			
e. Packet Telemtry Pink Book (102.0-P-2.0)			
f. Telecommand Summary of Concept & Service CCSDS-200-G-6			
g. Telecommand Pt. 1 Channel Service, Blue Book CCSDS-201-B-1			

General: - The ACE Project consists of two major components: the ACE observatory and the ACE ground system. The ACE Project, in the Explorers Project, Code 410, reports to the Flight Projects Directorate, GSFC Code 400, as shown in Figure 1100-1. ACE institutional facilities will be utilized to provide flight operations, data processing, storage, and distribution capabilities to support the ACE mission. The science operations facilities consists of the ACE Science Center (ASC), ACE Science Analysis Remote Sites (ASARs), National Space Science Data Center (NSSDC), and/or the Data Processing and Distribution Function (DPDF).

Project Objectives: - The objective of the ACE mission is to design, develop, launch, and successfully operate a spacecraft capable of meeting the scientific objectives of observing particles of solar, interplanetary, interstellar, and galactic origins, spanning the energy range from that of the solar wind (approximately 1 keV/nucleon) to galactic cosmic ray energies (several hundred MeV/nucleon). Studies will also be made of the abundance of essentially all isotopes from hydrogen to zinc, with exploratory isotope studies extending to zirconium. ACE will also monitor the solar wind and provide real-time data to scientists. Magnetic field, solar wind electrons, and solar flare electrons will also be measured.

The ACE observatory consists of the spacecraft subsystems, six primary science instruments and three monitoring instruments (listed below). The ACE mission phases include pre-launch, launch/ascent, transfer trajectory insertion, spacecraft/instrument turn-on and checkout, L1 "halo" orbit insertion, mission operations, and deactivation.



ACE 1110 — Experiment(s) Description

EXPERIMENT NAME/ACRONYM	POINT OF CONTACT	SCIENCE OBJECTIVES	INSTITUTION
Cosmic Ray Isotope Spectrometer (CRIS)	R. Mewaldt A. Cummings	The CRIS provides measurements of all stable isotopes of galactic cosmic ray nuclei from He to Zn (Z=2 - 30) over the general energy range from 100 to 600 MeV/nucleon.	CIT
Solar Isotope Spectrometer (SIS)	R. Mewaldt A. Cummings	The SIS measures the elemental and isotopic composition of solar energetic particles, anomalous cosmic rays, and interplanetary particles from Li to Zn. ($3 \leq Z \leq 30$) over the energy ranges 10-100 Mev/nucleon	CIT
Ultra Low Energy Isotope Spectrometer (ULEIS)	G. Mason R. Gold	The ULEIS measures suprathermal element and isotope particles of He through Ni(2 to 25) from about 20 keV/nuc to 10 MeV/nuc.	APL/UMD
Solar Energetic Particle Ionic Charge Analyzer (SEPICA)	E. Mobius L. Kistler	The SEPICA measures the ionic charge state (Q), the kinetic energy (E), and the nuclear charge (Z), of energetic ions above 0.2 MeV/nuc.	UNH
Solar Wind Ion Composition Spectrometer (SWICS)	G. Gloeckler	The SWICS determines the elemental and ionic charge composition and the temperature and mean speeds of all major solar wind ions from H through Fe at solar wind speeds ranging from 145 km/s (protons) to 1532 km/s (Fe^{+8})	UMD
Solar Wind Ion Mass Spectrometer (SWIMS)	G. Gloeckler	The SWIMS is a high mass and time resolution spectrometer which will provide unprecedented solar wind composition data. The velocity range is mass dependent, extending from 200-1500 km/sec for He and from 100-500 km/sec for Fe.	UMD
Electron, Proton, and Alpha - Particle Monitor (EPAM)	S. Krimingis R. Gold	The EPAM provides knowledge of the fluxes and energy spectra of energetic protons, alpha particles, and electrons that characterize the dynamic behavior of solar flares. It measures ions greater than 50kev and electrons greater than 30kev.	APL
Solar Wind Electron, Proton, and Alpha Monitor (SWEPAM)	D. McComas W. Feldman	The SWEPAM provides high quality measurements of electron (1-900 eV) and ion (0.26-35KeV) fluxes in the low energy solar wind range. Note: This experiment consists of two separate instruments.	LANL
Magnetometer (MAG)	L. Burlaga N. Ness	The two identical MAGs provide measurements of the interplanetary magnetic field.	GSFC/ U. of Del.
Real-time Solar Wind (RTSW)	J. Sinsky	The RTSW provides a reduced, composite science data stream from the SWEPAM instrument, the MAG instrument, and the EPAM instrument for downlink to NOAA ground stations for continuous monitoring and reacting to solar events.	JHU/APL

Summary of The Mission Operations Concept: - This summary relates only the major abstractions contained in the ACE Mission Operations Concept document and is not intended to be all inclusive. The ACE Mission Operations Concept document should be referenced for a more detailed description of ACE mission operations.

ACE Science Overview: - The ACE mission will observe particles of solar, interplanetary, interstellar, and galactic origins, spanning the energy range from that of the solar wind to galactic cosmic ray energies. In particular, ACE will provide the first extensive tabulation of solar isotopic abundances based on a direct sampling of solar material.

Mission Profile: - The Advanced Composition Explorer (ACE), a Class C observatory, will be launched no earlier than August 1997 into a modified halo orbit about the Earth-sun libration point, L1, on a Delta II (7920) launch vehicle from the Eastern Range. This orbit will be a "broken Lissajous" approximation to a true halo orbit, with in-ecliptic-plane and out-of-ecliptic-plane amplitudes of about 300,000 km and 150,000 km, respectively. At the L1 distance, these amplitudes will provide Sun-Earth-ACE angles of ten and five degrees respectively. The period of this "halo" orbit will be about 178 days. ACE will reach the vicinity of L1, 1.5 million km from Earth along the sun line, about 100 days after launch.

ACE will have a number of different maneuver types. The current baseline for the launch/transfer trajectory to the Earth-Sun L1 point includes the following maneuvers:

1) Transfer Trajectory Insertion (TTI) - performed by Delta.

2) Orbit Shaping Maneuver (OSM) - by Launch +20 days, restricts the Sun-Earth-Vehicle (SEV) angle.

3) Lissajous Orbit Insertion Maneuver (LOI) - at TTI + approximately 100 days; establishes the desired motion about L1.

An additional maneuver, Mid-Course Correction 1 (MCC1) - may be required to correct launch vehicle dispersions. This maneuver will be planned and executed by the Flight Dynamics Function. If required, it will be executed at Launch + 24 to 48 hours.

Once ACE is in its mission orbit, the following maintenance maneuvers will also be required:

1) Station keeping maneuvers - Once every 8 weeks; to keep ACE in bound to L1.

2) Orbit Shaping Maneuvers - Once every 3 - 6 months or as necessary to maintain SEV angle requirements.

3) Attitude Reorientation maneuvers - Once every 5 -7 days.

4) Spin rate adjustment maneuvers - As required.

The orientation of the spacecraft spin axis is constrained to vary between 4 and 20 degrees of the Sun, as a result of thermal, power, and payload safety considerations. Also, the spacecraft High Gain Antenna must remain pointed along the spacecraft/earth line within a cone with a 1/2 angle of 3°. In this configuration, eight instruments will measure the isotopic and elemental composition of the solar wind and energetic particles in the interplanetary medium. The ninth instrument measures the magnetic field which is important to data interpretation.

The ACE mission is planned for two years with a design goal of five years. Spacecraft and instrument control will be maintained by the ACE Mission Operations Center (MOC), located at Goddard Space Flight Center (GSFC), with commands through the Deep Space Network (DSN). Science operations will be conducted at the ACE Science Center (ASC) and ACE Science Analysis Remote sites (ASARs). Science direction will be provided by the ASC. Telemetry, including daily recorder dumps, will be acquired by the DSN and transmitted to GSFC for data capture, processing, recording, and subsequent product distribution to the ASC and ASARs.

Figure 1130-1 illustrates the ACE end-to-end telemetry and command data flow. ACE will be supported by a complement of NASA institutional facilities.

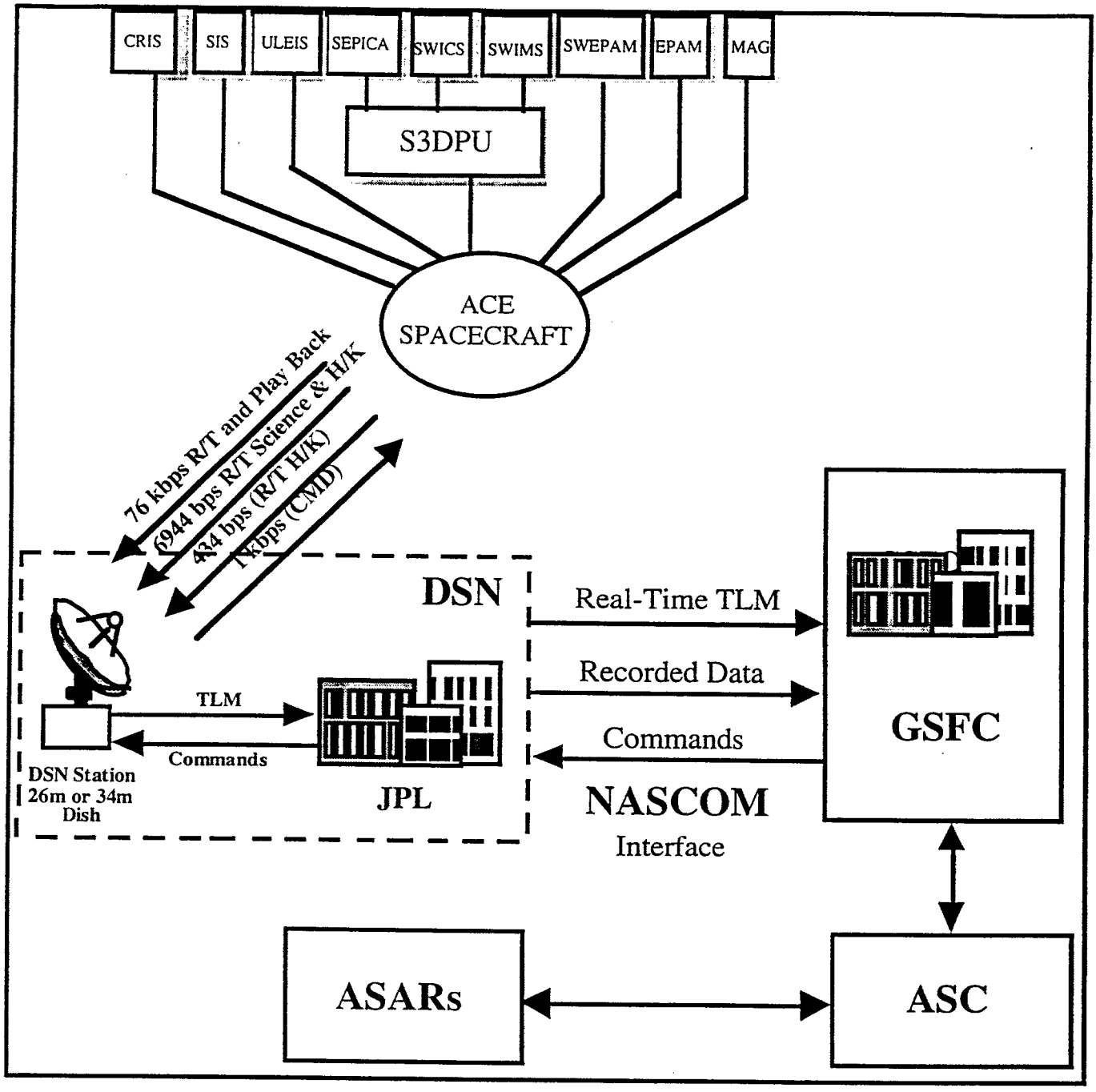


Figure 1130-1 ACE telemetry and command end-to-end data flow.

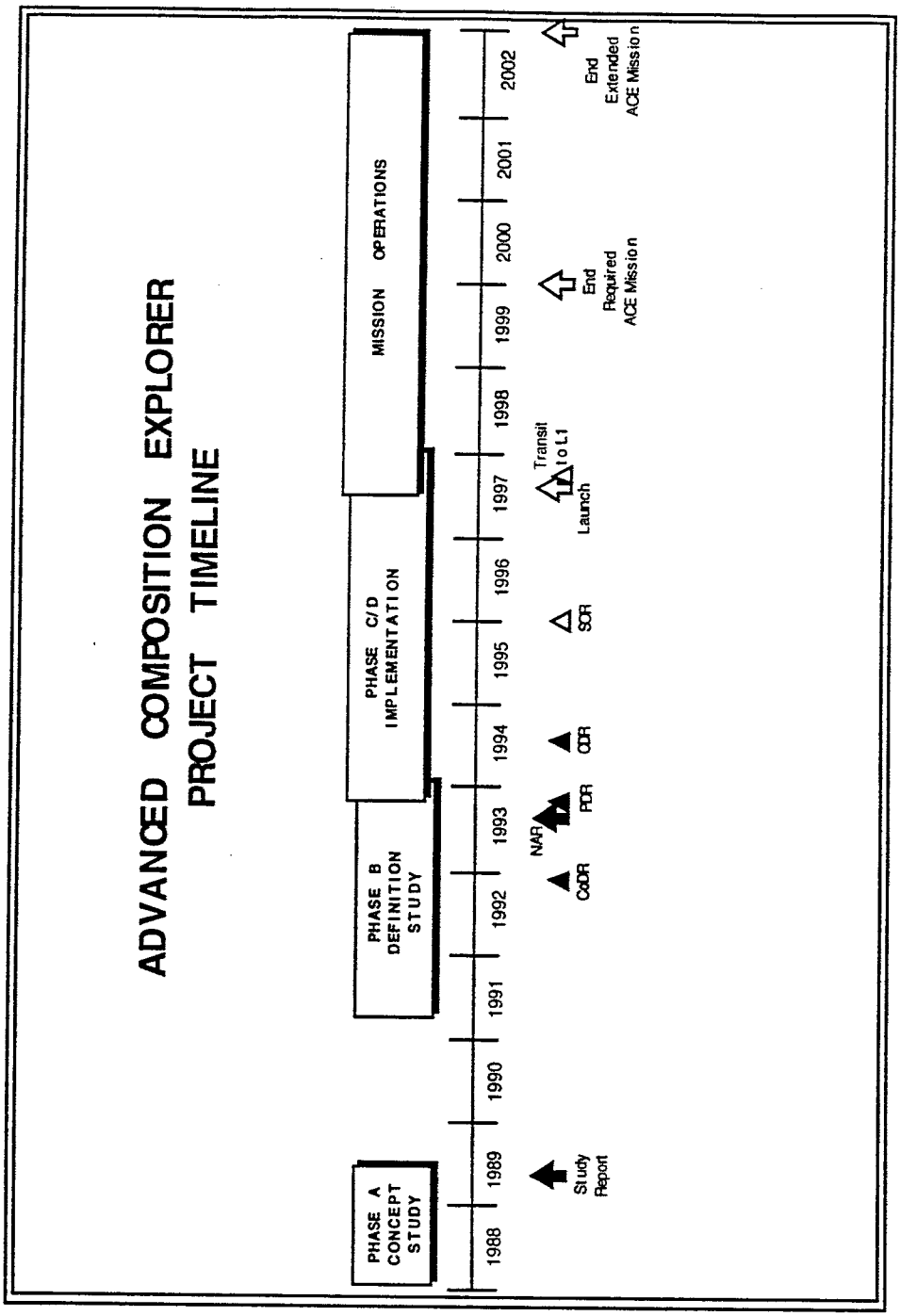


Figure 1140-1. ACE Project Schedule

ACE 1310 — Launch Vehicle Description - General

The ACE is scheduled for launch on a Delta II 7920 in August 1997. Typical field operations consist of spacecraft processing; ground transportation and handling; scheduling; and launch vehicle/spacecraft integration.

Delta II Launch Vehicle Description: - A two-stage Delta launch vehicle will be used for the ACE. The first-stage liquid-propellant booster is powered by a gimbaled main engine that is initially augmented by externally mounted solid propellant motors. The solid propellant motor cases are jettisoned after burn-out.

The second stage is powered by a pressure fed propulsion system. The thrust chamber assembly is mounted on a gimbal system for attitude control (pitch and yaw) during powered flight.

The launch vehicle command, telemetry, and tracking system and further details on the Delta launch vehicle are described in the Delta II Commercial Spacecraft User's Manual, McDonnell Douglas Astronautics Co.

Generic network support for Delta launches is described in Network Operations Support Plan for the Delta Launch Vehicle, STDN No. 601/Delta.

Payload Operational Interfaces: - The payload launch vehicle interface and the ACE-to-Delta II interfaces will be described in the ACE Response to Delta Spacecraft Questionnaire and in the ACE System Interface Specification.

General: - The ACE observatory consists of the spacecraft bus, nine science instruments and a SEPICA, SWICS, SWIMS Data Processing Unit (S3DPU). A diagram is provided in Figure 1320-1 below. The spacecraft provides mounting platforms, electrical power, attitude control, thermal control and command and data handling support for the scientific payload.

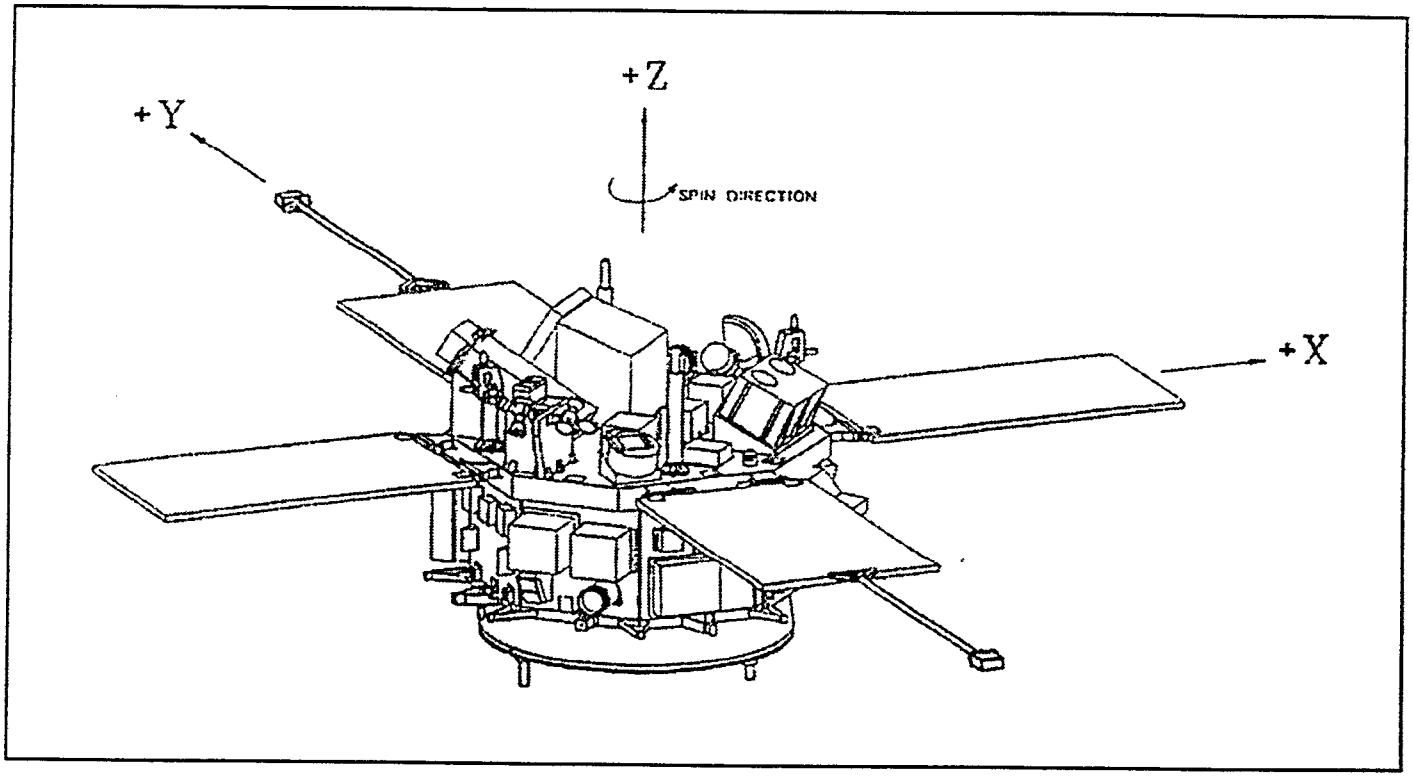


Figure 1320-1. ACE Spacecraft

The spacecraft system configuration includes:

- Instrument Subsystems (IS)
- CRIS, SIS, ULEIS, SEPICA, SWICS, SWIMS, EPAM, SWEPAM, MAG
- Command & Data Handling Subsystem (C&DH)
- RF Subsystem
- Attitude Control Subsystem (ACS)
- Propulsion Subsystem
- Power Subsystem
- Thermal Subsystem

ACE spacecraft structure: - The ACE spacecraft structure consists of a two deck, irregular octagon, 69 inches across the points and about 30 inches high. The spacecraft bus supports nine scientific instruments and two booms. Most of the instruments and spacecraft electronics are located on the upper deck or side panels. The lower deck primarily supports RF hardware and a hydrazine propulsion system which controls the orbit and attitude of the observatory.

The ACE spacecraft subsystems are described in the following paragraphs.

RF Communications (RF): - The RF subsystem is a redundant system designed to be supported by the Deep Space Network (DSN). The system is configured to provide a near total uplink command capability, a switched broadbeam low data rate downlink, and a high data rate narrow beam capability for nominal operations. It consists of the following primary components:

- 2 NASA Standard Transponders
- 2 Diplexers
- 2 RF Switch Assemblies (2 switches each)
- 2 Premodulation Conditioners
- 1 Parabolic Dish
- 4 Bifilar Helix Antennas

Command and Data Handling subsystem (C&DH): - The C&DH is a fully redundant microprocessor-based design with independent RTX2010 based microprocessors for the command and telemetry/data handling functions. Communication between the processors is accomplished through processor interface electronics located in each system. The C&DH system consists of the following:

- Command & Data Handling Component
- Power Switching Component
- Ordinance Fire Component
- Data Recorders

Power: - The ACE power subsystem is a Direct Energy Transfer (DET) system which transfers power generated from the solar array directly to the main bus. A nickel cadmium (NiCd) battery is provided to power the spacecraft through launch until deployment of the solar panels. The primary power subsystem components are as follows:

- Solar Array
- Nickel Cadmium Battery
- Digital Shunts
- Power Subsystem Dissipator Electronics
- Power Subsystem Control Electronics
- Shunt Resistors

Attitude Determination & Control (AD&C) - ACE attitude is determined on the ground using telemetered sensor data from one (1) star scanner and two (2) sun sensors. The ACE spacecraft (S/C) is spin stabilized with open loop ground control. Spin axis precession and spin-rate adjustments are achieved by ground commanded firing of thrusters.

Thermal: - The thermal environments are controlled using radiators, heaters and Multilayer Insulation (MLI).

Propulsion Subsystem: - The ACE Propulsion system is a liquid fuel (hydrazine) propulsion system designed to provide orbit insertion, attitude control, and orbit adjustment functions. The system is partially redundant and consists primarily of four tanks and ten thrusters (upper and lower decks).

The ACE instruments are described in the following paragraphs:

SIS: - The SIS consists of two identical "telescopes" composed of implanted and lithium-drifted silicon solid-state detectors. Each "telescope" consists of a hodoscope system made up of a pair of two-dimensional position-sensitive detectors and an energy loss stack.

CRIS: - The CRIS consists of a scintillating optical fiber telescope (SOFT) hodoscope and four identical stacks of large-area silicon solid-state detectors.

ULEIS: - The ULEIS consists of one telescope (time-of-flight mass spectrometer) with three time-of-flight start and stop micro channel plates (MCPs) with position-sensing anodes and an array of silicon solid-state detectors for measurement of residual energy.

SEPICA: - The SEPICA consists of three pairs of telescopes, with each pair sharing a high-voltage deflection electrode. Two of the pairs have collimators that are optimized for a large geometrical factor to allow high sensitivity to small solar energetic particle (SEP) events. The third pair has a fine collimator to improve the charge state resolution. SEPICA is connected to the S3DPU.

SWICS: - The SWICS consists of an electrostatic deflection system and a time-of flight versus energy system with start and stop micro channel plates and a solid-state residual detector and a separate solid-state proton/helium monitor. SWICS is connected to the S3DPU.

SWIMS: - The SWIMS consists of a three-chamber deflection system and a time-of-flight spectrometer with start and stop MCPs. SWIMS is connected to the S3DPU.

SWEPAM: - The SWEPAM consists of two curved plate electrostatic analyzers (one ion and one electron). The ion sensor consists of a 105 degree bending angle electrostatic analyzer (ESA) with 16 biased channel electron multipliers (CEMs). The electron sensor consists of a 120 degree bending angle ESA with seven large-funnel CEMs.

EPAM: - The EPAM consists of five apertures in two telescope assemblies. The apertures are two low energy magnetic spectrometers, two low energy foil spectrometers, and one composition aperture.

MAG: - The MAG consists of two identical magnetometer sensors located at the end of booms diametrically opposite each other. The magnetometers are wide-range tri-axial fluxgate mounted remotely from the spacecraft.

ACE 1405 — Frequency Utilization Summary

The DSN system is used for all ACE flight operations.

The ACE spacecraft bus provides redundant uplink and downlink communication capability compatible with the DSN 26 or 34 meter dish antenna systems.

The ACE uplink command rate is 1000 bps.

ACE has three downlink modes:

- recorder playback at 76.384 kbps
- real-time data at 6.944 kbps, and
- low rate data at 434 bps.

All communication formats and utilization frequencies are specified in section 2000.

The ACE operations objective is to record science and H/K data on-board the S/C and down link it once daily through the DSN during nominal on-orbit operations. The telemetry system will be compatible with CCSDS recommendations to reduce costs via standardization. The downlink format consists of a convolutional inner code concatenated with a Reed-Solomon outer code, to provide bit error rection and bit code correction. The ACE End-to-End BER is required to be 10-6 or better.

ACE will need one DSN contact per day approximately three and one-half hours in length during normal operations in the L1 orbit. Health, housekeeping, and science data are recorded continuously and nominally dumped once per day during the DSN contact. Each recoder is required to be capable of recording data for at least 26 hours and the storage capability at end of mission shall be at least 650 megabits. This will allow the ACE spacecraft to store additional data without overwriting delayed data if one DSN download is missed.

Each recorder will have three modes:

- record
- playback
- standby.

Each recorder will be cross strapped to both command and data handling (C&DH) subsystems.

The ACE to MOC TLM data flow is shown in Figure 2000-1. Science instruments operate 24 hours per day with a rate of 6552 bps. Both science and H/K data will be recorded continually, including being downlinked in real-time (R/T) during a DSN contact. The overall ACE mission requirement is for 90% science data recovery during the first two years of the mission with a goal of 90% thereafter up to five years.

TLM is downlinked during a DSN contact in one of three possible modes. The first is 434 bps continuous real-time H/K only data used for initial acquisition and anomalies. The second is R/T 6.9 kbps science and H/K data. The third is 76 kbps high rate recorder dump format, which consists of the R/T data and recorded data interleaved. In the high rate recorder dump format there are ten frames of recorded data for each frame of R/T data downlinked.

During nominal operations, all downlinked data are captured by a DSN ground station. During the real time pass, the MOC will monitor observatory health and safety and the ASC will monitor instrument performance. The DSN forwards real-time data from the telemetry stream directly to the MOC. All data are recorded at the DSN and forwarded to the ASC within limits of communications capabilities.

ACE 1421 — Spacecraft/Payload Telecommunications System Parameters - Telemetry

1. Transponder Transmitter Characteristics:

a. Operating Frequency: Primary: 2278.35 MHz Band; Secondary: N/A.

b. Transmitter Reference Frequency Source: Auxiliary oscillator

c. Bandwidth: DSN TLM: 3 dB, 6 MHz

d. Transmitter Total Output Power: 5 Watts

The spacecraft accepts commands at a 1 kbps rate through the high gain antenna nominally, or the broadbeam antenna as back-up. The command system is entirely redundant, except for the high gain antenna.

Large memory loads require the S/C to accept memory loads in separate segments over several days. The instrument memory will be loaded pre-launch. Major updates may be required on an instrument by instrument basis during checkout and for anomalous conditions thereafter. All instruments are capable of receiving and acknowledging commands.

ACE 1431 — Spacecraft/Payload Telecommunications System Parameters - Command

1. Transponder Receiver Characteristics

a. Operating Frequency: Primary: 2097.9806 MHz: Secondary: N/A.

b. Source Oscillator: Auxiliary oscillator - derived from coherent uplink

c. DSN Center Frequency Stability: 3×10^{-13} @ 1 second

d. Maximum DSN Carrier Acquisition Rate: 600 Khz/second; Threshold: TBS

e. Carrier Phase lock Threshold. DSN: -130 dBm

f. Maximum Carrier Loop Tracking Rate, DSN: 30 Hz/second

g. Maximum Carrier Loop Tracking Range, DSN: 83 MHz

h. Noise Figure: 2.5 dB max.

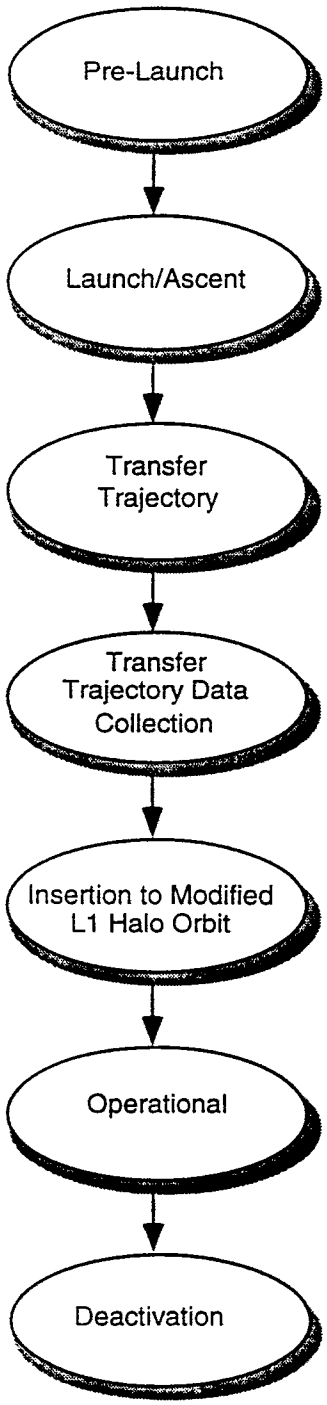
i. Receiver bandwidth for uplink range signal : 800kHz.

PRELIMINARY ASCENT TIMELINE

Event	Time (Sec)
Liftoff	0.0
Solid Motors Burnout (6)	63.1
Solid Motors Ignition (3)	65.5
Jettison Solid Motors (3)	66.0
Jettison Solid Motors (3)	67.0
Solid Motors Burnout (3)	128.8
Jettison Solid Motors (3)	131.5
Main Engine Cutoff (MECO)	260.7
Booster Separation	268.5
Second-Stage Ignition	274.0
Fairing Jettison	290.0
First Cutoff - Second Stage (SECO 1)	491.0
Begin Coast (C)	550.0
Restart Second Stage	550 + C
Second Cutoff - Second Stage (SECO 2)	788.3 + C
Begin Maneuver to S/C Separation Attitude	850.0 + C
Begin Roll Rate for S/C Spin Up	1150.0 + C
S/C Separation	1165.0 + C

Figure 1711-1. ACE/Delta Major Mark Events.

Figure 1715-1 summarizes the mission phases in the life cycle of the ACE observatory from pre-launch operations at the Eastern Range (ER) to spacecraft deactivation once usable Observatory operations have been concluded.



Appendages are deployed and activation of instruments begin as soon as possible following Delta II/Observatory separation and orbit acquisition initialization.

A transfer trajectory requiring several months will place the ACE Observatory in the vicinity of L1.

An initial checkout of the Observatory is conducted during the transfer trajectory. A thorough checkout and calibration is conducted prior to beginning normal operations

The on-board propulsion system will be used to insert the S/C into the modified L1 halo orbit.

Observatory deactivation occurs when the Observatory is no longer supplying useful data.

Figure 1715-1. ACE Mission Life cycle

General - ACE command, telemetry, and radiometric support will be provided through the Deep Space Network (DSN). The DSN will support pre-launch testing, transfer trajectory (first 3 months after launch) operations, nominal halo orbit operations, critical support operations, and emergency operations. The nominal ACE spacecraft-to-ground link is shown in Figure 2000-1.

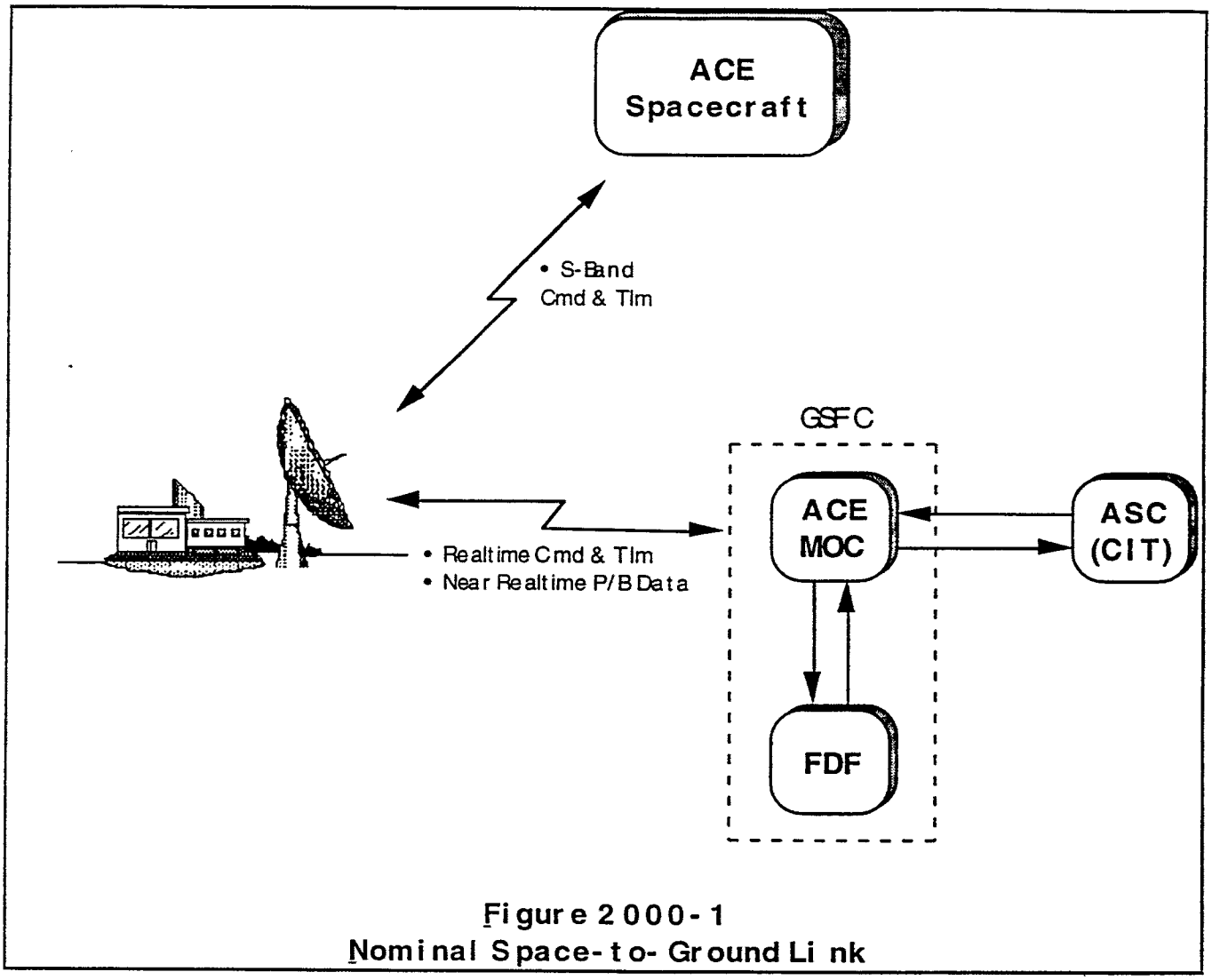


Figure 2000-1
Nominal Space-to-Ground Link

The DSN neither allocates nor commits its antenna resources. For the 34 meter subnet, these functions are performed by a committee of all Flight Project Users, the Joint User Resource Allocation Planning (JURAP) Committee, which generally is quite successful in negotiating antenna allocations that are acceptable to all parties. Criteria relevant to these negotiations include science content, spacecraft navigation, spacecraft health and safety, and engineering data. For the 26 meter subnet, the DSN acts as the scheduling agent to assist all the Flight Project Users in developing a conflict free schedule. Negotiation criteria are the same as for the 34-m subnet.

The ACE coverage requirements have been analyzed in terms of relative priority and daily intensity (i.e., hr/day), and in conjunction with other Flight Project Users of the DSN in 1996-1999. When the DSN estimates that there is a very high likelihood of being able to meet a particular coverage requirement, the

response "accepted" is used. When the ability to meet a particular coverage requirement is less certain, the response "partially accepted" is used, and it is accompanied by further discussion of the DSN ability to meet that requirement.

There is no communication with the ACE spacecraft until after S/C separation from the Delta II upper stage. Separation will occur a few minutes after the Transfer Trajectory Injection (TTI) burn ceases. Hence, communication with the ACE S/C will first occur at the beginning of the cruise phase.

The estimated communications timeline for early mission maneuvers is as follows:

- TTI - planned by Delta, will occur within hours of liftoff at approximately orbit midnight.
- MCC-1 - will occur within L + 48 hours.
- OSM will occur by L + 20 days.
- LOI will occur by L + 100 days.

During each ACE contact, spacecraft to ground telemetry, spacecraft commanding, and tracking activities will occur simultaneously. Hence coverage requirements for telemetry, commanding, and tracking will be identical.

The DSN Internet Protocol (IP) interface and the MODNET are considered secure. As such, there is no requirement for a secure gateway between DSN IP interface and the secure MODNET.

Pre-launch Support - The DSN will support pre-launch testing which will consist of tests to ensure RF, command, ranging and telemetry compatibility with the ACE spacecraft. The DSN MIL-71 facility and the Compatibility Test Trailer (CTT) will be required to support these tests.

Early Orbit and Nominal Support - For transfer trajectory and halo orbit operations, the ACE mission will use the DSN 26 meter antennas as primary and the 34 meter antennas as a backup. The DSN will provide the capability for command and radiometric tracking operations to occur simultaneously with telemetry reception.

Critical Operations Support - Special support will be required for supports in which critical operations will take place. Critical operations include all supports in which the ACE spacecraft will be performing maneuvers as well as all supports in which the ACE spacecraft will undergo major reconfigurations resulting from non-nominal operations.

Emergency Support - The DSN will provide emergency support as required.

2000-1

The DSN shall support ACE Project uplink and downlink frequencies and their respective characteristics as identified in Figure 2000-2.

DSN Response: *ACCEPTED*

Item Number	Link Frequency	Link Mode	Modulation/ Encoding Scheme	Mod Index			Data Rate	Data Type	Purpose and Remarks
				CMD Radians Peak	TLM Radians Peak	RNG Radians Peak			
1	Uplink 2097.981 MHz	Command	• NRZ-L • PCM	0.868	n/a	0.40	1 Kbit/sec	Command	All spacecraft commands modulated onto a 16 KHz sine wave subcarrier.
2	Downlink 2278.350 MHz	Low Rate Telemetry	• PCM • Bi-Ø • R/S Encoded • 1/2 Conv Endcoded	n/a	0.700	0.280	Decoded: 434 bps R/S Encoded: 498 bps R/S and Conv. Encoded: 996 bps	Realtime telemetry from the High Gain or Omni Antennas	VC1 - Data consisting of spacecraft housekeeping, attitude, memory dump, or bin dump information. Information is dependent on the C&DH telemetry mode selected. (NO SCIENCE DATA)
3	Downlink 2278.350 MHz	Default Rate Telemetry	• PCM • Bi-Ø • R/S Encoded • 1/2 Conv Endcoded	n/a	1.250	0.280	Decoded: 6.944 Kbps R/S Encoded: 7.968 Kbps R/S and Conv. Encoded: 15.936 Kbps	Realtime telemetry from the High Gain Antenna Only	VC1 - Data consisting of spacecraft housekeeping, attitude, memory dump, or bin dump information as well as science data. Information is dependent on the C&DH telemetry mode selected.
4	Downlink 2278.350 MHz	High Rate Telemetry	• PCM • Bi-Ø • R/S Encoded • 1/2 Conv Endcoded	n/a	1.250	0.280	Decoded: 76.384 Kbps R/S Encoded: 87.648 Kbps R/S and Conv. Encoded: 175.296 Kbps	Realtime telemetry and Playback Data from High Gain Antenna Only	VC1 - Data as defined in the default rate telemetry above. VC2 - Playback data from the Solid State Recorders. Both virtual channels are interleaved together to form the downlink.

Figure 2000-2. Radio Frequency Characteristics.

2000-1.1

The DSN shall ensure that the network maintains a 95 per cent or greater reliability of successful telemetry reception and real-time transmission to the ACE Project with a BER of 10-6 or better under strong signal conditions.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.2

First Acquisition after TTI - The DSN shall be capable of acquiring the S/C within 10 minutes of first rise over the assigned DSN station providing the S/C transmitter is on from the time of first rise and the actual trajectory falls within the 3-sigma dispersions of the best available predictions. If ACE launches during the currently baselined August 1997 time frame, first contact will occur at Canberra. If it launches outside of this time frame, either Goldstone or Madrid may be used for first contact.

DSN Response: *ACCEPTED*

2000-1.2.1

For the first acquisition after TTI, a backup antenna shall be immediately available due to the time critical nature of this contact.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.3

The DSN shall be capable of acquiring the S/C within 5 minutes of a scheduled track during any mission phase, excluding early launch and Earth orbit phase. Acquisition is defined as carrier lock.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.4

Deleted.

2000-1.5

The DSN shall provide S-Band acquisition support if required for launch injection errors.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.6

Deleted

2000-1.7

A 26 or 34 meter DSN antenna shall be used for ACE command, telemetry and tracking support.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.8

The DSN shall record all downlink telemetry.

Requirement will be met

DSN Respnse: *ACCEPTED*

2000-1.9

The DSN shall provide a backup for the antenna and all other operational support required during critical ACE operations.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.9.1

The DSN shall not take more than 15 minutes to achieve a backup reconfiguration.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.10

The DSN shall meet the radiometric requirements summarized in Figure 2000-3.

Requirement will be met

DSN Response: *ACCEPTED - with the condition that range accuracy requirements are only accepted under high signal level conditions.*

Mission Phase	Service	Data Type	Pass Frequency	Data Pts/sec	Accuracy	Data Delivery	Data Destination
Pre-Launch	Refer to Section 3000				Range bias: ≤15 meters, Range Noise: ≤1.5 meters, Range Rate Noise: ≤3 mm/sec Values stated are 3 sigma		
Launch to TTI	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Transfer Trajectory Phase	26-meter subnet prime and 34-meter subnet cold backup-radiometric data	Antenna Angles (26-Meter only), Doppler, and Range	One 10 hour pass per day from Launch to L+15 days, one 4 hour pass per day from L+15 to HOI,	Doppler at 1 sample per 10 seconds	Range bias: ≤15 meters, Range Noise: ≤1.5 meters, Range Rate Noise: ≤3 mm/sec Angle Accuracy of 0.095° Values stated are 3 sigma	DGIBs in real-time at rate of 1 every 10 seconds	FDF
Halo Orbit Phase	Same as above	Same as above	One 3 1/2 hour pass per day during Halo Orbit Operations	Same as above	Same as above	Same as above	Same as above

Figure 2000-3. Radiometrics requirements.

2000-1.11

The DSN shall support an uplink frequency of 2.0979806 GHz.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.11.1

The standard DSN interface shall be a residual carrier system.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.11.2

Commands shall be coherently binary phase shift keyed (BPSK), modulated onto 16 kHz sinusoidal subcarrier prior to modulation onto carrier.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.11.3

The data shall be NRZ-L.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.12

The DSN shall support downlink frequencies of 2.27835 GHz coherent and non-coherent.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.12.1

Deleted.

2000-1.12.2

The DSN shall support three downlink rates. Data are biphase - L modulated directly onto the carrier.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.12.3

The DSN shall support the High modulation index as specified in Figure 2000-2 for the high data rate downlink.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.12.4

The DSN shall support the Low modulation index as specified in Figure 2000-2 for the 434 bps data rate downlink data.

Requirement will be met

DSN Response: *ACCEPTED*

2000-1.13

The DSN shall support the downlink telemetry modulation normal mode: Biphase-L/PM data direct on carrier with convolutional coding K=7, R= 1/2 concatenated with an I=4, (255, 223) Reed-Solomon codeblock with 24 symbols (bytes) of fill for all data rates. The convolutional code uses the standard CCSDS connection vector. The Reed-Solomon code uses an interleave of four.

DSN Response: *ACCEPTED*

2000-2

The DSN shall be responsible for providing scheduled contacts as shown in Figure 2000 - 3.

Requirement will be met

DSN Response: *ACCEPTED*

2000-2.1

The DSN shall support Cruise Phase/Early Orbit Check-Out (Launch (August 1997) to L+15 days) with one contact per day, 10 hours per contact.

Requirement will be met

DSN Response: *ACCEPTED*

2000-2.2

The DSN shall provide one 12 hour contiguous contact scheduled to support the Mid Course Correction (L+1 or 2 days).

Requirement will be met

DSN Response: *ACCEPTED*

2000-2.3

The DSN shall provide 10 hours of support the day before, 10 hours of support the day of, and 10 hours of support the day after the orbit shaping maneuver. Whenever possible, support shall include data from sites in both the northern and southern hemisphere.

Requirement will be met

DSN Response: *ACCEPTED*

2000-2.4

Cruise Phase (L+16 days to Halo Orbit Injection (HOI)) The DSN shall support one Contact per day during the prime shift (8:00 am to 5:00 pm EST), 4 hours per contact.

Requirement will be met

DSN Response: *ACCEPTED*

2000-2.5

The DSN shall provide 10 hours of support the day before, 12 hours of support the day of, and 10 hours of support the day after the halo orbit insertion maneuver (L+ ~100 days). Whenever possible, support shall include data from sites in both the northern and southern hemisphere.

Requirement will be met

DSN Response: *ACCEPTED*

2000-2.6

Prime Science Phase (December 1997 to December 1999 (December 2002 extended)) The DSN shall support one contact per day during the prime shift (8:00 am to 5:00 pm EST), 3.5 hours per contact.

Requirement will be met

DSN Response: *ACCEPTED*

2000-2.7

The DSN shall support spacecraft emergencies/contingencies.

Requirement will be met

DSN Response: *ACCEPTED*

2000-2.8

The DSN shall meet the downlink requirements summarized in Figure 2000-4.

Requirement will be met

DSN Response: *ACCEPTED*

2000-3

The NASA/JPL Deep Space Network shall be the Ground Network for all ACE ground contact, except for possible early orbit support from other networks in case of DSN coverage gaps.

Requirement will be met

DSN Response: *ACCEPTED*

2000-3.1

An autotrack mode shall nominally be used by the supporting DSN station, and tracking angles and other radiometric data shall be collected and shipped at a rate of 1 block per 10 seconds, interspersed with telemetry, to GSFC/FDF during all times of support.

Requirement will be met

DSN Response: *ACCEPTED*

2000-3.2

Radiometric data types - Angle and Doppler data shall be provided when using the 26 meter subnet.

Doppler data shall be provided when using the 34 meter subnet. When the spacecraft is coherent, range data shall also be provided by the transmit site.

Requirement will be met

DSN Response: *ACCEPTED*

2000-3.3

The DSN shall provide raw radiometric data to the FDF in UTDF, as specified in DSN 820-13; trk 2-20 for 26M support: and trk 2-15A for 34M support.

Requirement will be met

DSN Response: *ACCEPTED*

2000-3.4

In the case where the SRA is used at the 26M net; the DSN shall, in addition to UTDF, provide the FDF metric data in DTDF. as specified in DSN820-13; trk 2-30.

Requirement will be met

DSN Response: *ACCEPTED*

2000-4

The DSN shall meet the RF telemetry requirements summarized in Figure 2000-4.

DSN Response: *ACCEPTED*

Mission Phase	Service	Data Type	Total Bit Rate	Pass Frequency	Pass Duration	Data Delivery	Data Dest.
Contingency, and Backup Operations	S-Band 2278.350 MHz	Realtime telemetry from the High Gain or Omni Antennas	Decoded: 434 b/sec R/S Encoded: 498 s/sec R/S and Conv. Encoded: 996 s/sec	N/A for Launch & As Required for Contingency and Backup Operatons	N/A for Launch & As Required for Contingency and Backup Operatons	VC1 data in Realtime	ACE MOC at GSFC, DPDF*, and ASC (as req.)
Transfer Trajectory Operations	S-Band 2278.350 MHz	Realtime telemetry from the High Gain or Omni Antennas	Decoded: 6.944 Kb/sec R/S Encoded: 7.968 Ks/sec R/S and Conv. Encoded: 15.936 Ks/sec	One support per day	Ten hours during the first 15 days and four hours thereafter	VC1 data in Realtime	ACE MOC at GSFC, DPDF*, and ASC (as req.)
	S-Band 2278.350 MHz	Realtime telemetry and Playback Data from High Gain Antenna Only	Decoded: 76.384 Kb/sec R/S Encoded: 87.648 Ks/sec R/S and Conv. Encoded: 175.296 Ks/sec			VC1 data in Realtime & VC2 data in near-Realtime	ACE MOC at GSFC, DPDF*, and ASC (as req.)
Halo Orbit Operations	S-Band 2278.350 MHz	Realtime telemetry from the High Gain Antenna Only	Decoded: 6.944 Kb/sec R/S Encoded: 7.968 Ks/sec R/S and Conv. Encoded: 15.936 Ks/sec	One support per day	Three and one half hours	VC1 data in Realtime	ACE MOC at GSFC, DPDF*, and ASC (as req.)
	S-Band 2278.350 MHz	Realtime telemetry and Playback Data from High Gain Antenna Only	Decoded: 76.384 Kb/sec R/S Encoded: 87.648 Ks/sec R/S and Conv. Encoded: 175.296 Ks/sec			VC1 data in Realtime & VC2 data in near-Realtime	ACE MOC at GSFC, DPDF*, and ASC (as req.)

* DPDF - Data Processing and Distribution Function

Figure 2000-4 Downlink requirements.

2000-4.1

The DSN shall be compatible with the telemetry structure defined in Figure 2000-5. Refer to the C&DH subsystem specification (APL document 7345-9030) and APL document 7345-9034 Telemetry Frame Format Descriptions for the most current information.

DSN Response: *ACCEPTED*

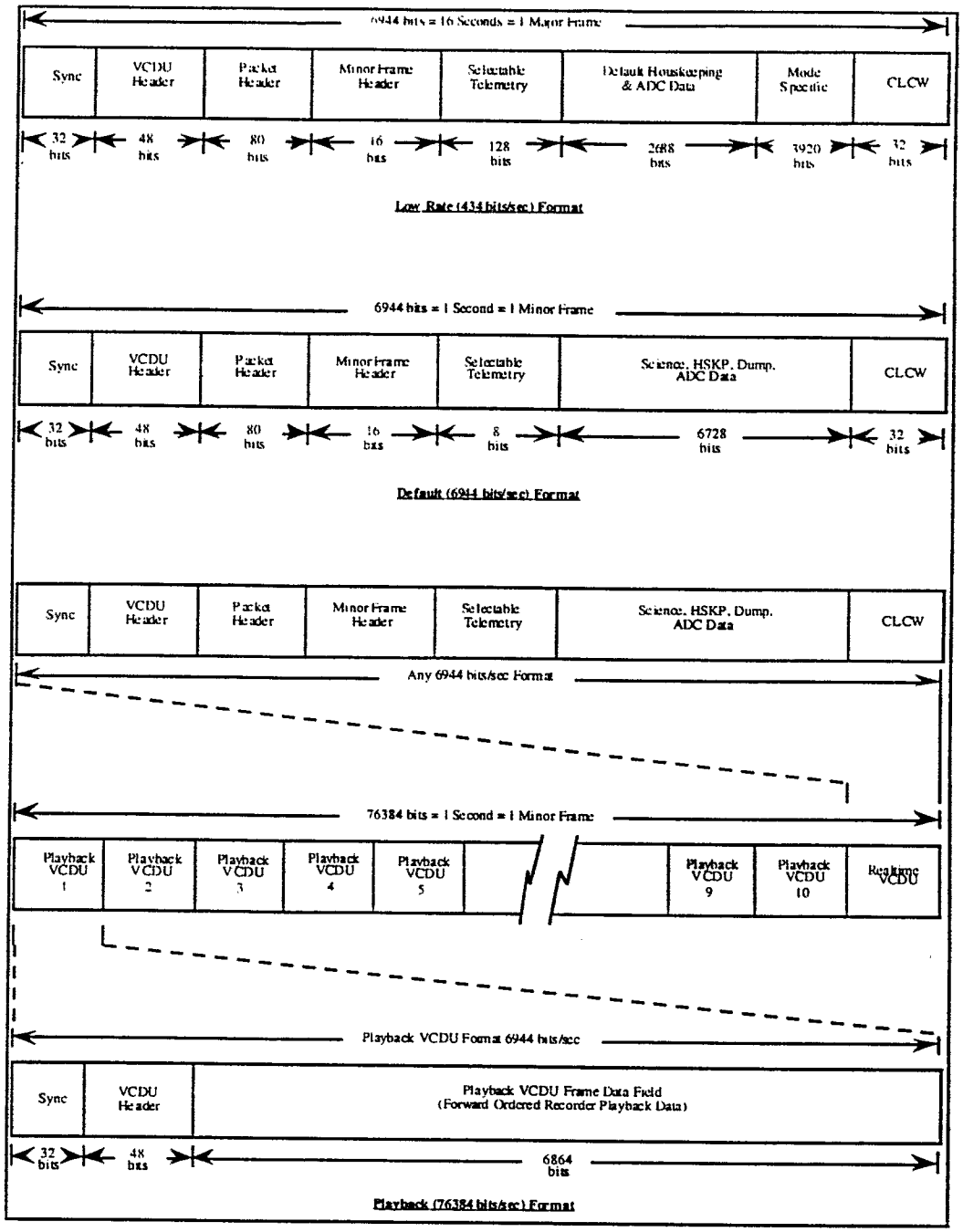


Figure 2000-5. Telemetry Structure.

2000-4.2

The DSN shall perform convolutional decoding of the downlink data.

Requirement will be met

DSN Response: *ACCEPTED*

2000-4.3

The DSN shall perform Reed-Solomon decoding and bit error correction of the downlink data.

Requirement will be met

DSN Response: *ACCEPTED*

2000-4.4

The DSN shall provide MIL-71 with communications and facility support to receive the telemetry stream data from the ACE spacecraft or simulator while at the ER.

Requirement will be met

DSN Response: *ACCEPTED*

2000-4.5

The DSN shall provide MIL-71 with communications and facility support needed to ship the telemetered data from MIL-71 to DSN for further dissemination to the ACE MOC.

Requirement will be met

DSN Response: *ACCEPTED*

2000-4.6

The DSN shall frame synchronize to the Reed-Solomon encoded telemetry data.

Requirement will be met

DSN Response: *ACCEPTED*

2000-4.7

The DSN shall format received ACE telemetry in accordance with DSN Document 820-13 Module TLM-3-27 (ACE).

Requirement will be met

DSN Response: *ACCEPTED*

2000-4.8

Virtual Channel 1 telemetry frames which can be successfully frame synchronized and RS decoded shall be packed into an SFDU with a DDD header as defined in DSN Document 820-13 Module TLM-3-27 (ACE) with new RS coding bits attached and saved to the Central Data Recorder (CDR) along with being sent to the ACE MOC in their own virtual stream within 10 seconds of receipt of the last bit of the frame and identified as Virtual Stream 1.

Requirement will be met

DSN Response: *ACCEPTED*

2000-4.9

Virtual Channel 2 telemetry frames which can be successfully frame synchronized and RS decoded

shall be packed into an SFDU with a DDD header as defined in DSN Document 820-13 Module TLM-3-27 (ACE) with new RS coding bits attached and saved to the CDR along with being sent to the ACE MOC in their own virtual stream within 10 minutes of receipt of the last bit of the frame and identified as Virtual Stream 2.

Requirement will be met

DSN Response: *ACCEPTED*

2000-4.10

Deleted.

2000-4.11

Contingency mode shall be supported by recording the bit stream in 7968 bit chunks with a DDD header as defined in DSN Document 820-13 Module TLM - 3 - 27 (ACE) and saved to the CDR and identified as Virtual Stream 3.

DSN Response: *ACCEPTED*

2000-4.12

Deleted.

2000-4.13

Deleted.

2000-4.14

Deleted.

2000-4.15

The DSN shall provide statistical information about the Reed-Solomon decoding to the ACE MOC. The content of statistical information shall be agreed upon by the DSN and the ACE Project.

Requirement will be met

DSN Response: *ACCEPTED*

2000-4.16

The Reed-Solomon Decoding Process shall not introduce a latency of frames prior to processing. Each frame shall be decoded and sent on as soon as it has arrived.

Requirement will be met

DSN Response: *ACCEPTED*

2000-5

The DSN shall be compatible with the command structure defined in Figure 2000-6. Refer to the ACE C&DH subsystem specification for the most current information.

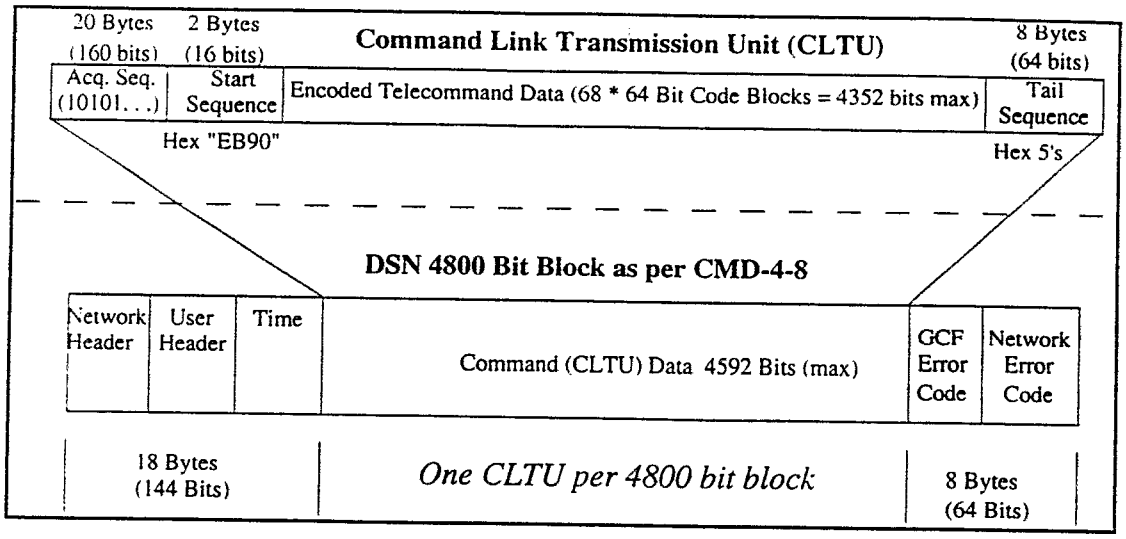


Figure 2000-6. ACE Command structure.

Requirement will be met

DSN Response: *ACCEPTED*

2000-5.1

The DSN shall provide command data storage and subsequent radiation to the ACE spacecraft in accordance with the real-time command interface as defined in DSN Document 820-13 Module CMD 4-8.

Requirement will be met

DSN Response: *ACCEPTED*

2000-5.2

Command Modulation- The DSN shall modulate NRZ-L command data (1000 bps) on a 16 kHz sinewave subcarrier prior to modulation onto a carrier. The command data shall be coherent with the 16 kHz subcarrier.

Requirement will be met

DSN Response: *ACCEPTED*

2000-5.3

Subcarrier Turn-on Time - The DSN shall turn-on the subcarrier within 30 seconds after completion of the uplink carrier acquisition sweep and shall remain in the "on" state until pass operations are completed.

Requirement will be met

DSN Response: *ACCEPTED*

2000-5.4

The DSN shall uplink command data (as required) in near real-time during the passes scheduled for

telemetry data acquisition.

Requirement will be met

DSN Response: *ACCEPTED*

2000-5.5

The DSN shall provide the capability to store, recover, and radiate commands in the DSCC in order to support emergency commanding of the ACE during periods when the communication lines between the IMOC and the DSN are down, as specified in CMD-4-8 DSN Throughput Command Interface, section 3.

Requirement will be met

DSN Response: *ACCEPTED*

2000-5.6

The MIL-71 facility shall transmit ACE MOC commands to the spacecraft or simulator on the launch pad or in ER support facilities during spacecraft tests prior to launch.

Requirement will be met

DSN Response: *ACCEPTED*

2000-5.7

The DSN shall be compatible with the uplink requirements summarized in Figure 2000-7.

DSN Response: *ACCEPTED*

Mission Phase	Service	Data Type	Total Bit Rate	Format	Pass Frequency	Pass Duration	Purpose
All Phases	S-Band 2097.981 MHz	Command	1 Kbit/sec	• NRZ-L • PCM • CCSDS COP-1	Passes will occur once per day for both Transfer Trajectory and Halo Orbit Operations	Passes will be 10 hours in length from Launch to L+15 days. From L+15 until Halo Orbit Insertion they will be at least 4 hours. During Halo Orbit Operations, they will be at least 3 1/2 hours.	Spacecraft command data. VC1 is used for C&DH-A VC2 is used for C&DH-B Also used for CCSDS control commands.

Figure 2000-7. Uplink requirements.

2000-5.8

The DSN shall provide command echo capability in real time.

Requirement will be met

DSN Response: *ACCEPTED*

2000-6

The DSN shall provide antenna and station monitoring information during each ACE support.

Requirement will be met

DSN Response: *ACCEPTED*

2000-6.1

The DSN monitoring information shall be collected and transmitted in each DSN monitoring block for the entire duration of the support.

Requirement will be met

DSN Response: *ACCEPTED*

2000-6.2

The DSN shall provide DSN monitor data to the ACE MOC every 5 seconds as defined in DSN Document 820-13, Module MON 5-16.

Requirement will be met

DSN Response: *ACCEPTED*

2000-7

Deleted.

2000-8

The DSN shall provide an Internet Protocol (IP) multimission network interface between JPL and GSFC which supports the ACE mission.

Requirement will be met

DSN Response: *ACCEPTED*

2000-8.1

The DSN shall provide the capability for the ACE MOC to request file transfers of all recorded ACE mission data in a post-pass (non-real-time) time frame. JPL will provide all support and maintenance of the interface.

Requirement will be met

DSN Response: *ACCEPTED*

2000-8.1.1

Deleted.

2000-8.2

The DSN shall provide the capability for the ACE Science Center to request file transfers of all recorded ACE mission data in a post-pass (non-real-time) time frame. JPL will provide all support and maintenance of the interface.

DSN Response: *ACCEPTED*

2000-8.3

All recorded ACE mission data 4 days old (or less) shall be available at JPL on-line for file transfer upon request. Older data (30 days old or less) will be retained off-line for file transfer upon request.

Requirement will be met

DSN Response: *ACCEPTED*

2000-8.4

Transport of all ACE real-time and near-real-time command, telemetry, and monitor data between the DSN and GSFC shall be supported by a reliable, fault-tolerant IP interface as described in DSN document 820-13, module GCF-10-21.

Requirement will be met

DSN Response: *ACCEPTED*

2000-8.5

The DSN-GSFC IP interface shall support the standard TCP/IP protocol suite of applications, including "ping," "traceroute," "SNMP," and "DNS."

Requirement will be met

DSN Response: *ACCEPTED*

2000-8.6

The DSN shall create, record, and/or transmit in real-time or near-real-time the telemetry virtual streams defined in Figure 2000-8 below:

Virtual Stream	Contents	Frame Sync'd	RS Decoded	Saved to CDR	Trans. to MOC	Trans. Latency
1	VC1 + New RS	Yes	Yes	Yes	Yes	10 sec
2	VC2 + New RS	Yes	Yes	Yes	Yes	10 Min.
3	All received telemetry bits	No	No	Yes	No	N/A

Figure 2000-8. Virtual Telemetry Streams

Requirement will be met

DSN Response: *ACCEPTED*

2000-8.7

Deleted.

2000-8.8

Deleted.

2000-8.9

Deleted.

2000-8.10

Deleted.

2000-8.11

The DSN shall transmit the ACE tracking data to the Flight Dynamics Facility at GSFC via TCP/IP. The data shall be formatted in the standard 4800 bit block tracking data block as defined in the GSFC/JPL Interface Control Document Revision January 1994. The interface for acquisition data transmission shall remain unchanged.

DSN Response: *ACCEPTED*

2000-9

The DSN shall perform pre-launch testing with appropriate ground system elements to verify that the network is compatible with the ACE telemetry, tracking and commanding systems.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.1

The DSN shall participate in simulations and spacecraft tests with GSFC elements.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.2

The MIL-71 facility shall support pre-launch testing of telemetry, ranging, and commanding through an RF link to the spacecraft at the launch site.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.3

The MIL-71 facility shall process the RF downlink into a bit stream.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.4

The MIL-71 facility shall transfer the bit stream to DSN for further dissemination to the ACE MOC.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.5

The DSN shall conduct a Mission Readiness Test Program during the period from 2/15/97 to 5/15/97. The successful completion of this program shall result in the DSN being declared to have achieved a state of operational readiness to support further Project/DSN testing and the actual mission.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.6

The DSN shall support ACE MRTs (Mission Readiness Tests) which will be scheduled from 2/15/97 to 5/15/97, including use of MIL-71 when applicable.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.7

The MIL-71 facility shall receive the RF downlink from the ACE spacecraft or simulator as summarized in Figure 2000-9.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.8

MIL-71 shall ship the telemetered data to DSN for further dissemination to the ACE MOC.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.9

The MIL-71 facility shall accept and forward commands from the ACE MOC to the ACE observatory during testing.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.10

The DSN shall support post-launch testing as required by mission operations as part of the preparations for specific mission phases and/or events.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.11

The DSN shall support the following test schedule:

Test Activity	Dates
CCSDS/CPA Compatibility testing	Mar/Apr 95
DTF-21 Compatibility testing	Jan 96
End-to-End with:	
DSN Compatibility Test Van @ APL	May 96
DSN Compatibility Test Van @ GSFC	Feb 97
Compatibility Test with MIL-71	Aug 97

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.12

The DSN shall provide an S-band uplink/downlink, and an MFR receiver in the Compatibility Test Trailer (CTT) by April 1, 1996 to support testing at APL and at GSFC.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.13

The DSN shall provide an MFR receiver at DTF-21 by December 1, 1995.

Requirement will be met

DSN Response: *ACCEPTED - DTF-21 will use one of MFRs installed in the CTT.*

2000-9.14

The DSN shall provide an S-band uplink/downlink, an MFR receiver at MIL-71 to support end-to-end MRT by June 1, 1997.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.15

The DSN shall provide MIL-71 to support MRT end-to-end test at ER.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.16

The DSN shall provide the DSN CTT for end-to-end compatibility testing.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.16.1

The CTT shall have the capability to interface to an IP network for transfer of telemetry and commands.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.17

The DSN shall provide DTF-21 for compatibility testing.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.18

CCSDS/CPA Test - The DSN shall provide DTF-21 for CCSDS/CPA command compatibility testing.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.19

The DSN shall support transponder compatibility testing and End-To-End network compatibility testing as specified in 2000.9.11

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.20

The DSN shall support all test activities with the identical telemetry and command requirements described in Figure 2000-2.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.21

The DSN shall support scheduled interface tests and simulations with the ACE MOC at GSFC. These data flows shall include all DSN stations projected for use during the ACE mission.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.22

The DSN shall accept digital spacecraft data for retransmission to the MOC at GSFC.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.23

The DSN shall support interface testing with a GSFC developed simulator as the data source at the DTF-21 and MIL-71 facilities.

DSN Response: *ACCEPTED*

2000-9.24

The DSN shall support engineering checkout testing of all operational data types over all assigned operational circuits.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.25

Configuration Verification - The DSN shall support interface testing which will be conducted shortly following installation of NASCOM circuits between GSFC NASCOM and the MOC.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.26

The DSN shall support initial circuit testing between JPL Communications and the ACE MOC.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.27

The DSN shall support checkout scheduling - periodically, as MOC capabilities come on line, data flows of various data types shall be required for check-out of those capabilities.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.28

Deleted.

2000-9.29

Telemetry data flows shall utilize project provided digital test data that shall be processed through DSN Telemetry Processing Equipment.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.30

Deleted.

2000-9.31

The DSN shall generate a report of RF testing results for use by the project and ground stations.

Requirement will be met

DSN Response: *ACCEPTED*

2000-9.32

The DSN shall provide a timetag accuracy of 1 millisecond referenced to UTC.

Requirement will be met

DSN Response: *ACCEPTED*

ACE 3000 — Testing and Training Summary

General - A series of tests will be performed to verify the readiness of the ground facilities to support the ACE mission. These tests will examine the compatibility of the ground facilities with the spacecraft and launch vehicle. Testing will also review overall launch readiness. Acceptance testing of the ground elements will be performed to demonstrate the capability of the ground elements to meet the requirements outlined in this document. Test Plans will be drawn up and submitted for Project review and approval.

A number of capabilities will be provided to enable system testing as noted below:

1 Use of MIL-71 at MILA to test end to end compatibility with the Deep Space Network.

2 A revised Program Data Formatter will be used to interface with the spacecraft or spacecraft Ground Support Equipment during testing and integration. This PDF may be of a different design than those of the past, in order to meet new ground communications protocols under consideration.

3 Means will be provided to allow data communications between the Applied Physics Laboratory and GSFC during observatory integration and test, and to facilitate data communications while the spacecraft is at the launch center.

4 Testing will use the simulator described in section 3400 of these requirements.

Current plans for RF compatibility testing include:

1 The spacecraft manufacturers to fly the transponder to DSN facilities in California.

2 JPL Compatibility Test Trailer interface testing with the spacecraft at APL.

3 JPL Compatibility Test Trailer interface testing with the spacecraft at GSFC

4 MIL-71 testing with the spacecraft at the launch site.

In overview, the ground system elements to be tested are:

1 The Deep Space Network

2 The Missions Operations Center

3 The Flight Dynamics Function

4 The Level Zero Processing Capability

5 Ground communications lines

6 The ACE Science Center

7 The ACE Remote Science Centers

Final testing must account for changes from previous missions; test plans reviewed by the Project must therefore also account for these changes.

ACE 3000 — Testing and Training Summary

Testing will include:

1 Ground Element to Element testing to assure individual element communications

2 Functionality assurance that each node can process received data properly.

3 End to end continuity: System communications check from the Spacecraft to the ACE Science Center.

4 End to end flight simulations : To assure that the ground systems are capable of meeting the flight scenarios.

Training of the ground system personnel will also be conducted. This will include training the teams of each ground system element. In addition, simulations will be conducted prior to launch that prepares the end-to-end ground system organization for flight. Several normal day, early operations and contingency operations simulations employing flight operations support personnel, voice lines, facilities, procedures, and systems will be drawn up to test and stress the ground team organization.

ACE 3100 — Compatibility Testing

3100-1

Testing shall be performed to verify the compatibility of the ground facilities with the spacecraft and launch vehicle. Compatibility testing shall include RF compatibility, command compatibility, telemetry compatibility, and other forms of compatibility. Test plans shall be created and made available for project review and approval for all tests that are to be conducted.

Requirement will be met

3100-2

Moved to 2000.9.31

3100-3

Tests shall be conducted with either direct access to the spacecraft, when commanding is required, or via spacecraft telemetry tapes when only data flow is needed.

Requirement will be met

3100-4

In order to perform the Spacecraft-to-ground system compatibility tests, the following shall be provided:

Requirement will be met

3100-4.1

A command and telemetry link between the S/C location and the ACE MOC/Special Operations Training Area (SOTA) at GSFC shall be provided.

Requirement will be met

3100-4.2

Two-way voice communication between the S/C location and the ACE MOC/SOTA at GSFC shall be provided.

Requirement will be met

3100-4.3

Equipment capable of performing the PDF function shall be provided.

Requirement will be met

3200-1

Network Readiness testing shall be conducted with all ground sites to verify the functional interfaces between GSFC and the sites, and to ensure the mission readiness of ground station hardware, software, and personnel. Test plans shall be created and made available for project review and approval for all tests that are to be conducted. The network readiness tests shall include, but are not limited to, tests that perform the following functions:

Requirement will be met

3200-1.1

Testing shall verify that telemetry data flows, at all required data rates, are properly processed and handled by the ground system.

Requirement will be met

3200-1.2

Testing shall verify that all command flows are properly processed and handled by the ground system.

Requirement will be met

3200-1.3

Testing shall verify that status and accounting information provided by the DSN is correct.

Requirement will be met

3200-1.4

Testing shall verify proper operation of all the scheduling system interfaces.

Requirement will be met

3200-2

Using telemetry tapes, project simulators, or site-provided data generators, data flows shall be performed between the DSN, ACE MOC, ACE Science Center (ASC), and facilities performing the data processing and data distribution functions.

Requirement will be met

ACE 3300 — Mission Readiness Testing

3300-1

Mission Readiness testing shall be conducted to verify the performance and demonstrate the readiness of the integrated MO&DSD Ground Data System (GDS) to support the ACE spacecraft/project.

Requirement will be met

3300-2

Test plans shall be created and made available for project review and approval for all tests that are to be conducted.

Requirement will be met

3300-3

A test schedule shall be provided for Project review.

Requirement will be met

3300-4

Deleted.

The mission readiness tests shall include:

3300-4.1

Data Analysis Tests.

Requirement will be met

3300-4.2

Telemetry/Command Processing Tests.

Requirement will be met

3300-4.3

Command Management Tests.

Requirement will be met

3300-4.4

Science Data Processing Tests.

Requirement will be met

3300-4.5

On Board Data Processing Tests.

Requirement will be met

3300-4.6

Telemetry/Tracking/Command Processing Tests.

Requirement will be met

3300-4.7

Mission/Science Planning Tests.

Requirement will be met

3300-4.8

Launch Site to GSFC I/F Tests.

Requirement will be met

3300-4.9

Fully integrated Ground Data System Tests.

Requirement will be met

3300-5

The Ground Elements shall support Project conducted mission simulations with the spacecraft and other simulations using the ACE simulator.

Requirement will be met

3300-6

Final verification of launch readiness shall be accomplished through hard-line and RF data flows with the spacecraft at the launch site.

Requirement will be met

3300-6.1

The hard-line interface shall be utilized by the MOC to assist the I&T staff in performing spacecraft functional tests and verifying the launch configuration.

Requirement will be met

3300-6.2

The RF interface shall be exercised with the GN/DSN to verify the ACE transponder performance.

Requirement will be met

3300-7

The following shall be provided to perform Mission Readiness testing:

Requirement will be met

3300-7.1

A command and telemetry link between the S/C location and the ACE MOC/SOTA at GSFC shall be provided.

Requirement will be met

3300-7.2

Two-way voice communication between the S/C location and the ACE MOC/SOTA at GSFC shall be provided.

Requirement will be met

3300-7.3

Equipment capable of performing the PDF function to interface with the spacecraft Ground Support Equipment shall be provided.

Requirement will be met

3400-1

SUPPORT REQUIREMENTS

The simulator shall support training of the ACE Project Flight Teams and testing of the ACE ground system

3400-2

EXTERNAL INTERFACES

The simulator shall model the IMOC to DSN interface as well as be able to support Launch Site testing.

3400-3

SYSTEM REQUIREMENTS

The simulator shall provide means for members of the ACE flight team to directly control its operations as well as providing a portable version that can support launch site testing

3400-4

DYNAMIC SPACECRAFT SIMULATOR REQUIREMENTS

The simulator shall model all of the major subsystems of the ACE spacecraft.

3500-1

The Ground Elements shall provide any necessary training to the FOT prior to tests in which the FOT will be involved.

Requirement will be met

General: - The GSFC MO&DSD will provide, integrate, maintain and operate the ACE ground system, including interfaces with the ACE MOC.

The MOC is the focal point for all ACE on-orbit operations; from the MOC the ACE FOT will plan and coordinate activities necessary to achieve ACE mission objectives. Processing for command uplinks and analysis of displayed downlink data for interactive observatory control will be accomplished by the FOT in the MOC. The Mission Operations Center (MOC) is required to support the conduct of pre-launch through on-orbit operations seven days per week. The MOC will support the FOT in ensuring that, as a minimum, 90% of all scientific data is provided to the ASC to meet mission requirements.

The MOC will provide the capability to allow the FOT to capture spacecraft and instrument H/K telemetry data, deliver attitude data to the FDF, determine data acquisition status, and manage the spacecraft recorders. The goal is to ensure acquisition of all data and to allow FOT commanded replay of data not acquired initially within the two day capacity of the spacecraft recorders.

The MOC will facilitate data capture and mission planning by offering an integrated environment that performs tasks associated with safe, pre-planned operation of the spacecraft. The system will make use of automated functions where possible, but will allow the option of manual overrides. Flexibility and ease of use will be maximized by methods such as utilization of namelist files and automatic process initiation. Graphic displays will be offered as an option to tabular or list displays. Color coding to enhance readability will be an integral part of the system's displays, and an on-line help function will be available for each subsystem .

The MOC will provide electronic mail to facilitate communications between the FOT and ASC.

4100-1

The MOC shall provide a physically secure facility which provides external interfaces and data security for a mission planning and scheduling system, a command and control capability, a telemetry data processing capability, and a data management capability to support mission operations.

Requirement will be met

4110-1

The MOC shall interface to the ACE Science Center, the Flight Dynamics Function, the Deep Space Network, the ACE Test & Training Simulator, and the Launch Facility.

Requirement will be met

4111-1

The MOC shall interface with the DSN.

Requirement will be met

4111-2

The MOC system shall ensure that there are no intervening command blocks between a multiblock command when sending commands to the DSN.

Requirement will be met

4111-3

The MOC shall error check the DSN/Goddard Interface Blocks (DGIB) blocks and provide cumulative counters of blocks with errors.

Requirement will be met

4111-4

The MOC shall provide data accounting statistics and displays.

Requirement will be met

4111-5

The MOC shall provide the capability to reset the accounting statistics.

Requirement will be met

4111-6

The MOC shall process data contained within erroneous DGIB blocks, but shall flag that data as of questionable quality.

Requirement will be met

4113-1

The MOC shall interface with the Flight Dynamics Function and as a minimum provide the following information: Maneuver Planning Information, Propulsion System Commands, Ground Station Contacts, Attitude and Orbit Information, Attitude Sensor Calibration. Refer to Section 7000 for additional information.

Requirement will be met

4115-1

The MOC shall be required to interface with the ACE Science Center.

Requirement will be met

4115-2

The MOC shall supply real-time and playback telemetry to each of the Science Instruments' Ground Support Equipment (IGSE).

Requirement will be met

4120-1

The MOC shall provide a user interface for control of all processes, retention of data and display of results.

Requirement will be met

4121-1

The MOC shall provide the capability to accept and process interface language requests.

Requirement will be met

4121-2

The MOC shall provide the capability to parse and verify directives.

Requirement will be met

4121-3

The MOC shall provide the capability to execute directives.

Requirement will be met

4121-4

The MOC shall provide the capability to execute procedures which may be initiated manually or called from other procedures.

Requirement will be met

4121-5

The MOC shall provide the capability to validate user operation privileges.

Requirement will be met

4121-6

Deleted.

4122-1

The MOC shall provide the capability to generate hard copy reports.

Requirement will be met

4122-2

The MOC shall provide the capability to generate display snapshots.

Requirement will be met

4122-3

The MOC shall provide the capability to generate sequential prints.

Requirement will be met

4122-4

The MOC shall provide the capability to generate MOC reports.

Requirement will be met

4122-5

The MOC shall provide the capability to print MOC reports.

Requirement will be met

4123-1

The MOC shall provide the capability to generate displays for the user in a windowing environment

Requirement will be met

4123-2

The MOC shall provide the capability to evaluate display requests.

Requirement will be met

4123-3

The MOC shall provide the capability to generate user parameter displays.

Requirement will be met

4123-4

The MOC shall provide standard system monitoring displays.

Requirement will be met

4123-5

The MOC shall provide the capability to generate user defined operational displays.

Requirement will be met

4123-6

The MOC shall provide the capability to generate the following graphical displays:

- Real-time rescalable X-Y and X-T plots of real-time or playback parameters.

- Mission planning timelines that graphically represent planned mission events in relation to each other on a time-oriented graph.

- Solid State Recorder (SSR) displays that show the data set allocations and playback status of each spacecraft SSR.

- Displays to graphically depict telemetry data sets for analysis.

- Displays to graphically depict spacecraft subsystem telemetry for analysis.

- X-Y plots and X-T plots that will animate from one to five virtual pens in a scrollable window for plotting from one to five real-time or playback data items against another parameter (X-Y plot) or time (X-T plot).

Requirement will be met

4123-7

The MOC shall provide the capability to generate command panels.

Requirement will be met

4123-8

The MOC shall provide a STOL Procedure Status Display.

Requirement will be met

4123-9

The MOC shall provide a STOL Procedure Execution Display.

Requirement will be met

4123-10

The MOC shall provide a real-time alarms display.

Requirement will be met

4123-11

The MOC shall provide history logging, replay, playback, and delogging displays.

Requirement will be met

4123-12

The MOC shall provide the capability to display telemetry ancillary data.

Requirement will be met

ACE 4124 — Event Message Requirements

4124-1

The MOC shall provide the capability to log and route events messages.

Requirement will be met

4130-1

The MOC shall provide a Mission Planning Function (MPF).

Requirement will be met

ACE 4131 — Planning Sources

4131-1

The MOC MPF shall receive and send network scheduling information from and to the DSN.

Requirement will be met

4131-2

The MOC MPF shall receive products from the Flight Dynamics Function.

Requirement will be met

4131-3

The MOC MPF shall receive input from the ACE FOT.

Requirement will be met

4131-4

The MOC MPF shall receive products from, and send products to, the ASC.

Requirement will be met

4131-5

The MOC MPF shall receive input from the Project Data Base (PDB).

Requirement will be met

4131-6

Deleted.

4132-1

The MOC shall maintain a Mission Planning Function (MPF).

Requirement will be met

4132-2

The MOC MPF shall have the capability to interactively enter planning information.

Requirement will be met

4132-3

The MOC MPF shall not lock out the user from interacting with the system for longer than 30 seconds.

Requirement will be met

4132-4

The MOC MPF shall provide a tool to submit DSN schedule requests, submit DSN contact sequences, and view confirmed DSN contact sequences and schedules.

Requirement will be met

4132-5

The MOC MPF shall have the capability to accept UTC, translate this data to S/C counter time, and make the translated S/C counter time available to all other MPF functions.

Requirement will be met

4132-6

The MOC MPF shall provide a tool to assemble bin load commands.

Requirement will be met

4132-7

Tools shall be available within the MOC to view all files generated by the MPF at the byte level, including binary files.

Requirement will be met

4132-8

The MOC MPF shall be available to support the ACE MOC testing schedule and operations.

Requirement will be met

4132-9

The MOC MPF shall support rapid replanning and regeneration of plans and schedules capable of

running concurrently with real time operations.

Requirement will be met

4132-10

The MOC MPF shall support rapid regeneration of loads. This function must be able to run concurrently with real time operations.

Requirement will be met

4132-11

The MOC MPF software shall allow the generation, in 10 minutes or less, of activity plans and schedules for generic support for a one week period.

Requirement will be met

4132-12

The MOC MPF will provide a capability to define and store a minimum of 20 prototype activity plans or schedules. These plans or schedules may or may not be for the same time period.

Requirement will be met

4132-13

The MOC MPF software shall allow maintenance operations (Software updates, backups/archives, file maintenance) to take less than 1 hour.

Requirement will be met

4132-14

The MOC MPF shall provide a tool to define and edit activities including commands and the rules/constraints associated with activities.

Requirement will be met

4132-15

As a minimum, the MOC MPF will provide the capability to differentiate between operational, development, test, and archive plan and schedule data.

Requirement will be met

4132-16

The MOC MPF shall provide an automated mechanism for cleaning up user defined "expired" data from the MOC MPF system.

Requirement will be met

4132-17

The MOC MPF shall maintain activities in a database and provide an interactive, graphical user interface to retrieve them during planning and scheduling.

Requirement will be met

4132-18

The MOC MPF shall provide an interactive, graphical user interface to define, edit, add, and delete activities and classes of activities from the activity plan.

Requirement will be met

4132-19

The MOC MPF shall provide constraint checking at the activity level.

Requirement will be met

4132-20

The MOC MPF shall provide the capability to define whether a spacecraft activity will go to the spacecraft C&DH-A or C&DH-B as specified in any of the following ways: Specific: A or B, Relative: Primary or Secondary, Active/Backup.

Requirement will be met

4132-21

Deleted.

4132-22

Deleted.

4132-23

Deleted.

4132-24

Deleted.

4132-25

When assembling time tag commands, the MOC MPF shall determine what goes into the "Time of Execution" field based on any of the following input formats: Raw S/C counter time, UTC, UTC offset from S/C or ground events, UTC offset from other commands or activities.

Requirement will be met

4132-26

The MOC MPF shall have the capability to integrate Spacecraft Absolute Time Activities and Spacecraft Relative Time Activities into a stream of commands which will execute at precise absolute times following check and satisfaction of all activity rules and constraints.

Requirement will be met

4132-27

Deleted.

4132-28

The MOC MPF shall provide a tool to generate new "TIME TAG BIN LOAD" commands to replace time-tag commands on the spacecraft which have not already executed when a spacecraft time set command is transmitted in real time.

Requirement will be met

4132-29

Deleted.

4132-30

The MOC MPF shall provide constraint checking at the command level.

Requirement will be met

4132-31

The MOC MPF shall be aware of data concerning the current and future status of all spacecraft bins.

Requirement will be met

4132-32

The MOC MPF shall have the capability to allow the mission planner to manually choose precisely which bin or bins will be used to place uploads and shall alert the user if any conflicts occur.

Requirement will be met

4132-33

The MOC MPF shall have the capability to automatically choose, based on the status of the bin during the planning period, into which block bins to place uploads and then use this information to automatically prepare LOAD BLOCK BIN commands.

Requirement will be met

4132-34

The MOC MPF shall sub-divide block bin loads which are larger than 256 bytes into multiple block bins.

Requirement will be met

4132-35

The MOC MPF shall add appropriate "EXECUTE BLOCK BIN" commands to block bin loads when a single load must be divided among more than one bin because it exceeds the block bin size of 256 bytes.

Requirement will be met

4132-36

The MOC MPF shall provide the capability, when building a spacecraft autonomy activity, to select any valid spacecraft telemetry mnemonic and convert it to autonomy target data by determining its byte offset in the spacecraft collection buffer.

Requirement will be met

4132-37

The MOC MPF shall ensure that all autonomy bin load commands are created and uploaded in the enabled state.

Requirement will be met

4132-38

The MOC MPF shall have the capability to automatically choose, based on the status of the bin during the planning period, which autonomy bin, and block bin(s) if needed, to place a spacecraft autonomy activity. The MOC MPF will then use this information to prepare AUTONOMY LOAD COMMANDS and, if needed, BLOCK BIN LOAD COMMANDS. It will also add appropriate commands to the autonomy upload if it takes more than one block bin to hold the upload.

For instance, if a spacecraft autonomy activity contains the rule and one command, then it can be held in just a single autonomy bin. If the spacecraft autonomy activity contains the rule and 10 commands, then the autonomy object command may be a BLOCK BIN EXECUTE (BIN #5) command. The balance of the commands must then be held in the block bin #5.

Requirement will be met

4132-39

The MOC MPF shall have the capability to automatically choose, based on the status of the bin during the planning period, which time tag bin, and block bin(s) if needed, to place a spacecraft relative or absolute time activity. The MOC MPF will then use this information to prepare TIME TAG LOAD COMMANDS and, if needed, BLOCK BIN LOAD COMMANDS. It will also add appropriate commands to the time tag upload if it takes more than one block bin to hold the upload.

For instance, if a spacecraft relative or absolute time activity contains the execute time and one command, then it can be held in just a single time tag bin. If the spacecraft relative or absolute time activity contains the execute time and 10 commands, then the time tag object command may be a BLOCK BIN EXECUTE (BIN #17) command. The balance of the commands must then be held in the block bin #17.

Requirement will be met

4132-40

The MOC MPF shall exclude any command not specifically designated for use as a block bin object command when assembling a block bin load command.

Requirement will be met

4132-41

The MOC MPF shall exclude any command not specifically designated for use as a time tag object

command when assembling a time tag bin load command.

Requirement will be met

4132-42

The MOC MPF shall exclude any command not specifically designated for use as an autonomy object command when assembling an autonomy bin load command.

Requirement will be met

4132-43

The MOC MPF shall ensure that all specified time limitations as noted in ACE C & DH Specifications document are obeyed when assembling a thruster setup command.

Requirement will be met

4132-44

The MOC MPF shall provide the capability to bypass all error checking, except size allocation, when generating a "DATA" command.

Requirement will be met

4132-45

The MOC MPF shall validate/error check command sub mnemonics during development of the schedule.

Requirement will be met

4132-46

The MOC MPF shall check constraints associated with all activities included in an activity plan and will warn the mission planner when constraints are violated.

Requirement will be met

4132-47

The MOC MPF shall provide constraint checking capabilities for all command types.

Requirement will be met

4132-48

The MOC MPF shall provide value checking (such as range or value consistency) for selected spacecraft or instrument tables and selected bins.

Requirement will be met

4132-49

The MOC MPF shall issue a warning if two time tag bins are being scheduled to fire at the same time. This warning will occur at the earliest possible moment in the planning cycle, including comparing time tag bins which already may be loaded on the spacecraft with those being planned to

be loaded.

Requirement will be met

4133-1

The MOC MPF shall generate spacecraft loads.

Requirement will be met

4133-2

The MOC MPF shall have the capability to produce and manage multiple loads for the same time period.

Requirement will be met

4133-3

The MOC MPF shall have the capability to save a copy of a load to all available user designated storage devices and storage areas.

Requirement will be met

4133-4

The MOC MPF shall have the capability to save to disk the ASCII equivalent of a binary load.

Requirement will be met

4133-5

A goal of the MOC MPF is that it shall have the ability to schedule and initiate procedures that configure and control ground elements.

Requirement will be met

4133-6

The MOC MPF shall automatically produce pass plans which can be printed or displayed.

Requirement will be met

4133-7

The MOC MPF shall have the capability to save copies of pass plans to all available user designated storage devices and storage areas.

Requirement will be met

4133-8

The MOC MPF shall automatically receive DSN schedules.

Requirement will be met

4133-9

The MOC MPF shall provide an interactive graphical user interface to view DSN network schedules.

Requirement will be met

4133-10

The MOC MPF shall provide an interactive, graphical user interface to submit network schedule change requests to the DSN.

Requirement will be met

4133-11

The MOC MPF shall generate an Integrated Contact Timeline which can be displayed or printed.

Requirement will be met

4133-12

The MOC MPF shall provide an automatically updated display showing progress of many days worth of planning.

Requirement will be met

4140-1

The MOC shall provide the capability to command the ACE spacecraft and control the ground system as defined by the requirements in the following sections.

Requirement will be met

4141-1

The MOC shall provide the capability to control the commanding environment.

Requirement will be met

4142-1

The MOC shall provide the capability for the user to modify the command environment.

Requirement will be met

4142-2

The MOC shall provide the capability to correct Ground Reference Image (GRI) files based on the dump image or initialization.

Requirement will be met

4143-1

The MOC shall provide the capability to generate real-time commands from mnemonic or raw input.

Requirement will be met

4143-2

The MOC shall provide the capability to perform criticality checks on real-time commands.

Requirement will be met

4143-3

The MOC shall provide the capability to build CCSDS Telecommand Packets.

Requirement will be met

4143-4

The MOC shall provide the capability to build CCSDS Control Commands.

Requirement will be met

ACE 4144 — Command Sequence Generation

4144-1

The MOC shall provide the capability to convert command sequences to information that can be uploaded to the spacecraft.

Requirement will be met

4144-2

The MOC shall provide the capability for the user to create and send each of the three types of spacecraft bin load commands: Autonomy, Timetag, and Block.

Requirement will be met

4144-3

The MOC shall provide the capability to format science instrument commands and selected spacecraft subsystem commands into spacecraft Data Commands.

Requirement will be met

4144-4

The MOC system shall be capable of ingesting the mission planning output files and performing any necessary processing for uplink as command sequence loads.

Requirement will be met

4144-5

The MOC system shall provide the capability to edit a command sequence product prior to final binary file generation.

Requirement will be met

4144-6

Deleted.

4145-1

The MOC shall provide the capability to process commands for uplink to the spacecraft from previously generated command load files.

Requirement will be met

4146-1

The MOC shall build CCSDS Transfer Frames. Refer to the C&DH subsystem specification for additional information.

Requirement will be met

4146-2

The MOC shall uplink command transfer frames.

Requirement will be met

4146-3

The MOC shall provide the user with the capability to build DSN Test Blocks.

Requirement will be met

4146-4

The MOC shall transmit command blocks upon user request.

Requirement will be met

4146-5

The MOC shall maintain a command buffer containing telecommand transfer frames that have been transmitted but are awaiting COP-1 verification, and telecommand transfer frames that are awaiting transmission. The Command Buffer display shall differentiate those commands that have been transmitted from those that have not been transmitted.

Requirement will be met

4146-6

The MOC shall provide a user configurable option to either package one command per transfer frame or package as many commands as will fit in a transfer frame.

Requirement will be met

4146-7

The MOC system shall ensure that commands that are assigned different VC's are placed into separate transfer frames.

Requirement will be met

4146-8

The MOC shall update the GRIs for bin loads and memory pokes based on command mode settings.

Requirement will be met

4146-9

The MOC shall maintain separate Frame Sequence Counters for each uplink Virtual Channel.

Requirement will be met

ACE 4150 — Spacecraft Telemetry

4150-1

The MOC shall receive and process ACE spacecraft telemetry.

Requirement will be met

ACE 4151 — Telemetry Reception

4151-1

The MOC shall be able to accept telemetry data from the spacecraft.

Requirement will be met

4151-2

The MOC shall be able to extract Telemetry Packets.

Requirement will be met

4151-3

The MOC shall be able to extract Telemetry Packet Time.

Requirement will be met

4151-4

The MOC shall provide the capability to receive and process telemetry in all telemetry formats.

Requirement will be met

4151-5

The MOC system shall be capable of processing ancillary ground message information in the same fashion and capability as it does the spacecraft data itself.

Requirement will be met

4151-6

The MOC shall provide accounting information regarding collected transfer frames and as a minimum:

- Provide event message with UTC time tag for transfer frame lock and loss-of-lock occurrences.

- Provide cumulative counters for transfer frames received.

- Provide a count of total frames accepted for each VC, identifying the total number of frames rejected.

- Provide separate counts of the cumulative number of R/S and sequence errors for each virtual channel.

Requirement will be met

4151-7

The MOC system shall strip out the Command Link Control Word (CLCW) from the transfer frames and conduct parameter stripping and conversion, making the data available for database driven displays, for use in STOL procedure logic, and by the command software.

Requirement will be met

4151-8

The MOC system shall provide a data accountability display.

Requirement will be met

4151-9

The MOC shall provide the capability to reset the accounting statistics.

Requirement will be met

4152-1

The MOC shall extract telemetry parameters from the CCSDS data packets, note the quality of the extracted data, and save the raw values for use by other MOC functions.

Requirement will be met

4152-2

The MOC shall be able to extract (decommutate) analog and discrete parameters from data packets based on database definitions that are defined in the DFCD for the PDB supporting the ACE MOC, and save the raw values for use by other MOC functions.

Requirement will be met

4152-3

The MOC shall monitor the incoming telemetry data and flag all telemetry parameters as poor quality or static when errors or dropouts are detected.

Requirement will be met

4152-4

The MOC shall be able to convert select telemetry to Discrete States.

Requirement will be met

4152-5

The MOC shall be able to convert select telemetry to Engineering Units.

Requirement will be met

4152-6

The MOC shall provide a STOL Directive that performs a one-shot limit check of all telemetry mnemonics (analog and discrete) and system variables.

Requirement will be met

4152-7

The MOC shall calibrate and convert individual telemetry parameters as identified in the Project Data Base (PDB).

Requirement will be met

4152-8

The MOC shall provide the capability to perform context dependent decommutation of telemetry data based on a context-switch mnemonic that is not in the current telemetry format, but is in the current value table.

Requirement will be met

4152-9

The MOC shall allow the user to enter limits for discrete state parameters as either raw counts or as text strings.

Requirement will be met

4152-10

The MOC shall provide the capability to issue an event message that displays the current limit definitions for any specified telemetry mnemonic.

4152-11

The MOC shall enable the user to select whether or not to process poor quality data.

Requirement will be met

4152-12

The MOC system shall be capable of monitoring recorder playback telemetry and automatically determining what data has not been successfully recorded on the ground and shall make this information available to the user during the real-time pass as a continually updating display.

Requirement will be met

4153-1

The MOC shall be capable of delivering telemetry to each of the Science Instruments' Ground Support Equipment.

Requirement will be met

ACE 4154 — Telemetry Analysis

4154-1

The MOC shall perform Limit Checking on select telemetry data.

Requirement will be met

4154-2

The MOC shall provide a Configuration Monitor capability.

Requirement will be met

4154-3

The MOC shall support off-line telemetry analysis.

Requirement will be met

4154-4

The MOC shall be capable of employing user defined equations to convert groups of select telemetry into new derived parameters that may be used for further processing.

Requirement will be met

4154-5

The MOC shall be able to correlate the spacecraft clock time to UTC time and as a minimum, shall:

- Accept the ground receipt time of the spacecraft data encoded within the DGIB header.

- Compare the DGIB time against the spacecraft telemetry time tag within the same DGIB block.

- Account for know delays in the system, including on-board processing, RF propagation delays, DSN equipment processing, bit offsets between telemetry time tag, and DGIB time tagging.

Requirement will be met

4154-6

Deleted.

4154-7

The MOC shall accept alarm processing algorithms from the ACE Science Center and incorporate them into real-time data processing for the real-time stream.

Requirement will be met

4154-8

The MOC shall perform Telemetry Trend and Statistical Analysis.

Requirement will be met

4154-8.1

The trending system shall be capable of ingesting all data from the sources mentioned in Section 4151 and be capable of ingesting history data recorded and saved earlier in the MOC.

Requirement will be met

4154-8.2

The trending system shall be able to analyze the individual telemetry parameters within the data stream.

Requirement will be met

4154-8.3

The trending system shall be capable of analyzing data in converted and unconverted bit forms.

Requirement will be met

4154-8.4

The trending system shall be capable of ingesting and analyzing the data that accompanies the telemetry from the DGIB blocks, the monitor blocks, and the data quality annotation provided by the LZP function.

Requirement will be met

4154-8.5

The trending system shall be capable of ingesting and analyzing the quality check information done by other parts of the MOC system.

Requirement will be met

4154-8.6

The trending system shall provide interactive and automated analysis features. Upon data ingest, the automatic analysis function shall conduct mathematical transformations, save data and results, provide plots, reports and export of data as specified in predefined procedures without further operator interaction.

Requirement will be met

4154-8.7

The MOC system shall provide analysis tools for conducting statistical analysis, algebraic manipulation, curve fitting and transcendental functions.

Requirement will be met

4154-8.8

The trending system shall provide parameter processing to include, as a minimum, statistical processing, occurrence counting, Relational Telemetry Expression (RTE), and curve fitting.

Requirement will be met

4154-8.9

The trending system shall provide a means for defining mathematical data transformations, telemetry parameters, and the output that the transforms produce, and shall maintain a library of such transformations which can be reviewed and updated.

Requirement will be met

4154-8.10

The data analysis tools of the trending system shall be accessible for interactive and automatic processing.

Requirement will be met

4154-8.11

The trending system shall provide graphical plotting tools, which allow the user to define, as a minimum, axis size, tick marks, text annotation, stacked plots, multiple Y axis, and shall support automated analysis and interactive investigations.

Requirement will be met

4154-8.12

The trending system shall provide the capability to plot the following data types:

Requirement will be met

4154-8.12.1

Data transforms vs. Data transforms shall be provided.

Requirement will be met

4154-8.12.2

Data transforms vs. Parameter shall be provided.

Requirement will be met

4154-8.12.3

Data transforms vs. TIME shall be provided.

Requirement will be met

4154-8.12.4

Parameter vs. TIME shall be provided.

Requirement will be met

4154-8.12.5

RTE vs. Parameter shall be provided.

Requirement will be met

4154-8.12.6

RTE vs. RTE shall be provided.

Requirement will be met

4154-8.12.7

RTE vs. TIME shall be provided.

Requirement will be met

4154-8.13

The trending system shall provide the capability to create the following plot types:

Requirement will be met

4154-8.13.1

X vs. Y plots shall be provided.

Requirement will be met

4154-8.13.2

Double Y axis plots shall be provided.

Requirement will be met

4154-8.14

The trending system shall provide the following formatting capabilities:

Requirement will be met

4154-8.14.1

User defined X & Y axis, titles, fonts, styles, and size shall be provided.

Requirement will be met

4154-8.14.2

User defined annotated text within the plots (styles, size) shall be provided.

Requirement will be met

4154-8.14.3

User defined axes range shall be provided.

Requirement will be met

4154-8.14.4

User defined parameter titles shall be provided.

Requirement will be met

4154-8.14.5

User specified tick marks, line styles, and parameter plot icons shall be provided.

Requirement will be met

4154-8.14.6

The MOC shall specify axes in logarithmic or decimal form.

Requirement will be met

4154-8.14.7

The MOC shall specify grid tick marks.

Requirement will be met

4154-8.14.8

The MOC shall provide zooming capabilities.

Requirement will be met

4154-8.15

The trending system shall provide the following plot displays:

Requirement will be met

4154-8.15.1

Display plots on CRTs or hard copies (printouts) shall be provided.

Requirement will be met

4154-8.15.2

Display of up to 6 plots per page shall be provided.

Requirement will be met

4154-8.15.3

Display of up to 15 Y-axis parameters on a single plot shall be provided.

Requirement will be met

4154-8.16

The trending system shall provide a plot editor which shall allow the creation and editing of a definition file which shall incorporate all plotting features for use with the automated portion of the system.

Requirement will be met

4154-8.17

The trending system shall provide the capability to retain signatures of telemetry performance and shall identify deviation or drifts in the data over subsequent samples of the same periodicity.

Requirement will be met

4154-8.18

The trending system shall provide the capability of storing incoming information and the results of mathematical work and shall retain and organize all the data on a combination of storage media (e.g. disks and tapes), providing more immediate access to the most salient data.

Requirement will be met

4154-8.19

The user shall be able to prioritize the importance of select data within the trending system, so that higher priority data is retained on quick access storage media.

Requirement will be met

4154-8.20

The trending system shall provide the capability to retain raw or EU data.

Requirement will be met

4154-8.21

There shall be a variety of query features for polling the database of the trending system including poll for samples satisfying an individual parameter's range and poll against ranges of a number of parameters.

Requirement will be met

4154-8.22

Industry standard multiple platform export features for export of selected information from the database via a data formatting function shall be provided.

Requirement will be met

4154-8.23

The trending system shall provide report tools which provide means for the user to develop tables of information such as tables of mnemonic values or summaries of analysis work.

Requirement will be met

4154-8.24

The trending system shall provide the capability to output a time ordered print out.

Requirement will be met

4154-8.25

The report function of the trending system shall allow the user to print values of individual telemetry mnemonics, data residing in the database, and results of mathematical investigations.

Requirement will be met

4154-8.26

The report function of the trending system shall support the ability to print delta values.

Requirement will be met

4154-8.27

The trending system shall provide the ability to generate hard copies of plots and tables.

Requirement will be met

4154-8.28

The trending system shall print plots on a local or network printing device.

Requirement will be met

4154-8.29

The trending system shall provide the user the ability to print plots in portrait or landscape orientation.

Requirement will be met

4154-8.30

The trending system shall scale the axis of each plot on a page such that the plots fit.

Requirement will be met

4154-8.31

The trending system capacity shall be sufficient to meet the mission daily data processing needs.

Requirement will be met

4154-8.31.1

Quick access storage (e.g. hard disk) shall be sufficient to hold the last three days of work.

Requirement will be met

4154-8.31.2

Total data storage (on-line and off-line) shall be sufficient to retain all processed data from the duration of the mission.

Requirement will be met

4155-1

The MOC shall provide the capability to perform memory dump processing.

Requirement will be met

4155-2

The MOC shall accept requests to perform memory image processing.

Requirement will be met

4155-3

The MOC shall collect memory image dump data from the real-time telemetry packets.

Requirement will be met

4155-4

The MOC shall compare the downlinked dump image with the corresponding GRI and report miscomparisons to the user.

Requirement will be met

4155-5

The MOC shall provide various image processing reports including, as a minimum, dump image listing, GRI listing, and an image comparison report.

Requirement will be met

4155-6

The MOC shall provide the capability for the user to enable/disable automatic updating of the dump image as defined below:

- When enabled, the MOC shall update the composite dump image as dump information is received in the telemetry.
- When disabled, the MOC shall compare the dump with the current image, notify the user of the differences, and provide the user with the capability to chose whether or not to overwrite the dump image.

Requirement will be met

4160-1

The MOC shall provide the capability to manage operational data.

Requirement will be met

4161-1

The MOC shall provide the capability to manage operational support database files.

Requirement will be met

4161-2

The MOC shall provide the capability to manage the project database.

Requirement will be met

4161-3

The MOC shall provide the capability to edit the project database.

Requirement will be met

4161-4

The MOC shall provide the capability to validate the project database.

Requirement will be met

4161-5

The MOC shall provide the capability to generate the operational database.

Requirement will be met

4161-6

The MOC shall provide the capability to generate project database reports.

Requirement will be met

4161-7

The MOC shall provide project database validating and reporting comparison against the specifications outlined in the Database Format Control Document (DFCD).

Requirement will be met

4162-1

The MOC shall be able to generate Display Definitions.

Requirement will be met

4162-2

The MOC shall be able to generate Configuration Monitor Definitions.

Requirement will be met

4162-3

The MOC shall be able to generate and retain operations interface language procedures.

Requirement will be met

4162-4

The MOC shall be able to generate Sequential Print Definitions.

Requirement will be met

4162-5

The MOC shall be able to generate Telemetry Subset Definitions.

Requirement will be met

4162-6

The MOC shall be able to generate and retain MOC Parameter Definitions.

Requirement will be met

4163-1

The MOC shall allow the user to interactively control management and retention of data received, generated within, or distributed by the MOC system.

Requirement will be met

4163-2

The MOC shall provide the capability to record history data.

Requirement will be met

4163-3

The MOC shall provide the capability to replay history data on user request and the retrieved data will be replayed as though received in real-time.

Requirement will be met

4163-4

The MOC shall provide the capability to maintain, archive and restore history data created, captured, or stored in the MOC.

Requirement will be met

4163-5

The MOC shall be capable of recording information generated in the course of telemetry processing.

Requirement will be met

4164-1

Deleted.

4164-2

Deleted.

4164-3

Deleted.

4164-4

Deleted.

4165-1

The MOC shall provide a set of file maintenance functions that will aid the FOT with data management.

Requirement will be met

4166-1

The MOC shall provide the capabilities for the user to initialize and terminate the system for operations.

Requirement will be met

4170-1

While processing real time data, the MOC shall be able to simultaneously process Clock Correlation, Expert system Monitoring, Recorder collection monitor/protection operations, Limits Processing and Trending or Mission Planning support for future day operations.

Requirement will be met

4170-2

When not collecting real-time data, the system shall be capable of simultaneously conducting trending and mission planning operations.

Requirement will be met

4170-3

The system shall be capable of processing data from two streams simultaneously and as a minimum be capable of:

- Handling hand-offs of the spacecraft from one ground station to the next.

- Fully processing the real-time stream including data accounting, decommutation and conversion, and telemetry analysis.

- Performing data accounting and data retention for the playback stream in real-time.

Requirement will be met

4170-4

The MOC shall be able to reconfigure from site to site to allow real-time data capture and spacecraft command privileges within 60 seconds.

Requirement will not be met
Requirement pending Prototype results (April 1996)
"To accommodate reconfigurations from simulated to actual data and rapid transitions from one site to another the MOC shall provide a rapid reconfiguration capability of 60 seconds."

4170-5

Deleted.

4170-6

The MOC shall be capable of capturing quality telemetry data within 7 minutes of a cold start.

Requirement will not be met
Requirement pending Prototype results (April 1996)
"Rapid reconfiguration shall also be capable of bringing the system up from a cold start within 7 minutes."

4170-7

For critical supports, a hot backup string shall be available and capable of assuming spacecraft command privileges and capturing quality telemetry data within 15 seconds.

Requirement will be met

4170-8

Rapid reconfiguration shall include changing the system from one configuration to another within 5 minutes.

Requirement will be met

4170-9

After all needed data has arrived in the MOC, the trending system shall be able to process 24 hours worth of the data within a 4 hour period.

Requirement will not be met
Requirement pending Prototype results (April 1996)
'For automated processing, the trending system shall be able to keep ahead of the arriving data. Starting with 24 hours worth of data having arrived in the MOC, the system shall be able to complete processing within half a shift, or 4 hours."

ACE 4300 — Facilities Requirements

4300-1

The Mission Operations Center (MOC) shall support the conduct of pre-launch through on-orbit operations seven days a week.

Requirement will be met

4300-2

The MOC shall support the mission operations philosophy described in Section 1130.

Requirement will be met

4300-3

An on-line help function shall be available for each subsystem .

Requirement will be met

4300-4

The MOC shall include electronic mail to facilitate communications.

Requirement will be met

4300-5

MOC facilities (Government Furnished Equipment [GFE]) shall be provided for ACE FOT by launch minus 20 months.

Requirement will be met

4300-6

The MOC shall provide support for real-time, off-line, and backup operations.

Requirement will be met

4300-7

Mission Operations Room (MOR) - The ACE MOR is required to provide adequate space to support R/T operations with a console staff of two spacecraft analysts, and additional staff for pre-launch activities, launch and early orbit checkout, and special orbital operations. Additional staff may also be present to support level zero processing. A minimum of four positions is required per string of workstations.

Requirement will be met

4300-8

A Mission Analysis Room (MAR) shall be provided to allow adequate work space for mission planning, network scheduling, command management, level zero processing, trend analysis, and off-line processing functions.

Requirement will be met

4300-9

The MOC shall provide adequate facilities for MOC staff.

Requirement will be met

4300-10

Additional facilities shall be provided during launch and early orbit operations to support ACE transfer orbit injection and observatory checkout activities.

Requirement will be met

4300-10.1

These facilities shall be required for 30 days prior to and 180 days after launch.

Requirement will be met

4300-10.2

These facilities shall accommodate up to three instrument GSE's simultaneously.

Requirement will be met

4300-10.3

The office space in Requirement 4300-10 shall accommodate at least 10 spacecraft engineers and at least 9 instrument engineers simultaneously.

To be resolved:

4300-11

The MOC shall provide facsimile (FAX) capability to exchange operations data between the MOC and external operations facilities.

Requirement will be met

4300-12

The MOC shall provide Closed Circuit TV (CCTV) capabilities permitting operations and management personnel to monitor CRT displays generated by other GSFC MO&DSD support facilities.

Requirement will be met

4300-13

The MOC shall provide Universal Time Coordinated (UTC) and user configurable count-up/count-down clock displays in the MOR and MAR facilities. The two clocks (MOR & MAR) shall be synchronized.

Requirement will be met

4300-14

The MOC shall support operations schedule as follows:

1. L to L+15 days; 24 hours/day,

2. L+15 to L+90; 16 hours/day coordinated with DSN acquisition schedules,

3. L+90 to EOM one 8 hour shift per day coordinated with DSN acquisition schedules.

Requirement will be met

4300-15

Deleted.

4300-16

Facilities shall be provided to the MOC for additional personnel assigned to participate in contingency operations.

Requirement will be met

4300-17

The MOC shall provide adequate floor space as needed to meet mission requirements.

Requirement will be met

4300-18

Facilities shall include phone service reserved for the ACE FOT in the MOR and MAR as well as the FOT offices.

Requirement will be met

4300-18.1

The MOR and MAR shall have at least one phone in each room reserved for the ACE FOT.

Requirement will be met

4300-18.2

ACE MOR and MAR communications panels shall support 4 SCAMA lines and two long distance (but not overseas) telephone lines.

Requirement will be met

4300-18.3

The offices shall have a minimum of 3 phone lines. At least one of these lines shall allow conference calls and at least one of these lines shall support communications via an analog high speed modem.

Requirement will be met

4300-19

The capability shall exist in the FOT offices, the MAR, and the MOR, to conduct high speed Internet communications with the ACE Science Center (ASC) and the Deep Space Network (DSN) including E-Mail, FTP and Telnet capabilities.

Requirement will be met

4300-20

The MOC shall provide the VC1 data stream, in real time, to NOAA.

This requirement will be met, with the understanding that this capability will be implemented as part of the fanout box function. See Section 5000, requirement 5100-1, table row 1.3.7, and 5100-1.1.

ACE 5000 — Ground Communications and Data Transport Requirements - Summary

General:

Data communications shall be provided between the various ground elements from the period starting during S/C I&T in Fall 1995 through to the mission end of life. Major phases affecting ground communications are listed below:

a. I&T and testing at APL (Sept. 95)

b. Testing at GSFC (L-10 months)

c. Testing at the ER (L-2 months)

d. Launch

e. On-orbit checkout and normal orbital operations

Data and voice communications during I&T between the ACE MOC and the two sources of spacecraft data shall be provided. During I&T, the two sources of spacecraft data are:

a. The S/C, which will be located at APL during spacecraft I&T, at GSFC during environmental testing, and at ER during pre-launch I&T.

b. The ACE Test and Training Simulator (ATTS), which will be located at GSFC during spacecraft I&T and testing and at ER during pre-launch testing. When the spacecraft is located at APL during I&T, GSFC will be responsible for all spacecraft to MOC communications between GSFC and APL spacecraft I&T. APL will provide telemetry transfer frames and will accept commands into the system. GSFC shall be required to supply MOC to communication line interface, comm line, and comm line to spacecraft I&T interface.

Testing at ER will require communications to support integration testing, end-to-end testing and simulations. The integration testing support will require voice communications and data communications with GSFC. End-to-end testing and simulations will require voice and data communications between ER, DSN, ASC, and GSFC.

Ground communication lines shall be provided to support in-orbit checkout and normal operations between the various support elements, including: MOC, DPDF, DSN, FDF, and the ASC.

Data and voice communications are required from the ASC to the ASARs from L-12 months through end of in-orbit mission plus one year. This capability is to support day-to-day communications and transfer of processed science data. This link will be included in end-to-end tests. Since there is a delay from the time the ASC receives LZP data and sends Level 1 data to the ASARS.

5100-1

Each row in the following tables shall be considered an individual requirement.

Requirement will be met

Item No.	Terminals (Comm. Paths Req'd Between)		Type Comm. Req'd	Capa-bility 1 Way or 2Way	Data			Service Date(s) & Duration	Comments
	A	B			Data Source	Source Data Rate	Delivery Time		
1.1	MOC	S/C @ ACE I&T (APL)	DATA	1W	S/C CMDS	1 kpbs	R/T	L-22 Mo. to L-10 Mo.	
1.2	S/C @ ACE I&T (APL)	MOC	DATA	1W	S/C TLM	434 bps 6,944 bps 76,384 bps	R/T	L-22 Mo. to L-10 Mo	
1.3	S/C @ ACE I&T (APL)	SDP Function	DATA	1W	S/C TLM	434 bps 6944 bps 76,384 bps	R/T	L-22 Mo. to L-10 Mo	I & T Sched
1.4	CTT	ACE S/C	DATA	1W	S/C CMDS	1 kpbs	R/T	L-14 Mo. to L-12 Mo.	
1.5	ACE S/C	CTT	DATA	1W	S/C TLM	434 bps 6,944 bps 76,384 bps	R/T	L-14 Mo. to L-12 Mo.	
1.6	MOC	CTT	DATA	1W	S/C CMDS	1 kpbs	R/T	L-14 Mo. to L-12 Mo.	CTT at GSFC
1.7	CTT	MOC	DATA	1W	S/C TLM	434 bps 6,944 bps 76,384 bps	R/T	L-14 Mo. to L-12 Mo.	CTT at GSFC
1.8	S/C @ ACE I&T (GSFC)	MOC	DATA	1W	S/C TLM	434 bps 6,944 bps 76,384 bps	R/T R/T R/T	L-10 Mo. thru L-6 Mo.	
1.9	MOC	S/C @ ACE I&T (GSFC)	DATA	1W	S/C CMDs	1 kbps	R/T	L-10 Mo. to L-6 Mo.	
1.10	MOC	ATTS @ GSFC	DATA	1W	S/C CMDs	1 kbps	R/T	L-18 Mo thru EOM	
1.11	ATTS @ GSFC	MOC	DATA	1W	S/C TLM	434 bps 6,944 bps 76,384 bps	R/T R/T R/T	L-18 Mo thru EOM	
1.12	MOC	ATTS @ ER	DATA	1W	S/C CMDs	1 kbps	R/T	L-3 Mo to Launch	
1.13	ATTS @ ER	MOC	DATA	1W	S/C TLM	434 bps 6,944 bps 76,384 bps	R/T R/T R/T	L-3 Mo to Launch	
1.14	MOC	S/C @ ER	DATA	1W	S/C CMDs	1 kbps	R/T	L-3 Mo to launch	
1.15	S/C @ ER	MOC	DATA	1W	S/C TLM	434 bps 6,944 bps 76,384 bps	R/T R/T R/T	L-3 Mo to Launch	
1.16	MOC	S/C GSE @ ER	DATA	1W	S/C CMDS	1 kpbs	R/T	L-3 Mo to launch	
1.17	S/C GSE @ ER	MOC	DATA	1W	S/C TLM	434 bps 6,944 bps 76,384 bps	R/T	L-3 Mo to launch	

ACE 5100 — Ground-to-Ground Data Transport Requirements

Item No.	Terminals (Comm. Paths Req'd Between)		Type Comm. Req'd	Capa-bility 1 Way or 2Way	Data			Service Date(s) & Duration	Comments
	A	B			Data Source	Source Data Rate	Delivery Time		
1.18	ER/ MILA/ Mil-71	MOC	DATA	1W	S/C TLM	434 bps 6944 bps 76,384 bps	R/T	L-3 Mo. thru Launch.	
1.19	MOC	ER/ MILA/ Mil-71	DATA	1W	S/C Cmd.	1 kpbs	R/T	L-3 Mo. thru Launch.	
1.20	ATTS	SDP Function	DATA	1W	S/C TLM	434 bps 6944 bps 76,384 bps	R/T R/T R/T	L-18 Mo thru EOM	
1.21	ER	Flt. Dyn. Function	DATA	1W	Launch Vehicle (DRIMS Data)	13.89 kbps	RT	L-4 hrs. to launch	Standard for Delta Launch
1.22	MOC	DSN	DATA	1W	S/C CMDs	1 kbps	R/T	L-8 Mo. thru EOM	
1.23	DSN	MOC	DATA	1W	S/C TLM (Cmd. Echos DSN Mon. Blocks)	434 bps + 6,944 bps +	R/T R/T	L-8 Mo. thru EOM	DSN Monitor blocks (add 4800 bits/5 sec)
1.24	DSN	MOC	DATA	1W	S/C P/B TLM P/B Strm R/T Strm (Cmd. Echos DSN Mon. Blocks)	76,384 bps 69,440 bps 6,944 bps	NRT R/T	L-8 Mo. thru EOM	DSN Monitor blocks (add 4800 bits/5 sec)
1.25	DSN	Flt. Dyn. Function	DATA	1W	Track	1 Block /10 sec.	R/T	L-8 Mo thru EOM	
1.26	Flt. Dyn. Function	DSN	DATA	1W	Acq Data	E-Net	As Req.	L-8 Mo thru EOM	
1.27	Flt. Dyn. Function	MOC	DATA	1W	Orbit and Att	E-Net	NRT	L-9 Mo thru EOM	
1.28	MOC	Flt. Dyn. Function	DATA	1W	S/C TLM	434 bps 6,944 bps	R/T & NRT	L-9 Mo thru EOM	
1.29	Flt. Dyn. Function	MOC	DATA	1W	Planning Aids	E-Net	NRT	L-9 Mo thru EOM	
1.30	SDP Function	MOC	DATA	1W	S/C TLM	434 bps 6,944 bps 76,384 bps	As Req., Delayed	L-17 Mo thru EOM	
1.31	DSN	SDP Function	DATA	1W	S/C TLM	434 bps 6,944 bps	R/T R/T	L-8 Mo thru EOM	
1.32	DSN	SDP Function	DATA	1W	S/C P/B TLM P/B Strm R/T Strm	76,384 bps 69,440 bps 6,944 bps	NRT R/T	L-8 Mo thru EOM	

ACE 5100 — Ground-to-Ground Data Transport Requirements

Item No.	Terminals (Comm. Paths Req'd Between)		Type Comm. Req'd	Capa - bility 1 Way or 2Way	Data			Service Date(s) & Duration	Comments
	A	B			Data Source	Source Data Rate	Delivery Time		
1.33	MOC	NCC	DATA	2W	DSN Reconfig & Network Sts	224 Kb/sec	NRT	L-8 Mo. thru EOM	
1.35	Deleted								
1.36	Deleted								
1.37	MOC	NOAA	DATA	1W	MOC	6.944 Kb/sec	R/T	L-6 Mo. thru EOM	VC1 Data
2.1	Deleted								
2.2	Deleted								
3.1	MOC	ACE I&T (APL)	VOICE	2W				L-22 Mo. To L-10 Mo.	
3.2	MOC	ACE I&T (GSFC)	VOICE	2W				L-10 Mo. To L-6 Mo.	
3.3	MOC	Flt. Dyn. Function	VOICE	2W				L-18 Mo. thru EOM	
3.4	MOC	SDP Function	VOICE	2W				L-18 Mo. thru EOM	
3.5	Deleted								
3.6	MOC	DSN	VOICE	2W				L-8 Mo. thru EOM	
3.7	MOC	ATTS @ GSFC	VOICE	2W				L-18 Mo. thru EOM	
3.8	MOC	ATTS @ ER	VOICE	2W				L-3 Mo to Launch	
3.9	DSN	NCC FDF MOC SOTA	VOICE Net-work Dir.	2W				Launch Schedule	
3.10	DSN	NCC FDF MOC SOTA	VOICE Launch Coord.	2W				Launch Schedule	
3.11	DSN	NCC FDF	VOICE Track Coord.	2W				Launch Schedule	

ACE 5100 — Ground-to-Ground Data Transport Requirements

Item No.	Terminals (Comm. Paths Req'd Between)		Type Comm. Req'd	Capa-bility 1 Way or 2Way	Data			Service Date(s) & Duration	Comments
	A	B			Data Source	Source Data Rate	Delivery Time		
3.12	DSN	NCC FDF	VOICE Comp. Coord.	2W				Launch Schedule	
3.13	DSN	NCC MOC FDF SOTA	VOICE Launch Vehicle Coord.	2W				Launch Schedule	
3.14	DSN	NCC MOC SOTA FDF	VOICE Launch Status	2W				Launch Schedule	
3.15	DSN	NCC MOC SOTA	VOICE	2W				L-8 Mo. thru EOM	
3.16	MOC	NOAA	VOICE	2W				L-6 Mo. thru EOM	
3.17	ER	NCC MOC SOTA	Video	1W	Launch Cameras		R/T	L-TBD hrs thru Launch	

5200-1

Each row in the following table shall be considered an individual requirement.

Requirement will be met

Item No.	Terminals (Comm. Paths Req'd Between)		Type Comm. Req'd	Capa-bility 1 Way or 2Way	Data			Service Date(s) & Duration	Comments
	A	B			Data Source	Source Data Rate	Delivery Time		
1.1	MOC	ASC	DATA	1W	Planning Aids, User Reports	E-Net	As required	L-8 Mo. thru EOM	
1.2	ASC	MOC	DATA	1W	Cmd. Req. & Proc. loads	E-Net	As required	L-8 Mo. thru EOM	
1.3	IMOC	ASC	DATA	1W	S/C TLM	6944 bps	NRT	L-8 Mo. thru EOM	
1.4	IMOC	ASC	DATA	1W	S/C P/B Tlm.	76,384 bps	48 hrs	L-8 Mo. thru EOM	
1.5	ASC	ASARS	DATA	1W	Processed Sci. Data	E-Net	Delayed	L-7 Mo. thru EOM	For info. only. Not a project reqmt.
3.1	MOC	ASC	VOICE	2W				L-8 Mo. thru EOM	
3.2	SDP Function	ASC	VOICE	2W				L-8 Mo. thru EOM	
3.3	ASC	ASARS	VOICE	2W				L-7 Mo. thru EOM	For info. only. Not a project reqmt.

ACE 6000 — Data Processing Requirements - Summary

General - For the ACE Mission, data will come from either the ACE spacecraft itself, or the ACE Testing and Training Simulator (ATTS). Both data sources shall have identical formats, and shall be referred to in the following sections as spacecraft telemetry. Spacecraft telemetry for ACE will conform to CCSDS standards. There will be two Virtual Channels (VC) employed. The real-time data will be in VC1 while the playback (P/B) data will be in VC2.

Data Structure - All groups process the entire transfer frame. While ACE does conform to CCSDS, it has only one packet ID. Within the packet, the data is commutated in a TDM fashion. There are no separate packets for each instrument, nor is there a separate VC ID for spacecraft housekeeping. All data is commutated within the single packet.

There are a number of TDM commutation formats, depending on down link mode. Normally the playback stream (VC2) will contain the default science mode, while the real-time stream (VC1) telemetry mode will change from time to time as flight needs dictate.

ACE Science Center - The ASC shall receive VC1 data in near real-time for contingency operations. This is not needed for every pass. The expectation is that it will be needed quite frequently in the early mission. In nominal mission, ASC R/T support will be less frequent

Data Retention - For both the MOC and the ASC, the data will archived to tape for the life of the mission and subsequently retained against the need for retransmission.

Data Processing And Distribution Function - The Data Processing and Distribution Function shall receive data from the DSN and perform functions to support the ACE MOC and ASC requirements. The data consisting of level-0 data, level-0 H/K data, definitive attitude, predictive and definitive orbit, key parameters, summary, and command history data, etc., shall be provided to the users by determined media.

Playback Data - Playback Data is data collected in VC2 during a spacecraft contact. During a nominal 3.5 hr contact, 24 hrs of recorded VC2 will be played back in forward order.

Routine Production Data - Processed, reassembled packet data produced from Real-Time data (VC1) and playback (VC2) data. Data is quality checked, chronologically ordered, and any redundant data is removed. Data quality and accounting capsules and missing data lists are included as part of the level-0 data product.

Real-Time data - data delivered with minimal delay(within 10 seconds). This includes H/K and science data.

Production Data - Production Data is a single LZP'd data set spanning a designated period of time. For instance ACE production data sets may include 1 days worth of data from 12:00 am to 11:59:59 PM. Nominally this will consist of a single VC2 dump. It may however involve combining two or more VC2 dumps and possibly real time data.

Quicklook Data - Data created expeditiously post pass. Typically consists of subsets of the data collected, selected on an acquisition session, as determined by the user. One quicklook data set undergoes minimal processing and usually averages about 20 percent of the total data, allowing a much faster transfer. The Quicklook dataset is made available to the user within 2 hours of receipt of the last packet. Packets included in the Quicklook dataset are also included in the Routine Production dataset. Quicklook data is normally done with VC1, not VC2.

6100-1

The capability to receive real-time data from the DSN shall be provided.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC DSN interface function. See requirement 4111-1.2

6100-2

The capability to receive data formatted according to the CCSDS 102.0-B-2 blue book January 1987 shall be provided.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC Telemetry Reception function. See requirement 4151-2.1

6100-3

The capability to transmit the ACE real time telemetry stream to ASC within 10 seconds of receipt during initialization checkout and anomaly investigation shall be provided.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the Fan-out Box function. See requirement 5200-1 Table row 1.3

6100-4

All data shall be recorded as received in its transmitted format.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC History Data function. See requirement 4163-2.1

6100-5

Data flow and quality statistics shall be made available, in real time, for display and processing. Statistics to be made available shall include, but not be limited to the following list:

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC Display function. See requirement 4123-4.7

6100-5.1

Total number of Transfer Frames received.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC Display function. See requirement 4123-4.7

6100-5.2

Total number and rate of Transfer Frames received for each Virtual Channel (VC).

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC Display function. See requirement 4123-4.7

6100-5.3

Total number of Transfer Frames in each VC with corrected R-S errors.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC Display function. See requirement 4123-4.7

6100-5.4

R-S correction statistics.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC Display function. See requirement 4123-4.7

6100-5.5

Total number of Transfer Frames in each VC with sequence errors.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC Display function. See requirement 4123-4.7

6100-5.6

Deleted.

6100-5.7

Deleted.

6100-5.8

Total number of packets received.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC Display function. See requirement 4123-4.7

6100-5.9

Deleted.

6100-5.10

Deleted.

6100-6

The MOC shall be provided with sufficient information, either using DSN monitor blocks, quality data, or the playback stream to determine, in real time, what data from the S/C recorder has been

received successfully on the ground.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC Reports and Display functions. See requirements 4122-4.2.2 and 4123-6.32

6100-7

A summary of ACE real-time Data Processing Requirements can been seen in Figure 6100-1 (Real-time Data Processing Requirements Table).

Figure 6100-1 (Real-time Data Processing Requirements Table)

Data Type	Data Source	Processing Function	Processing Frequency	Data Destinations	Duration of Service	Remarks
Real-time Science, H/K (S/C and Instrument), C&DH Memory/Bin Dump, and ADC Data (**VC1**)	ATTS at GSFC, or ETR	Real-time data as it is received	Per Test Schedule (see Section 3000) and as required during normal operations	ACE MOC, ASC *	L-18 to End of Mission	Real-time Data will be required to support testing and simulations
	I&T S/C at APL, GSFC, or ETR	Real-time data as it is received	Per Test Schedule (see Section 3000)	ACE MOC, ASC *	L-18 to L-0 mos.	Real-time Data will be required to support testing only prior to launch
	Ground Stations	Real time data as it is received	L&EO/Initial-ization and Checkout -- per support (see Section 2000)	ACE MOC, ASC *	L-0 to L+3 mo.	Real-time Data will be required by the ASC frequently on a per request basis.
	Ground Stations	Real time data as it is received	Normal Operations per support (see Section 2000)	ACE MOC, ASC	L+3 mo. to End of Mission	Real-time data will be required by the ASC occasionally on a per request basis.

* The Instrument GSE will be located in the ACE MOC and will receive data via Ethernet or an RS-232 interface.

Figure 6100-1 (Real-time Data Processing Requirements Table)

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC External Interface function. See requirement 4110-1.5

6100-8

The real-time telemetry stream shall be provided to the IGSE in real time.

Requirement will be met

This requirement is accepted with the understanding that this capability will be implemented as part of the MOC Science Center Interface function. See requirement 4115-2

6100-9

Extraction from VC1 of S/C housekeeping data in real-time shall be provided.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC Telemetry Reception and Data Decommutation and Conversion functions. See requirements 4151-1, 4151-2, 4151-3, 4151-4, 4152-1, and 4152-2

6100-10

Deleted.

6200-1

Deleted.

6200-2

The capability to perform LZP on playback data shall be provided.

Requirement will be met

6200-3

The capability to request, accept, merge and LZP replay of data from the DSN shall be provided in case of loss of data through the DSN to GSFC connection.

Requirement will be met

6200-4

LZP data and data accounting information shall be provided to the ASC within 10 days of receipt of the raw data set

Requirement will be met

6200-5

LZP data and data accounting information shall be made available to the FOT within 24 hours of receipt of the last data bit in a data set.

Requirement will be met

6200-6

At least the following statistics shall be made available, post pass, for display and processing:

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC DSN Interface, Report and Telemetry Reception functions. See requirements 4111-1.5.5, 4122-4.2.1, 4122-4.2.2, and 4151-6

6200-6.1

Total number of Transfer Frames received.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC DSN Interface, Report and Telemetry Reception functions. See requirements 4111-1.5.5, 4122-4.2.1, 4122-4.2.2, and 4151-6

6200-6.2

Total number and number/sec. of Transfer Frames received for each Virtual Channel (VC).

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part

of the MOC DSN Interface, Report and Telemetry Reception functions. See requirements 4111-1.5.5, 4122-4.2.1, 4122-4.2.2, and 4151-6

6200-6.3

Total number of Transfer Frames in each VC with R-S errors.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC DSN Interface, Report and Telemetry Reception functions. See requirements 4111-1.5.5, 4122-4.2.1, 4122-4.2.2, and 4151-6

6200-6.4

R-S correction statistics.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC DSN Interface, Report and Telemetry Reception functions. See requirements 4111-1.5.5, 4122-4.2.1, 4122-4.2.2, and 4151-6

6200-6.5

Total number of Transfer Frames in each VC with sequence errors.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC DSN Interface, Report and Telemetry Reception functions. See requirements 4111-1.5.5, 4122-4.2.1, 4122-4.2.2, and 4151-6

6200-6.6

Identity of Transfer Frames in each VC with errors.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC DSN Interface, Report and Telemetry Reception functions. See requirements 4111-1.5.5, 4122-4.2.1, 4122-4.2.2, and 4151-6

6200-6.7

Identity of Recorder Transfer Frames with errors.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC DSN Interface, Report and Telemetry Reception functions. See requirements 4111-1.5.5, 4122-4.2.1, 4122-4.2.2, and 4151-6

6200-6.8

Total number of packets received.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC DSN Interface, Report and Telemetry Reception functions. See requirements 4111-1.5.5, 4122-4.2.1, 4122-4.2.2, and 4151-6

6200-6.9

Deleted.

6200-6.10

Deleted.

6200-7

ACE non-real-time data processing shall include:

Requirement will be met

6200-7.1

Providing daily Level Zero Processed (production) data sets to ASC and MOC.

Requirement will be met

6200-7.2

Providing the VC1 data file to the ASC within Quick-look time constraints defined in Figure 6200-1 (Non-Real-Time Data Processing Requirements Table).

Requirement will be met
This requirement is accepted with the understanding that it will be implemented as part of the ACE Fan-out Box requirements. See Section 5200. The VC-1 data will also be available for FTP transfer from the JPL Central Data Recorder. See requirements 2000-8.1.1, 2000-8.2, and 2000-8.4

6200-8

Level Zero Processing shall include, but not be limited to: extraction of data from the playback stream, quality checking and processing of packets, time ordering, merging of data sets, annotating data quality and missing data, and removing redundant data.

Requirement will be met

6200-9

Production data sets shall contain all data collected by the spacecraft between two negotiated times, successfully downlinked, and LZPd.

Requirement will be met

6200-10

Level zero processing shall include the option of combining no more than 10 real-time data sets with no more than 10 playback data sets to produce one continuous 24 hour level zero processed data set.

Requirement will be met

6200-11

Level zero processing shall include the option to combine data collected during normal operations and data collected as the result of a DSN retransmission.

Requirement will be met

6200-12

A summary of ACE non-real-time Data Processing Requirements can be seen in Figure 6200-1 (Non-Real-Time Data Processing Requirements Table).

Figure 6200-1 (Non-Real-Time Data Processing Requirements Table)

Data Type	Data Source	Processing Function	Processing Frequency	Data Destinations	Duration of Service	Remarks
Real-time Data (VC1) Stored Science, H/K (S/C and Instrument), C&DH Memory/Bin Dump, and ADC Data from the on-board Solid State Recorder (VC2)	ATTS at GSFC, or ETR	Quicklook and Production	Per Test Schedule (see Section 3000) and as required during normal operations	ACE MOC, ASC *	L-18 to End of Mission	Quicklook and Production Data will be required to support testing and simulations
	I&T S/C at APL, GSFC, or ETR	Quicklook	Per Test Schedule (see Section 3000)	ACE MOC, ASC *	L-18 to L-0 mos.	Quicklook Data will only be required for testing purposes prior to Launch.
	I&T S/C at APL, GSFC, or ETR	Production	Per Test Schedule (see Section 3000)	ACE MOC, ASC *	L-18 to L-0 mos.	Level Zero Processed Data will only be required for testing purposes prior to Launch.
	Ground Stations	Quicklook	L&EO/Initial-ization and Checkout--per support	ASC *	L-0 to L+3 mo.	Quicklook Data will be provide by the MOC in a format TBD in order for the ASC to meet their processing requirements.**
	Ground Stations	Production	L&EO/Initial-ization and Checkout--per day	ACE MOC, ASC *	L-0 to L+3 mo.	LZP data will be provided to the MOC within 24 hours of ground receipt and to the ASC within 10 calendar days of transmission from the S/C.
	Ground Stations	Quicklook	Normal Operations per support	ASC	L+3 mo. to End of Mission	See L&EO Quicklook Data requirement
	Ground Stations	Production	Normal Operations per day	ACE MOC, ASC	L+3 mo. to End of Mission	See L&EO Production Data requirement

* The Instrument GSE will be located in the ACE MOC and will receive data via Ethernet or an RS-232 interface.

** The latency time for quicklook processing must be less than 24 hours after spacecraft transmission of data during normal work days, less than 36 hours after resumption of normal work days for data received on weekends and holidays, and less than 3 hours upon pre-arranged special request (from SRD).

Requirement will be met

6200-13

The data processing function shall have the capability to provide for verification of data capture and quality assurance requirements, provide analysis tools/functionality which: provide fault isolation to LRU within ground system, permit access to each stage of science data processing, and provide human discernible formats of intermediate and final science data products.

Requirement will be met

6200-14

The Data Processing and Distribution Function shall provide the capability to automatically, without operator intervention, process twice the ACE playback daily volume within a 24 period.

Requirement will be met

6300-1

The capability to store all mission data listed below on some standard media (e.g. 4 mm, 8 mm, VCR, CD-ROM) shall be provided.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC History Data function. See requirements 4163-4.2, 4163-4.2.1, 4163-4.2.2, 4163-4.2.3, 4163-4.2.4, and 4163-4.2.5

6300-1.1

Real-time and playback stream as it was received at GSFC/MOC.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC History Data function. See requirements 4163-4.2, 4163-4.2.1, 4163-4.2.2, 4163-4.2.3, 4163-4.2.4, and 4163-4.2.5

6300-1.2

LZP data.

Requirement will be met

6300-1.3

DSN Monitor Blocks.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC History Data function. See requirements 4163-4.2, 4163-4.2.1, 4163-4.2.2, 4163-4.2.3, 4163-4.2.4, and 4163-4.2.5

6300-1.4

Data Quality information.

Requirement will be met

6300-1.5

All MOC event logs.

Requirement will be met
This requirement is accepted with the understanding that this capability will be implemented as part of the MOC History Data function. See requirements 4163-4.2, 4163-4.2.1, 4163-4.2.2, 4163-4.2.3, 4163-4.2.4, and 4163-4.2.5

6300-2

For both the MOC and the ASC, the data shall be retained against the need for retransmission.

Requirement will be met

6300-2.1

Mission data less than 5 days old shall be made available to the FOT within 1 minute of request.

Requirement will be met

6300-2.2

All mission data (including LZP data) shall be archived for the life of the mission.

Requirement will be met

6300-2.3

Any particular file or set of files shall be made available to the FOT within 24 hours of request.

Requirement will be met

ACE 7000 — Trajectory and Attitude Support Requirements - Summary

The Flight Dynamics function will provide trajectory support for transfer to, acquisition, and maintenance of a trajectory about the Earth-Sun L1 point.

The major mission constraints are as follows:

1 The angle between the sun and the spin axis of the spacecraft must be less than 20 degrees.

2 During science collection at the L1 point, the SEV angle must stay within 5° to 10° of the earth sun line - 5° for the solar exclusion zone for communications and 10° for science operations.

3 On orbit, the SEV angle must be less than 10 degrees.

4 SEV during the transfer orbit must remain small enough to allow using the HGA antenna to downlink the science data collected, while meeting the 20 degree spin axis pointing constraint.

5 During operations when science data is being collected and being played back, the -Z axis and high gain antenna must remain aligned within 3° of the Earth to provide sufficient link margin to downlink the science data while meeting the 20° requirement noted in item 1 above.

6 Trajectory and attitude support will ensure that during science data collection, the spin rate remains at 5.0 +/- 0.1 rpm.

Pre-mission planning support will be provided for trajectory analysis that maximizes science data collection and science time during the transfer trajectory to the vicinity of the L1 point within propellant limits, while maintaining the required spin axis orientation.

Support will be provided during the mission to determine the trajectory, attitude and spin rate and to provide maneuver plans to the MOC to achieve and maintain the planned trajectories, required attitudes and spin rate. Reports and contingency support will be provided as requested to the MOC. Flight support will start with separation from the launch vehicle. Support during the pre-mission test and training phase of the mission will also be provided. Definitive orbit ephemeris will be provided. Planning aids in the form of ground station coverage predicts will be provided for use by the MOC. Acquisition data will be sent to the DSN.

Sensor data will be provided to the FDF for generation of real-time and fine Attitude. "Attitude", as defined here, consists of spin axis orientation, phase angle and spin rate, unless otherwise noted. Real-time attitudes will be used during passes to support maneuvers as well as to monitor constraints. Fine attitudes will be used by the ACE Science Center to propagate the attitude between passes.

7100-1

Fine attitude determination shall be provided to the MOC and ASC from TTI to End of Mission (EOM) as noted below:

Requirement will be met

7100-1.1

Fine Attitude Determination information shall be provided to the ACE MOC and the ACE Science Center (ASC). The capability shall exist to conduct attitude determination with any selection of the onboard sensors.

Requirement will be met

7100-1.2

Output: A vector shall be provided including: spin rate, spin axis orientation, phase angle and a time tag indicating when the spacecraft had this attitude.

Requirement will be met

7100-1.3

Accuracy: Spin axis orientation shall be provided to within a 0.7 degree (3 sigma) cone from the true direction of the spin axis. Phase angle to within 1 degree (3 sigma) of the true phase angle, and the spin rate to within 0.001 rpm (3 sigma).

Requirement will be met
Accept subject to the following: This accuracy is based on availability of Star and Sun sensor data measurements. The attitude accuracy if only Sun sensor data is available, will be the best results.

7100-1.4

Delivery: Shall be provided once per ground station contact when no maneuvers are scheduled. For maneuvers, one shall be provided at a time just before the maneuver, and one after the maneuver.

Requirement will be met

7100-2

Real-time attitude determination shall be provided to the MOC from TTI to EOM as follows:

Requirement will be met

7100-2.1

The capability shall exist to determine and monitor mission constraint compliance and the attitude in real time.

Requirement will be met

7100-2.1.1

The quality of the determination shall be sufficient to monitor the safety of the maneuvers.

Requirement will be met

7100-2.1.2

The quality of the determination shall be sufficient to monitor compliance with mission constraints.

Requirement will be met

7100-2.2

Output: Moment by moment update of the attitude solution shall be provided including: spin axis orientation, spin rate and phase angle information, updates of the angle of the spin axis to the spacecraft-sun line, angle of the HGA to the Spacecraft-Earth line.

Requirement will be met

7100-2.3

Accuracy: Spin axis orientation shall be provided to within a 1 degree (3 sigma) cone from the true direction of the spin axis, phase angle to within 1 degree (3 sigma) of the true phase angle, and spin rate to within 0.001 rpm (3 sigma)

Requirement will be met

7100-2.4

Delivery: Shall be provided every pass.

Requirement will be met

7100-3

Sensor calibration shall be provided to the MOC and ASC, once in early mission, with an update as needed.

Requirement will be met

7100-3.1

Calibration, evaluation and reports of the attitude sensors shall be provided with sufficient accuracy to meet the attitude determination requirement.

Requirement will be met

7100-3.2

Calibration of the sun sensors shall include determination of misalignment from the principle axis of the spacecraft.

Requirement will be met

7100-3.3

Calibration shall include the determination of misalignment from the principle axis of the star tracker.

Requirement will be met

7100-3.4

Calibration shall include assessment of the performance of the special integrating software being employed in the ACE star tracker.

Requirement will be met

7100-3.5

Output: Shall contain misalignment matrices for the sun sensor and star tracker and assessment report of the special integrating software.

Requirement will be met

7100-3.6

Accuracy: Shall meet all mission attitude accuracy requirements.

Requirement will be met

7100-3.7

A rotation matrix shall be provided for the principle axis and geometric axis.

Requirement will be met

7100-4

Attitude analysis and trending shall be provided to the MOC, ASC and ACE Project from TTI to EOM.

Requirement will be met

7100-4.1

The attitude of the spacecraft shall be analyzed to check for violations of mission constraints.

Requirement will be met

7100-4.2

Output shall include anomaly reports.

Requirement will be met

7100-4.3

Deleted.

7100-5

Maneuver planning aids shall be provided to the MOC, as required from TTI to EOM.

Requirement will be met

7100-5.1

Information shall be provided to allow comparison with the real-time attitude determination function

during the maneuver.

Requirement will be met

7100-5.2

Predicted post maneuver attitude shall be provided.

Requirement will be met

7100-5.3

Deleted.

7100-5.4

Deleted.

7100-5.5

High gain and omni antenna pointing predictions shall be provided with sufficient detail to determine where the Earth will be in each respective field of view before, during and after the maneuver.

Requirement will be met

7100-5.6

Predictions of what the angle the Sun will be with respect to the geometric axis of symmetry (i.e. the +Z axis) of the spacecraft before, during and after the maneuver shall be provided.

Requirement will be met

7100-5.7

Predictions of sensor coverage and possible interference before, during and after the maneuver shall be provided.

Requirement will be met

7100-5.8

Output from planning aids shall be integrated with the real-time attitude monitoring function to allow comparison during the pass.

Requirement will be met

7100-5.9

Accuracy shall be sufficient to meet all mission requirements.

Requirement will be met

7100-5.10

After each orbit maneuver planning aids shall be updated.

Requirement will be met

7100-6

Deleted.

7110-1

All newly developed flight dynamics software shall operate in a distributed workstation environment.

Requirement will be met

7120-1

A user interface for the flight dynamics function shall be provided.

Requirement will be met

ACE 7130 — FDF Attitude Ground Support

7130-1

The flight dynamics function shall provide attitude ground support.

Requirement will be met

7200-1

Orbit determination shall be provided from launch to EOM.

Requirement will be met

7200-1.1

Ingest and processing of radiometric tracking data from DSN to determine spacecraft trajectory/orbit shall be provided.

Requirement will be met

7200-1.2

Deleted.

7200-1.3

Deleted.

7200-1.4

Deleted.

7200-1.5

Deleted.

7200-2

Predictive ephemeris shall be provided from first contact to EOM.

Requirement will be met

7200-2.1

Delivery shall be bi-weekly.

Requirement will be met

7200-2.2

Output: Predictive Orbit ephemeris and state vectors shall be provided.

Requirement will be met

7200-2.3

Accuracy shall be within 10,000 km.

Requirement will be met

7200-3

Definitive ephemeris shall be provided to the MOC and ASC.

Requirement will be met

7200-3.1

Definitive ephemeris shall be provided.

Requirement will be met

7200-3.2

Output shall be provided with one sample per 10 minutes.

Requirement will be met

7200-3.3

Accuracy shall be within 10,000 kilometers

Requirement will be met

7200-3.4

Delivery shall be bi-weekly.

Requirement will be met

7200-4

Deleted.

7210-1

Orbit Adjust support shall be provided to the MOC from separation to EOM.

Requirement will be met

7210-1.1

Verification of thruster performance, performance of thruster calibration, and computation of fuel remaining and new spacecraft mass properties shall be provided as needed.

Requirement will be met

7210-1.2

Maneuver planning shall be provided to ensure mission constraints are satisfied.

Requirement will be met

7210-1.3

Evaluation of the orbit adjust burn shall be provided for Delta-V burn efficiency and resultant orbit in accordance with the planned orbit adjust.

Requirement will be met

7210-1.4

Real-time contingency support during maneuvers shall be provided.

Requirement will be met

7210-1.5

Output: Command requests for maneuvers, and reports as negotiated.

Requirement will be met

7210-1.6

Accuracy: Shall be the best available.

Requirement will be met

7210-1.7

For routine stationkeeping, delivery shall be 3 weeks prior to maneuver with fine planning updates provided as necessary.

Requirement will be met

7210-2

Maneuver Plans shall be provided to the MOC from pre-launch through EOM.

Requirement will be met

7210-2.1

Maneuver predicts shall be made available prior to the event.

Requirement will be met

7210-2.2

Transfer Orbit plans shall be baselined 18 months prior to launch.

Requirement will be met

7210-2.3

MCC-1 plans shall be provided as soon as possible, but at least within 2 hours of the maneuver.

Requirement will be met

7210-2.4

Maneuver plans for transfer trajectory maneuvers after MCC-1 will be provided 2 weeks in advance, with fine planning updates provided as necessary.

Requirement will be met

7210-2.5

Once in the L1 orbit, maneuver plans shall be provided 3 weeks in advance with updates as needed.

Requirement will be met

7210-2.6

A schedule covering attitude maneuvers shall provided three days in advance of maneuver.

Requirement will be met

7210-2.7

Plans shall include an event timeline of sufficient detail to permit the MOC to schedule resources and prepare personnel.

Requirement will be met

7210-2.8

Planning information provided shall interface electronically with the MOC mission planning function.

Requirement will be met

7210-3

Maneuver Command Generation shall be provided to the MOC from separation through EOM.

Requirement will be met

7210-4

Maneuver monitoring shall be provided to the MOC and ASC from TTI to EOM.

Requirement will be met

7210-4.1

Monitoring support of the associated attitude sensors shall be provided during each maneuver.

Requirement will be met

7210-4.2

Verification that all mission constraints are met shall be provided.

Requirement will be met

7210-4.3

Output: Anomaly reports shall be provided

Requirement will be met

7210-5

Post Maneuver nutation assessment shall be provided to the MOC and ASC from separation to EOM.

Requirement will be met

7210-5.1

Nutation information shall be provided during that period subsequent to maneuvers when the nutation is large enough to impact science data collection.

Requirement will be met

7210-5.2

Output: Nutation angle between the principal axis and the spin axis of the spacecraft shall be provided.

Requirement will be met

7210-5.3

Accuracy shall be 0.25° on 10 second centers.

Requirement will be met

7210-5.4

Delivery shall be provided after maneuvers concurrent with delivery of the Fine Attitude.

Requirement will be met

ACE 7220 — Mission Scheduling Operational Planning and Support Requirements

7220-1

Support shall be provided to the ACE Project prior to launch sufficient to meet all Project schedules.

Requirement will be met

7220-1.1

Mission analysis, launch window analysis and mission planning shall be provided.

Requirement will be met

7220-1.2

ELV launch, post launch and deployment activities to determine DSN pointing angles for acquisition shall be provided.

Requirement will be met

7220-1.3

Ephemeris and s/c attitude files to support pre-launch testing and simulations shall be provided.

Requirement will be met

7220-1.4

Early orbit activation, nominal mission and extended mission support shall be provided.

Requirement will be met

7220-1.5

Flight sensor alignment support shall be provided.

Requirement will be met

7220-1.6

A flight sensor calibration support plan shall be provided.

Requirement will be met

7220-1.7

S/C maneuver support plans shall be provided.

Requirement will be met

7220-1.8

Contingency operations support shall be provided, as a minimum from launch minus 6 months (L-6).

Requirement will be met

7220-2

Station contact predictions which interface electronically with the MOC shall be provided to the MOC once a week, covering a 1 month time span, in 10 minute intervals. The predictions will include the following:

Requirement will be met

7220-2.1

Deleted.

7220-2.2

Deleted.

7220-2.3

Deleted.

7220-2.4

Deleted.

7220-2.4

Deleted.

7220-2.5

Deleted.

7220-2.6

Angle between sun and spin axis shall be provided.

Requirement will be met

7220-2.7

Deleted.

7220-2.8

Station identification and antenna selection shall be provided.

Requirement will be met

7220-2.9

Ground station antenna pointing angles (azimuth and elevation) shall be provided.

Requirement will be met

7220-2.10

Acquisitions and loss of acquisition times (aos, los) shall be provided.

Requirement will be met

7220-2.11

Slant range shall be provided.

Requirement will be met

7220-2.12

Deleted.

7230-1

The flight dynamics function shall provide mission analysis support.

Requirement will be met