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Earth Science Mission Operations Project, Code 428

Earth Observing System (EOS) Terra Flight Dynamics System (FDS) / Earth Observing System Data and Information System (EOSDIS) Interface Control Document (ICD)

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Earth Observing System (EOS) Terra Flight Dynamics System (FDS) / Earth Observing System Data and information System (EOSDIS) Interface Control Document (ICD)

Signature/Approval Page

This document is controlled by ESMO CM and the signatures constitute concurrence that the contents represent the latest agreements and understandings among the parties involved.

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Preface

The purpose of this interface control document (ICD) is to provide complete information concerning the products to be transferred between the Flight Dynamics System (FDS) and the Earth Observing System (EOS) Mission Operations Systems (EMOS), in support of the AM-1 mission. The AM-1 mission was renamed Terra after launch. The contents are complete to a level sufficient to develop and operate the interface; therefore, the document is intended for use only by those directly involved with the mission and/or facilities involved. No attempt has been made to relate this ICD to the total EOS Terra ground system or to no pertinent aspects of the facilities/organizations involved. Changes to this document shall be made only by complete revision.

This document was prepared by a team consisting of members of the Mission Engineering and System Analysis Division / Navigation and Mission Design, EOS FDS group and the Earth Science Mission Operations Branch. Questions and proposed changes concerning this document shall be addressed to:

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Abstract

This document provides information concerning the products to be transferred between the Flight Dynamics System (FDS) and the Earth Science Mission Operations (ESMO) and the Distributed Active Archive Centers (DAACs) in support of the Earth Observing System (EOS) Terra mission. This document explains in sufficient detail about the communication links, the communication protocols, data formats and interface services that satisfy the requirements for the referenced facilities.

Change Information Page

List of Affected Pages

Page Number	Revision Number	Date
Title Page	Revision 1	5/96
Signoff Page	Revision 1	5/96
iii to x	Revision 1	5/96
1-1 to 1-2	Revision 1	5/96
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Sec 5, App A, App C	Revision 4	4/98
Table 3-1, Sec 3.7, Sec 3.18, Sec 3.20, Sec 3.29, Sec 3.80, Sec 3.81 (new), Sec 3.82 (new), Sec 4.7, Sec 4.12, App C	Revision 4	8/98
Table 3-1, Sec 3.4, Sec 3.17, Sec 3.83 (new), App C	Revision 4	8/98
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All	Revision 5	12/98
All	Revision 6	5/99
Sec 3.80	Revision 6	11/99
Table 3-1; Sections 3.12, 3.17, 3.18, 3.20, 3.31, 3.67, 3.80, 3.81, 3.82, 3.83, 3.85 (new), and 3.86 (new), 5.4; Appendices C, F, and G	Revision 7	3/2000
All	Revision 8	9/2007
All	Revision 9	3/2009
All	Revision 10	11/2013
All	Revision 11	3/2016

Page Number	Revision Number	Date
Sections 3.88 to 3.91	Revision L	10/2017
Remove Appendix D	Revision L	11/2017
Remove SBU designation from cover page and header, corrected field lengths for orbit number from 5 to 6 characters in all products including that parameter.	Revision L	11/2017
Removed all SBU references and removed Appendix D (also removed Section 5.1 which references it).	Revision L	11/2017
Updated Section 3.24.3 format, Section 8, CRMS to FDS Products (8.1 Terra OPM Maneuver Data), C.5 Files from FDS to CRMS (Orbit Ephemeris Message (OEM) Files), Section 6. FDS to CRMS Products, Product 6.7 Terra Nominal Predicted Ephemeris and Covariance Data , Product 6.8 Terra No-Burn Predicted Ephemeris and Covariance Data Added FDS products Checklist and INCData to Section 3 (EMOS/MMS). Added FDS products Daily Report, LOWELEVATION, and SolarRFI to Section 7 (FOT Reports). Changed the task lead from Susan Good to Haijun Shen.	Revision M	05/2020

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Document History

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Issues Workoff Plan

Issue #	ICD Section	Description	Work-off Plan Tasks	Resolution Date
16	Section 3	Details needed for new TDRS High Gain Antenna (HGA) related products	FDS task to provide formats for new products (see EMOS CCR 13-007). Templates for 4 new products were put into this document as place holders.	TBD 2014

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Section 1. Introduction

1.1 Purpose

This interface control document (ICD) defines the complete interface between the Flight Dynamics System (FDS) and the Earth Observing System (EOS), system elements in support of the Terra mission.

This ICD covers the delivery and receipt of products between the FDS and EOS for prelaunch analysis, training and simulation activities through the launch, early mission, routine operations, and end-of-life activities. The products themselves are separated into attitude and orbit related functions, as described in Reference 1.

This ICD covers all products, analysis and timed events that will occur between the FDS and the EOS Operations Center (EOC). The EOC is responsible for the high-level monitoring and control of all instruments on-board the EOS Terra spacecraft. The EOC, together with the Instrument Support Terminal (IST) toolkits, constitutes the EOS Mission Operations System (EMOS). The EOS is the ground system that provides for all flight operations support and data processing and archiving systems for the EOS missions.

This ICD also covers analysis support and the FDS products provided to the Langley Research Center (LaRC) Science Data Processing System (SDPS), and the Goddard Earth Sciences (GES) Data and Information Services Center (DISC) for the purpose of repairing attitude and orbit data. The LaRC SDPS and the GES DISC are segments of EOS known as Distributed Active Archive Centers (DAACs) and are responsible for the processing, product generation, and distribution and archival of Level 1 through Level 4 data.

1.2 Mission Phase

The EOS Terra mission phases are defined as follows (see Reference 4):

a. Prelaunch Phase – During this phase, the mission requirements were defined and analyzed, the ground support systems integrated and tested, and the spacecraft was integrated, tested, installed on the launch vehicle, and prepared for launch. This phase also included the training of the personnel in the operations of the ground systems.
b. Launch/Acquisition – This phase began with the transition to internal power before launch. During this phase, the spacecraft nulled any

attitude rates and performed Earth acquisition. It also included the delta-V maneuvers required to establish the operational orbit.

c. Checkout – This phase began after the initial delta-V maneuvers were complete. It included initialization and checkout activities prior to normal operations.
d. Operational – This phase began after initialization and checkout activities were completed and continues through the life of the mission. It includes operations and maintenance activities to maintain nominal orbit and spacecraft health and safety, and to support end of mission.

1.3 Mission Specific Characteristics

The EOS Terra was the first of a series of EOS spacecraft that are part of the Earth Science Enterprise (ESE). The EOS Terra spacecraft was planned for a 5-year mission lifetime that has been extended beyond that. The EOS Terra spacecraft was launched from the western launch facility on an expendable Atlas IIAS launch vehicle, and placed into a transfer orbit. The mission orbit, a near polar, sun-synchronous orbit at an altitude of 705 kilometers is being attained through spacecraft propulsive maneuvers.

The EOS program has the objective to provide long-term observations of the Earth's terrestrial and atmospheric environment. In particular, the EOS Terra scientific goal is to provide data for the understanding and characterization of the terrestrial and oceanic surfaces, clouds, radiation, aerosols and radiative balance. The EOS Terra spacecraft carries five scientific instruments onboard. They are the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), Clouds and Earth's Radiant Energy System (CERES), Multi-angle Imaging SpectroRadiometer (MISR), Moderate Resolution Imaging SpectroRadiometer (MODIS), and Measurements of Pollution in the Troposphere (MOPITT).

1.4 AM-1 Guidance, Navigation and Control

The EOS Terra is a three axis stabilized, nadir-pointing spacecraft. Attitude determination and control as well as orbit determination are provided by the Guidance, Navigation and Control Subsystem (GN&CS) during all operational phases of the mission. The GN&CS is an ensemble of sensors, actuators, software, support hardware, and associated electronics that provide control of the spacecraft attitude and orbit. Flight software resident in the Spacecraft Controls Computer (SCC) implements most of the GN&CS algorithms. The GN&CS uses the TDRSS Onboard Navigation System (TONS) for state vector estimation, spacecraft clock bias estimation, and Doppler compensation for navigation purposes.

The major components of the attitude determination and control hardware are:

a. Attitude Control Electronics (ACE) (1 primary, 1 redundant)
b. Coarse Sun Sensor (CSS) (5 units)
c. Inertial Reference Unit (IRU) (3 units)
d. Earth Sensor Assembly (ESA) (2 units)
e. Fine Sun Sensor (FSS) (1 unit)
f. Three Axis Magnetometer (TAM) (2 units)
g. Solid State Star Tracker (SSST) (2 units)
h. Reaction Wheel Assembly (RWA) (4 units)
i. Magnetic Torque Rod (MTR) (3 units)

The GN&CS interfaces with the Propulsion Subsystem for controlling a set of 12 (6 primary and 6 redundant) attitude control thrusters for backup momentum unloading and rate nulling after launch vehicle separation. The major components of the orbit determination and control software and hardware are the following:

a. TONS
b. Propulsion Subsystem's Delta-V Thrusters (2 primary, 2 redundant)
c. Communications Subsystem's S-band Transponder

The TONS software uses TDRSS one-way forward link Doppler data for orbit position determination. The S-band transponder provides Doppler frequency from TDRSS forward link service. The delta-V thrusters enable the spacecraft to perform orbit adjust and ground track maneuvers.

The EOS Terra attitude is defined relative to the local horizontal-local vertical (LVLH) reference frame.

The X, Y, and Z-axes of the LVLH frame are defined as follows:

a. Y is along the negative orbit normal vector
b. Z is along the nadir vector
c. X is defined to complete the right-handed coordinate system

The spacecraft attitude relative to the LVLH is expressed as a 3-1-2 Euler rotation.

1.5 Related Documentation

1.5.1 References

1. National Aeronautics and Space Administration (NASA), Goddard Space Flight Center (GSFC), *Earth Observing System AM-1 Detailed Mission Requirements* , 2013.

2. (Deleted)

3. Lockheed Martin Corporation, DR OPD-140, *(Preliminary) Telemetry Handbook for EOS-AM Spacecraft* , January 1995 (Related/Static Document Reference).

4. Lockheed Martin Corporation, EOS-DN-SE&I-001 (Revision C), *System Operating Mode* , February 1994 (Related/Static Document Reference).

5. National Aeronautics and Space Administration (NASA), Goddard Space Flight Center (GSFC), 553-FDD-91/028, *Flight Dynamics Division (FDD) Generic Data Products Formats Interface Control Document*. .

6. NASA/GSFC, 423-ICD-002 Appendix B, Interface Control Document (ICD) Between the Earth Observing System (EOS) Data and Information System (EOSDIS) Subsystems Networks and the Flight Dynamics System (FDS) Elements at GSFC.

7. (Deleted)

8. Lockheed Martin Missiles & Space, *EOS AM-1 Spacecraft Flight Systems Manual* , OPD-100, Vol. IV, 20054746, July 31, 1996 (Related/Static Document Reference).

9. Newman, L., M. Woodard, and C. Matusow, *EOS AM-1 Flight Dynamics System (FDS) Operations Procedures Handbook* , This document is a living document updated about once a week and is available at http://missionsystems.gsfc.nasa.gov/EOS-Terra under the documents link.

10. Herberg, J. R., EOS-GN&C-417, *Computation of EOS and TDRS Mean Orbit Element Rates* , March 7, 1996 (Related/Static Document Reference).

11. Federal Information Security Modernization Act (FISMA) of 2014.

12. NPR 2810.1A.

13. Earth Science Mission Operations System Security Plan (CD-0000-M-GSF-3270)

Section 2. Facilities/Systems

2.1 Purpose

This section provides a brief description of the EOS Elements and the FDS, along with
the interfaces between the two systems.

2.2 EOS Operations Center (EOC)

The EOC is an EMOS element which provides for all the ground support for the EOS program. The EOC provides for the operation of the EOS spacecraft and instruments. The EOC coordinates spacecraft telemetry and commanding with the EOS Data and Operations System (EDOS), EOSDIS Backbone Network (EBnet), and external systems such as the Network Control Center (NCC) and the FDS.

2.3 Flight Dynamics System (FDS)

The FDS is a collection of workstations that host flight dynamics applications software required for supporting the EOS AM-1 mission. The FDS is physically located within the EOC facility, and shares with EOC the facility-provided infrastructure such as electric power and communications network capabilities. The FDS provides orbit, attitude, and maneuver capabilities. Orbit support includes generation of predicted and definitive ephemeris, support for the TDRSS Onboard Navigation System (TONS), and evaluation of the onboard ephemeris processes. Attitude support includes all ground attitude determination, validation of onboard attitude determination and star ephemeris, and calibration of attitude sensors. Maneuver support includes generation of maneuver planning and calibration products.

2.4 Distributed Active Archive Centers (DAACs)

The LaRC SDPS and the GES DISC are EOSDIS segments known as Distributed Active Archive Centers (DAACs) that are responsible for Level 1 through Level 4 science data processing, product generation, distribution, and archival. The DAACs are geographically distributed centers, which are facilities with resident expertise in specific Earth science disciplines. The DAACs need orbit and attitude data to geolocate instrument data points, which are normally provided by TONS and onboard attitude determination (and control) system. The FDS provides the DAACs with necessary repaired products.

2.5 FDS/EOC Interface Description

Figure 2-1, adapted from Reference 6, shows a simplified view of the interfaces between the EOC and FDS functional entities. For details of the FDS architecture, see Reference 9

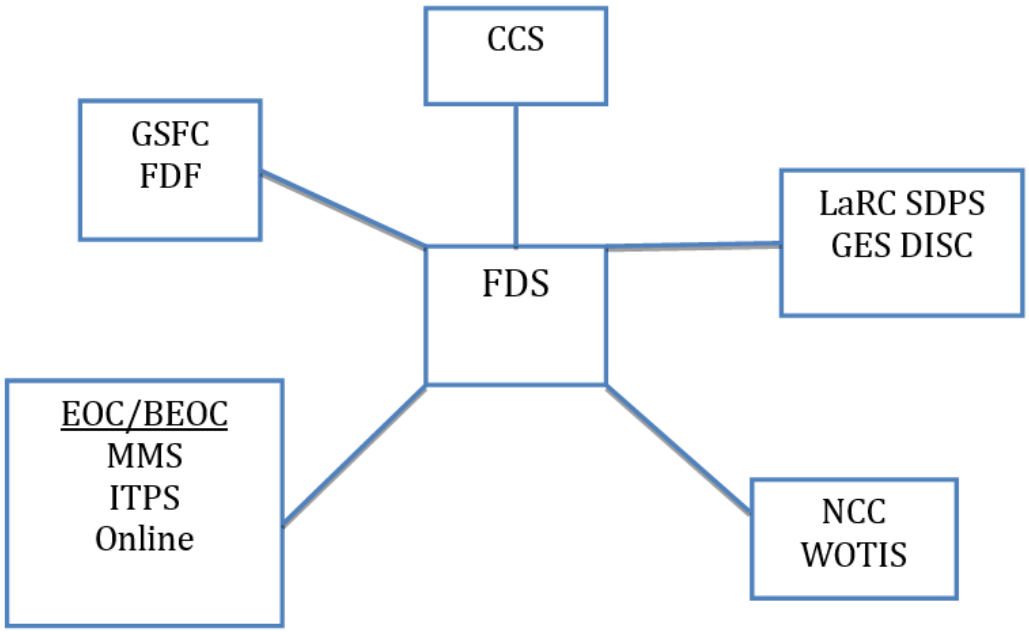


Figure 2-1. EOC/FDS Interface for EOS Terra

The following provides a description of how the EOC operator uses the FDS workstations, presents rudimentary aspect of the file transfer which the FDS applications should be aware of, and provides the guidelines and rules for the FDS product formats.

2.5.1 File Transfer

File transfers between the FDS, EOC and EOS entities are conducted through the use of Secure File Transfer Protocol (SFTP). A generic message sequence applies for all automated file transfers between the FDS and the EOC. In this transfer sequence, the sender of the data initiates the communications session with the receiver. The sender transfers the data file to a specified directory on the receiving host computer.

2.5.2 Formats for FDS Products

Data formats for all the FDS products (with only a few exceptions) delivered to the EOC will follow the following rules and guidelines:

a. All data products are generated in an ASCII format
b. Each record has a carriage return or newline character (‘\n’) at the end (only if a hard return is not automatically generated by the software that writes the file)
c. All data fields within a record are separated by exactly one blank character (‘ ’) (but there is no blank character between the last character of the last data field and the newline character)
d. Each data field in a record is left justified
e. All data products are generated based on the Mean Equator and Equinox of J2000 reference system
f. Positive numeric values may optionally have a plus sign (‘+’) to the left of the value. The plus sign, if present, must be immediately followed by the value without any blanks in between.
g. A minus sign (‘–’) precedes a data value to designate a negative numeric value. The minus sign must be immediately followed by the value without any blanks in between.
h. Ranges for values are specified in the ICD only where applicable
i. The “Start Time of the File” and the “End Time of the File” data field values in the header record are the times associated with the beginning and end of the time period over which the file was generated.

Two FDS products (i.e., Definitive Orbit Data and Local Oscillator Frequency Report) are standardized so that they can be used by

almost all conceivable missions. Data formats for these products deviate from the guidelines given here.

Section 3. FDS to EOC Products

3.1 Product Summary Chart

Table 3-1 summarizes all the products that are transferred from the FDS to the EOC. The backup medium "Tape" referred on the second to the last column is a 40GB Native DLTtape IV. The last column lists section numbers of the EOS AM-1 Detailed Mission Requirements (DMR) document (Reference 1), which are pointers to the requirements to be met by the FDS product listed on the corresponding row of the first column. The following sections provide more detail about each product.

Table 3-1. Summary of FDS to EOC Products

Product Name	ICD Sec	Purpose	Delivery Schedule	Timespan	Medium (Prime/Bkup)	DMR No.
Real-Time Attitude Determination	3.1	S/C monitoring	All real-time passes	Length of pass	FOT uses EOC-resident FDS workstation /(N/A)	7110-1
Sensor Calibration Table	3.3	Upload	Once in Checkout and then as needed	N/A	SFTP/Tape	7120-3, 7120-4, 7120-5, 7120-6, 7120-7, 7120-8
Attitude Slew Table	3.4	Upload	Once in Checkout and then as needed	N/A	SFTP/FAX	7130-1
EOS Terra Mission Star Catalog	3.5	Upload (SSST ops)	Once prelaunch and then as needed	N/A	SFTP/Tape	7140-2
Star Density Profile	3.6	Analysis	Weekly	3 weeks	SFTP/Tape	7140-4
SSST Star Interference	3.7	Analysis	Weekly	3 weeks	SFTP/Tape	7140-5

Product Name	ICD Sec	Purpose	Delivery Schedule	Timespan	Medium (Prime/Bkup)	DMR No.
ESA Sun/Moon Interference	3.8	Analysis	Weekly	7 weeks	SFTP/Tape	7140-7
FSS Visibility Predict	3.9	Analysis	Weekly	3 weeks	SFTP/Tape	7140-8
TDRS State Vectors	3.11	Upload	Daily and After each orbit maneuver	2 Days	SFTP/Tape	7210-7
EOS Terra Brouwer-Lyddane Elements	3.12	Upload (TONS ops)	Daily and After each orbit maneuver	2 Days	SFTP/Tape	7210-9
TDRS Brouwer-Lyddane Elements	3.13	Upload	Daily and After each orbit maneuver	2 Days	SFTP/Tape	7210-10
Simulated EOS Terra Ephemeris	3.15	Simulation	As needed	As requested	SFTP/Tape	7210-16
Filter Tuning Parameters	3.16	Upload (TONS ops)	As needed	N/A	SFTP/Tape	7210-17
Nadir OMNI to TDRSS Viewing Times	3.17	Planning & scheduling (P&S)	Weekly Daily	7 weeks 7 days	SFTP/Tape	7230-1
HGA to TDRSS Line of Sight Viewing Times	3.18	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7230-2
OMNI to Ground Station Viewing Times	3.19	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7230-3
HGA Gimbal Angles	3.20	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7230-8
Predicted EOS-Terra Ephemeris	3.21	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7210-14
Predicted TDRS Ephemeris	3.22	Analysis	Weekly Daily	7 weeks 7 days	SFTP/Tape	7210-21
Orbit Adjust Maneuver	3.24	P&S	Weekly	7 weeks	SFTP/FAX	7220-1

Product Name	ICD Sec	Purpose	Delivery Schedule	Timespan	Medium (Prime/Bkup)	DMR No.
Request						
Delta-V Parameters Table	3.25	Upload (Orbit maneuver ops)	Preliminary 24 hrs. prior: final 4 hrs. prior to each maneuver	N/A	SFTP/Tape	7220-2
Mass and Center of Mass Location Estimates	3.26	Analysis	After each orbit maneuver	N/A	SFTP/FAX	7220-3
Predicted EOS Terra Ranging Data	3.27	S/C time correlation (RDD)	Daily	1 day	SFTP/Tape	7230-9
Attitude Predictions	3.28	Analysis	As needed	N/A	SFTP/Tape	7130-2
Predicted Orbital Events	3.29	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7300-4, 7300-5, 7300-8, 7300-14, 7300-17, 7300-19, 7300-20
Planned Orbit Maneuver Dataset	3.30	P&S	Weekly Monthly	7 weeks 78 weeks	SFTP/Tape	7300-1
Solar/Lunar Azimuth and Elevation Angles	3.31	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7300-2, 7300-3
Solar Beta Angles	3.32	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7300-6
Predicted Local Sun Time	3.33	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7300-7
Lunar Beta Angles	3.34	P&S	Weekly	7 weeks	SFTP/Tape	7300-9
MODIS Sun/Moon FOV	3.35	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7300-10

Product Name	ICD Sec	Purpose	Delivery Schedule	Timespan	Medium (Prime/Bkup)	DMR No.
Events						
MODIS Planet/Star FOV Events	3.36	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7300-11
Predicted Sub-Satellite Point Dataset	3.37	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7300-12
Predicted Spacecraft Altitude	3.38	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7300-13
Predicted S/C Day/Night Length	3.39	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7300-16
Terra State Error Covariance Matrix	3.40	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-6
Local Oscillator Frequency Report	3.48	Report for FOT	Weekly	N/A	SFTP/FAX	7210-23
X-Band Interference Times	3.50	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7230-11
Predicted Orbit Number and Start Times	3.53	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7300-21
UTC to UT1 Timing Difference	3.54	Upload (TONS)	Daily	1 day	SFTP/Tape	7210-11
Predicted Instrument Orbit Events	3.55	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7300-15
Predicted EOS Terra State Vector	3.56	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-5
Simulated TDRS State Vectors	3.57	Simulation	As needed	N/A	SFTP/Tape	7210-16
Simulated EOS Terra Brouwer-Lyddane	3.58	Simulation	As needed	N/A	SFTP/Tape	7210-16

Product Name	ICD Sec	Purpose	Delivery Schedule	Timespan	Medium (Prime/Bkup)	DMR No.
Elements						
Simulated TDRS Brouwer-Lyddane Elements	3.59	Simulation	As needed	N/A	SFTP/Tape	7210-16
Simulated EOS Terra State Vectors	3.60	Simulation	As needed	N/A	SFTP/Tape	7210-16
X-Band Ground Station Contact Times	3.61	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7230-12
MODIS FOV Target View Period	3.62	P&S	As needed	Up to 7 wks	SFTP/Tape	7230-13
Earth Gravity Model Spherical Harmonic Coefficients	3.63	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-17
Earth Gravity Model Degree Variance	3.64	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-17
Harris-Priester Atm. Density Model	3.65	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-17
Solar Ephem Modification Data	3.66	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-17
EOS Terra Modeling Data	3.67	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-17
TDRS Modeling Data	3.68	Upload (TONS)	Daily and after each TDRS maneuver	N/A	SFTP/Tape	7210-17
Ground Antenna Modeling Data	3.69	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-17
State Tolerance Data	3.70	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-17
Doppler Meas. Tolerance Data	3.71	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-17
Covariance Tolerance Data	3.72	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-17

Product Name	ICD Sec	Purpose	Delivery Schedule	Timespan	Medium (Prime/Bkup)	DMR No.
Navigation Time Step Data	3.73	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-17
Phys. and Math. Constants	3.74	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-17
Atmospheric Drag Data	3.77	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-17
TDRSS Measurement Bias Data	3.78	Upload (TONS)	As needed	N/A	SFTP/Tape	7210-17
Simulated UTC to UT1 Timing Difference	3.79	Simulation	As needed	(User-specified)	SFTP/Tape	7210-16
Navigation Thruster Table	3.80	Upload (Orbit maneuver)	4 hrs. prior to each maneuver	N/A	SFTP/Tape	7220-2
HGA to TDRSS S-Band Viewing Times	3.81	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7230-2
HGA to TDRSS TONS-based Viewing Times	3.82	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7230-2
Zenith Omni to TDRSS Viewing Times	3.83	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7230-1
TAM FDIR Predict Table	3.84	Upload (Attitude maneuver)	As needed	13042 seconds	SFTP/Tape	7210-22
Thruster Control Parameters Table	3.85	Upload (Attitude maneuver)	As needed	(None)	SFTP/Tape	7220.2
CERES FOV Intrusion Times	3.86	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7230-13
TDRSS to S/C Ray Patch Height	3.87	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	7230-1
HGA Hotzone Times	3.88	P&S	Weekly Daily	7 weeks 7 days	SFTP/tape	New
HGA Keyhole Unwind Times	3.89	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	New

Product Name	ICD Sec	Purpose	Delivery Schedule	Timespan	Medium (Prime/Bkup)	DMR No.
HGA Keyhole High Slew Rate Times	3.90	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	New
HGA Keyhole Sun Interference Times	3.91	P&S	Weekly Daily	7 weeks 7 days	SFTP/Tape	New
FDS Checklist	3.92	FOT	Weekly Daily	n/a n/a	SFTP/Tape	New
Inclination (Yaw) Data	3.93	FOT	Weekly	7 weeks	SFTP/Tape	New

3.2 Real-Time Coarse Attitude Determination

3.2.1 Description

The real-time attitude determination system (RTADS) is used for real-time verification of the spacecraft's attitude determination process onboard.

3.2.2 Mission Phase

The real-time coarse attitude determination function is to be available during all mission phases.

3.2.3 Format

The real-time coarse attitude determination system produces a formatted display output to be accessible by the EOC on their network.

3.2.4 Accuracy/Completeness

The FDS determines the roll, pitch and yaw Euler angles in real-time with an accuracy of ±1 degree (3 sigma) for each axis after calibration. Before calibration the accuracy was ± 7 degrees (3 sigma) for each axis.

3.2.5 Delivery Schedule

The real-time coarse attitude display is available as needed in the EOC for all real-time passes during all phases of the mission. The RTADS was delivered and used during EOC prelaunch for simulations and ground network testing.

3.2.6 Timespan

The data timespan per support is at the discretion of the FOT, but the RTADS is capable of supporting all real-time passes.

3.2.7 Transmission Medium

The real-time attitude display is generated on an FDS workstation, which resides in the EOC and in the Backup EOC (BEOC). There is no backup transmission medium for this product.

3.2.8 Volume Estimate

There is no volume estimate associated with the RTADS.

3.3 (Moved to Section 7)

3.4 Sensor Calibration Table

3.4.1 Description

The FDS delivers to the EOC the results of each calibration effort in the form of a dataset that are converted to uplink tables by the EOC. The FDS performs calibrations during the Checkout and Operational phases of the mission.

The following are the attitude related sensors to be calibrated, along with the parameters for each sensor as indicated:

a. SSSTs – alignments, star magnitude sensitivity, and scale factors
b. IRUs – alignment and scale factors and biases
c. FSS – alignment and field-of-view (FOV)

3.4.2 Mission Phase

This product is to be delivered during the Checkout and Operational phases.

3.4.3 Format

Formats for the following tables are described separately:

a. FSS transformation table
b. FSS calibration table
c. SSST transformation table

d. SSST parameters table
e. IRU transformation table
f. IRU scaling table
g. IRU biases table

3.4.3.1 FSS Transformation Table

This table contains the Euler parameters that describe the mounting orientation of the FSS relative to the spacecraft body frame. The Euler parameters represent the transformation from the spacecraft body frame to the sensor frame.

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: FSS_XFORM_TABLE
b. Table Number: 125

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	No unit (NU)	First of four Euler parameters describing the mounting orientation of FSS relative to the spacecraft body frame.
2	LF	NU	Second of four Euler parameters.
3	LF	NU	Third of four Euler parameters.
4	LF	NU	Fourth of four Euler parameters.

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 FSS_XFORM_TABLE 125 5 1996124.112233 \
1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 3.2963381000E-01\n
2 9.0189837000E-01\n
3 -2.5905955000E-01\n
4 -1.0396645000E-01\n
```

3.4.3.2 FSS Calibration Table

A flight software component receives alpha and beta angle inputs from the FSS and applies up to nine compensation coefficients per input to define the FSS position output to the “Update Filter” or attitude initialization function. These compensation coefficients comprise 18 elements of this table (nine each for alpha input and beta input).

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: FSS_CAL_TBL
b. Table Number: 63

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	NU	Alpha angle calibration coefficient #1.
2	LF	counts $^{-1}$	Alpha angle calibration coefficient #2
3	LF	NU	Alpha angle calibration coefficient #3
4	LF	rad/count	Alpha angle calibration coefficient #4
5	LF	rad	Alpha angle calibration coefficient #5
6	LF	NU	Alpha angle calibration coefficient #6
7	LF	rad/count	Alpha angle calibration coefficient #7
8	LF	rad	Alpha angle calibration coefficient #8
9	LF	rad	Alpha angle calibration coefficient #9
10	LF	NU	Beta angle calibration coefficient #1
11	LF	counts $^{-1}$	Beta angle calibration coefficient #2
12	LF	NU	Beta angle calibration coefficient #3
13	LF	rad/count	Beta angle calibration coefficient #4
14	LF	rad	Beta angle calibration coefficient #5
15	LF	NU	Beta angle calibration coefficient #6
16	LF	rad/count	Beta angle calibration coefficient #7
17	LF	rad	Beta angle calibration coefficient #8
18	LF	rad	Beta angle calibration coefficient #9

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 FSS_CAL_TBL 63 5 1996124.112233 \
1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 -6.2486900000E-01\n
2 7.6278000000E-05\n
3 0.0000000000E+00\n
.
.
9 0.0000000000E+00\n
10 -6.2486900000E-01\n
11 7.6278000000E-05\n
.
.
18 0.0000000000E+00\n
```

3.4.3.3 SSST Transformation Table

This table contains two sets (one for each of two SSSTs) of Euler parameters which define the mounting orientation of SSST1 and SSST2 relative to the spacecraft body frame. The Euler parameters represent the transformation from the spacecraft body frame to the sensor frame.

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: SSST_EULER_PARAMS_TBL
b. Table Number: 178

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	NU	First of four Euler parameters describing the mounting orientation of SSST1 relative to the spacecraft body frame.
2	LF	NU	Second of four Euler parameters (SSST1).
3	LF	NU	Third of four Euler parameters (SSST1).
4	LF	NU	Fourth of four Euler parameters (SSST1).
5 through 8	Preceding four records are repeated for SSST2.		

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 SSST_EULER_PARAMS_TBL  178 5 \
1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 7.6537181000E-01\n
2 3.2488106000E-01\n
3 5.1140510000E-01\n
4 -2.1707859000E-01\n
5 3.2488106000E-01\n
6 7.6537181000E-01\n
7 2.1707859000E-01\n
8 -5.1140510000E-01\n
```

3.4.3.4 SSST Parameters Table

This table contains two scale factors (LSB definitions) for the angle (X and Y) measurements and the magnitude input from either SSST along with measurement correction factors for the X angle, Y angle and magnitude inputs received (one set of correction factors for each SSST).

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: SSST_PARAMS_TBL
b. Table Number: 65

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
3	IT	counts	SSST 1 horizontal meas. correction
4	IT	counts	SSST 2 horizontal meas. correction
5	IT	counts	SSST 1 vertical meas. correction
6	IT	counts	SSST 2 vertical meas. correction
7	IT	counts	SSST 1 magnitude meas. correction
8	IT	counts	SSST 2magnitude meas. correction

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 SSST_PARAMS_TBL  65 5 1996124.112233 \
1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
3 0\n
4 0\n
5 0\n
6 0\n
7 0\n
8 0\n
```

3.4.3.5 IRU Transformation Table

This table contains the nine elements of the 3x3 alignment matrix which define the transformation of IRU sensor measurements to the spacecraft body frame.

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: IRU_XFORM_TBL
b. Table Number: 72

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1 through 9	LF	NU	(p, q) element of the transformation matrix, where p = (N-1)/3 + 1, q = (N-1)%3 + 1, N = table field number (1,..., 9)

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 IRU_XFORM_TBL 72 5 1996124.112233 \
1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 1.0000000000E+00\n
2 0.0000000000E+00\n
3 0.0000000000E+00\n
4 0.0000000000E+00\n
5 1.0000000000E+00\n
6 0.0000000000E+00\n
7 0.0000000000E+00\n
8 0.0000000000E+00\n
9 1.0000000000E+00\n
```

3.4.3.6 IRU Scaling Table

This table contains 12 scale factors (radians/count) to be applied to the high and low rate outputs for each axis (roll, pitch, yaw) for the two IRUs.

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: IRU_SCALING_TBL
b. Table Number: 70

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	rad/count	IRU1 high scaling factor (roll)
2	LF	rad/count	IRU2 high scaling factor (roll)
3	LF	rad/count	IRU1 high scaling factor (pitch)
4	LF	rad/count	IRU2 high scaling factor (pitch)
5	LF	rad/count	IRU1 high scaling factor (yaw)
6	LF	rad/count	IRU2 high scaling factor (yaw)
7	LF	rad/count	IRU1 low scaling factor (roll)
8	LF	rad/count	IRU2 low scaling factor (roll)
9	LF	rad/count	IRU1 low scaling factor (pitch)
10	LF	rad/count	IRU2 low scaling factor (pitch)
11	LF	rad/count	IRU1 low scaling factor (yaw)
12	LF	rad/count	IRU2 low scaling factor (yaw)

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 IRU_SCALING_TBL \
70 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 3.8785094000E-06\n
2 3.8785094000E-06\n
3 3.8785094000E-06\n
4 3.8785094000E-06\n
5 3.8785094000E-06\n
```

```
6 3.8785094000E-06\n
7 2.4240684000E-07\n
8 2.4240684000E-07\n
9 2.4240684000E-07\n
10 2.4240684000E-07\n
11 2.4240684000E-07\n
12 2.4240684000E-07\n
```

3.4.3.7 IRU Biases Table

Header Record: 137 bytes.

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: IRU_BIASES_TBL
b. Table Number: 73

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	rad	IRU1 high-rate bias (roll)
2	LF	rad	IRU2 high-rate bias (roll)
3	LF	rad	IRU1 high-rate bias (pitch)
4	LF	rad	IRU2 high-rate bias (pitch)
5	LF	rad	IRU1 high-rate bias (yaw)
6	LF	rad	IRU2 high-rate bias (yaw)
7	LF	rad	IRU1 low-rate bias (roll)
8	LF	rad	IRU2 low-rate bias (roll)
9	LF	rad	IRU1 low-rate bias (pitch)
10	LF	rad	IRU2 low-rate bias (pitch)
11	LF	rad	IRU1 low-rate bias (yaw)
12	LF	rad	IRU2 low-rate bias (yaw)

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 IRU_BIASES_TBL \
73 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 3.8785094000E-01\n
2 3.8785094000E-01\n
3 3.8785094000E-01\n
```

```
4 3.8785094000E-01\n
5 3.8785094000E-01\n
6 3.8785094000E-01\n
7 2.4240684000E-02\n
8 2.4240684000E-02\n
9 2.4240684000E-02\n
10 2.4240684000E-02\n
11 2.4240684000E-02\n
12 2.4240684000E-02\n
```

3.4.4 Accuracy

There is no direct accuracy requirement for calibration of attitude sensors. The calibration is done to reduce the residuals such that the attitude determination function residing in the SCC will meet knowledge requirements.

3.4.5 Delivery Schedule

The calibration product for each attitude sensor is to be delivered once during the Checkout phase and as needed during the Operational phase.

3.4.6 Timespan

There is no timespan associated with this product

3.4.7 Transmission Medium

3.4.7.1 Prime Medium

The file transfer method is SFTP to the EOC.

3.4.7.2 Backup Medium

The backup medium for the calibration file is a 40GB Native DLTtape IV.

3.4.8 Volume Estimate

The data volume (of one full table) for each table is listed below.

Table Name	Data Volume (bytes)
FSS_XFORM_TABLE	245 (= 137 + 4*27)
FSS_CAL_TBL	972 (= 137 + 18*27)
SSST_EULER_PARAMS_TBL	353 (= 137 + 8*27)
SSST_PARAMS_TBL	299 (= 137 + 6*27)
IRU_XFORM_TBL	380 (= 137 + 9*27)
IRU_SCALING_TBL	461 (= 137 + 12*27)
IRU_BIASES_TBL	461 (= 137 + 12*27)

3.5 Attitude Slew Table

3.5.1 Description

The FDS provides the EOC with attitude slew tables required for attitude maneuver.

3.5.2 Mission Phase

The attitude slew table is to be delivered during the Checkout and Operational phase.

3.5.3 Format

This table contains attitude slew rate, slew axis identifier, and number of slew cycles.

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: ATTITUDE_SLEW_TBL
b. Table Number: 126

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
5	LF	rad/s	Attitude slew rate
6	LF	rad/s ^{2}	• Slew acceleration limit
7	IT	NU	Slew axis (1 = roll, 2 = pitch, 3 = yaw)
8	IT	NU	Number of slew cycles (1 cycle = 0.512 s)

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 ATTITUDE_SLEW_TBL 126 5 1996124.112233 \
1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
5 -1.7450000000E-03\n
6 1.7453290000E-05\n
7 2\n
8 1\n
```

3.5.4 Accuracy

There is no accuracy requirement for this product.

3.5.5 Delivery Schedule

The product is delivered as needed during the Checkout and Operational phases.

3.5.6 Timespan

There is no timespan associated with this product.

3.5.7 Transmission Medium

3.5.7.1 Prime Medium

The file transfer method is SFTP to the EOC.

3.5.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.5.8 Volume Estimate

The volume of one full table is 218 (= 137 + 3*27) bytes.

3.6 EOS Terra Mission Star Catalog

3.6.1 Description

The FDS is responsible for generating and delivering to the EOC the EOS Terra mission star catalog to be used by the SCC. The catalog is generated in the J2000 reference system. The EOS Terra mission catalog contains star instrument magnitudes and star position unit vectors.

3.6.2 Mission Phase

The catalog was delivered to the EOC during the prelaunch phase for use during system tests and training. The parameters defined in the catalog can be updated as needed and requested by the EOC during any of the mission phases.

3.6.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: STAR_CATALOG_TBL
b. Table Number: 179

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	FL	NU	Direction cosine between x-axis and star #1 position vector
2	FL	NU	Direction cosine between y-axis and star #1 position vector
3	FL	NU	Direction cosine between z-axis and star #1 position vector
4	IT	NU	Star #1 instrument magnitude
5 through up to 2800	Preceding 4 records are repeated up to 699 times more.		

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 STAR_CATALOG_TBL  179 5 \
1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 8.73300E-01\n
2 3.20000E-02\n
3 4.86200E-01\n
4 2400\n
```

3.6.4 Accuracy

The accuracy for the generation of the EOS star catalog is found in the set of criteria used to create the catalog.

They are the following:

a. Instrumental magnitudes from 2 to 5.7.
b. No stars included with instrumental magnitude uncertainty greater than 0.25.
c. No variable stars included with instrumental magnitude amplitudes greater than 0.1.
d. No stars included with proper motions greater than 0.7 arc-seconds per year.
e. No stars included with position uncertainties greater than 0.25 arcseconds.

f. For a component of a multiple star, nearest star is not less than 5 magnitudes dimmer, or is less than 5 arcseconds away
g. A near neighbor star within 0.2 degrees must be dimmer by at least 5 magnitudes
h. A near neighbor star within 0.6 degrees must have a magnitude difference of at least 0.75 magnitudes

3.6.5 Delivery Schedule

The EOS mission catalog was delivered to the EOC during the prelaunch phase and can be updated as requested by the EOC during any of the mission phases.

3.6.6 Timespan

Except for updates, the EOS star catalog is used for the duration of the mission lifetime.

3.6.7 Transmission Medium

3.6.7.1 Prime Medium

The EOS Terra star catalog is sent to the EOC via SFTP.

3.6.7.2 Backup Medium

The backup transfer medium for this product is a 40GB Native DLTtape IV.

3.6.8 Volume Estimate

The volume of one full table (consisting of 700 stars) is 75,737 (= 137 + 2800*27) bytes.

3.7 Star Density Profile

3.7.1 Description

The FDS will provide the EOC with a prediction product that will give for each orbit in the requested timespan a statistical representation for the star density of that orbit. Each orbit begins with an ascending node and end at the next ascending node. There is to be a set of statistical parameters per orbit for each SSST. This product is generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed.

3.7.2 Mission Phase

The product was delivered prior to the Launch phase and can be updated as needed throughout all phases of the mission.

3.7.3 Format

The format for the star density report is as follows (for each SSST):

Header Record: 71 bytes.

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite id of the Terra spacecraft (“AM1”).
File Type	14	This field indicates the type of file. The only valid value is STARDENPROF.
File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.
SSST ID	1	SSST Identification number (value is 1 or 2).

Data Records: 47 bytes.

Field Name	Maximum Field Width	Description
Time of start of ascending node	14	Time of ascending node in the form YYYYDDD.HHMMSS.
Orbit number	6	Orbit number. Format is XXXXXX.
Minimum orbit angle separation	8	Minimum star separation orbit angle (degrees) between stars (XX.XXXXX).
Maximum orbit angle separation	8	Maximum star separation orbit angle (degrees) between stars (XX.XXXXX).
Average orbit angle separation	8	Average star separation orbit angle (degrees) between stars (XX.XXXXX).

Sample Header Record

```
AM1 STARDENPROF 1999225.123034 1999230.000000 1999232.235900 1\n
```

Sample Data Records

```
1999225.123034 12 45.56201 90.26521 67.52564\n
1999226.123056 13 48.45342 88.36541 80.30675\n
```

3.7.4 Accuracy

There is no accuracy requirement for this product.

3.7.5 Delivery Schedule

The product is delivered weekly.

3.7.6 Timespan

The timespan of the product is 3 weeks.

3.7.7 Transmission Medium

3.7.7.1 Prime Medium

The prime medium for transfer of this product is via SFTP.

3.7.7.2 Backup Medium

The backup transmission medium is a 40GB Native DLTtape IV.

3.7.8 Volume Estimate

The size for each report, one for each SSST, is 118 bytes.

3.8 SSST Star Interference

3.8.1 Description

The FDS will provide to the EOC a report that gives information about interference of each SSST with bright objects that enter the FOV. FDS will predict the times when the Sun is within 45 degrees of either SSST boresight and when the Moon is within 17 degrees of either SSST boresight. FDS will also predict the times when each of the planets (excluding Earth)

enters and exits either SSST FOV. This product is generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed.

3.8.2 Mission Phase

The star interference prediction report is to be delivered to the EOC during the Checkout and Operational phases.

3.8.3 Format

Header Record: 74 bytes

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite id of the Terra spacecraft (“AM1”).
File Type	14	This field indicates the type of file. The only valid value is STARINTERFER.
File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS.
Start Time of the file	16	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.S.
End Time of the file	16	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.S.
SSST ID	1	SSST Identifier (1 or 2).

Data Records: 54 bytes

Field Name	Maximum Field Width	Description
STAR ID	8	The SKYMAP ID of the STAR (up to 8 chars) or 0 (zero) if the sun or moon is in the FOV.
Interference start time	16	Start time of interference (YYYYDDD.HHMMSS.S).
Interference stop time	16	End time of interference (YYYYDDD.HHMMSS.S).
Interference type	2	Interference flag: Moon = 2, Sun = 3, Mars = 4, Jupiter = 5, Saturn = 6, Uranus = 7, Neptune = 8; Pluto = 9, Mercury = 10; Venus = 11.
Separation angle	8	Separation angle between star and interfering solar system body. The angles range from -12 degrees to +12 degrees. Format is -XX.XXXX for negative values and XX.XXXX for positive values. If the sun or moon is in the FOV, then the valid value is 0 (zero).

Sample Header Record

```
AM1 STARINTERFER 1996207.184925 1998181.004000.0 1998182.000000.0 1\n
```

Sample Data Records

```
10220058 1998181.005736.0 1998181.011346.0 3 12\n
```

3.8.4 Accuracy

The star interference report file predicts event times to be within 0.1 seconds.

3.8.5 Delivery Schedule

The product is to be delivered weekly.

3.8.6 Timespan

The timespan of the product is 3 weeks.

3.8.7 Transmission Medium

3.8.7.1 Prime Medium

The prime medium for transfer is via SFTP.

3.8.7.2 Backup Medium

The backup transmission medium is a 40GB Native DLTtape IV.

3.8.8 Volume Estimate

The size of each product, one for each SSST, is 74 bytes plus 79 bytes times number of data records per SSST prediction.

3.9 ESA Sun/Moon Interference

3.9.1 Description

The FDS provides to the EOC a list of times that the Sun and/or Moon enter the ESA field of view (FOV). For each ESA, the interference occurs when the Sun or Moon is in the range of 40 to 50 degrees half-cone angle from the ESA boresight, and also in the range of 4.0 degrees below to 7.0 degrees above the Earth limb. This product is generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed. The data records are in time order based on the "Interference Start Time" field.

3.9.2 Mission Phase

The ESA interference product is to be generated during the Launch/Acquisition, Checkout and Operational phase.

3.9.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite id of the Terra spacecraft ("AM1").
File Type	14	This field indicates the type of file. The only valid value is ESAINTERFER.
File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.

Data Records: 35 bytes.

Field Name	Maximum Field Width	Description
ESA number	2	Earth Sensor Assembly number (1 or 2).

Interference start Time	14	Start time of interference after entrance into the FOV (YYYYDDD.HHMMSS).
Interference stop Time	14	End time of interference before exit from the FOV (YYYYDDD.HHMMSS).
Interfering object	2	Interference flag: =1 for Sun, =2 for Moon

Sample Header Record

```
AM1 ESAINTERFER 1996215.141123 1998181.004000 1998182.000000\n
```

Sample Data Records

```
1 1998181.004335 1998181.004517 01\n
2 1998181.004725 1998181.005002 01\n
```

3.9.4 Accuracy

The accuracy of the event predictions is to be 60 seconds at the end of the 3 week timespan.

3.9.5 Delivery Schedule

The product is delivered weekly.

3.9.6 Timespan

The timespan of the product is 7 weeks.

3.9.7 Transmission Medium

3.9.7.1 Prime Medium

The product is transferred to the EOC using SFTP.

3.9.7.2 Backup Medium

The backup medium for the ESA interference predict is a 40GB Native DLTtape IV.

3.9.8 Volume Estimate

The size of this product is (68 + number of interferences * 35) bytes

3.10 FSS Visibility Predict

3.10.1 Description

The FDS provides the times that the sun is visible to the FSS along with corresponding alpha and beta angles. This product is to be generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed.

3.10.2 Mission Phase

This predict is to be generated during the Launch/Acquisition, Checkout, and Operational phases.

3.10.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite id of the Terra spacecraft (“AM1”).
File Type	14	This field indicates the type of file. The only valid value is FSSVISPREDICT.
File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.

End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.

Data Records: 71 bytes.

Field Name	Maximum Field Width	Description
Orbit number	6	Orbit in which the sun visibility is predicted. Format is XXXXXX.
FSS sun visibility start time (AOS)	14	Acquisition of signal (AOS) event time (YYYYDDD.HHMMSS) (0.0 if no AOS in this orbit)
FSS sun visibility stop Time (LOS)	14	Loss of signal (LOS) event time (YYYYDDD.HHMMSS) (0.0 if no LOS in this orbit)
Alpha angle at AOS	8	FSS FOV reference coordinate system - alpha angle (degrees) at AOS. The angle ranges from –32 degrees to 32 degrees. Format is SXX.XXXX, where S = '–' for negative values.
Alpha angle at LOS	8	FSS FOV reference coordinate system - alpha angle (degrees) at LOS. The angle ranges from –32 degrees to 32 degrees. Format is SXX.XXXX, where S = '–' for negative values.
Beta angle at AOS	8	FSS FOV reference coordinate system - beta angle (degrees) at AOS. The angle ranges from –32 degrees to 32 degrees. Format is SXX.XXXX, where S = '–' for negative values.
Beta angle at LOS	8	FSS FOV reference coordinate system - beta angle (degrees) at LOS. The angle ranges from –32 degrees to 32 degrees. Format is SXX.XXXX, where S = '–' for negative values.

Sample Header Record

```
AM1 FSSVISPREDICT 1996215.150154 1998181.004000 1998182.000000\n
```

Sample Data Records

```
16 1998181.005423 1998181.005927 -5.2437 -3.3578 31.1446 -31.0922\n
17 1998181.023423 1998181.024927 -5.2437 -3.3578 31.1446 -31.0922\n
18 1998181.041423 1998181.042927 -5.2437 -3.3578 31.1446 -31.0922\n
```

3.10.4 Accuracy

The predict is to be accurate to 60 seconds at the end of the 3 week prediction timespan.

3.10.5 Delivery Schedule

The product is to be delivered weekly and as needed.

3.10.6 Timespan

The timespan of the product is 3 weeks.

3.10.7 Transmission Medium

3.10.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.10.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.10.8 Volume Estimates

The volume estimate is (68 + n * 71) bytes, where n is the number of sun visibility periods.

3.11 (Moved to Section 7)

3.12 Predicted TDRS State Vectors

3.12.1 Description

FDS provides the EOC with four separate tables (one for each of four operational TDRSS spacecraft) each containing a predicted state vector. These vectors are propagated onboard.

3.12.2 Mission Phase

This product is to be delivered during the prelaunch (for simulations), Launch, Checkout, and Operational phases.

3.12.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: TDRS*k*_STATE_TABLE (*k* = 1, 2, 3, 4 for TDRS 1, 2, 3, and 4)

b. Table Number: 272, 273, 274, and 275 for TDRS1 through TDRS4, respectively. (**Note:** "k" represents not the actual TDRS spacecraft name but an arbitrary assignment of a particular TDRS spacecraft to a slot in the flight software. A mapping is required between the actual spacecraft to be used in a slot and the slot number. This mapping is given in Section 4.12 and will change as the operational constellation of TDRS spacecraft changes.)

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	IT	days	Number of calendar days from January 1, 1958 00:00:00.000000.
2	LI	ms	milliseconds of day. Valid range of values is 0 - 86400999.
3	IT	µs	microseconds of millisecond. Valid range of values is 0 - 999.
4	LF	m	x-component of the position vector (in meters).
5	LF	m	y-component of the position vector.
6	LF	m	z-component of the position vector.
7	LF	m/s	x-component of the velocity vector (in meters/second).
8	LF	m/s	y-component of the velocity vector.
9	LF	m/s	z-component of the velocity vector.
10	IT	days	Time limit. Number of calendar days from January 1, 1958 00:00:00.000000.
11	LI	ms	Time limit. milliseconds of day. Valid range of values is 0 - 86400999.
12	IT	µs	Time limit. microseconds of millisecond. Valid range of values is 0 - 999.

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 TDRS1_STATE_TABLE 272 5 1996124.112233 \
1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 12345\n
2 12345678\n
3 123\n
4 -1.4023886435E+07\n
5 -6.9430616641E+07\n
6 -3.0905939313E+03\n
7 -1.0502194183E+04\n
8 2.0323145049E+03\n
9 -7.4268210686E+04\n
10 12345\n
11 17200678\n
12 123\n
```

3.12.4 Accuracy

This product is to maintain an accuracy such that the position is within 75 meters and the velocity is within 0.0055 meters/second, 3 sigma, at the end of one day. The state vector time tag is to be within +10 to +100 minutes prior to the uplink time.

3.12.5 Delivery Schedule

This product is delivered once per day for routine operations and after each TDRS maneuver for the mission lifetime.

3.12.6 Timespan

There is no timespan associated with this product.

3.12.7 Transmission Medium

3.12.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.12.7.2 Backup Medium

The backup transmission medium for this product is a 40GB Native DLTtape IV.

3.12.8 Volume Estimate

The volume of one full table is 461 (= 137 + 12*27) bytes.

3.13 Predicted EOS Terra Brouwer-Lyddane Elements

3.13.1 Description

FDS provides the EOC with the predicted EOS Terra Brouwer-Lyddane mean orbital elements.

3.13.2 Mission Phase

This product is to be delivered during the Launch/Acquisition, Checkout and Operational phases.

3.13.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: EOS_OE_TABLE
b. Table Number: 201

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	IT	days	Epoch day - Number of calendar days from January 1, 1958 00:00:00.000000.
2	LI	ms	milliseconds of day. Valid range of values is 0 - 86400999.
3	IT	µs	microseconds of millisecond. Valid range of values is 0 - 999.
4	LF	m	Semi-major axis.
5	LF	NU	Eccentricity.
6	LF	deg	Inclination.
7	LF	deg	Argument of perigee.
8	LF	deg	Right Ascension of Ascending Node (RAAN).
9	LF	deg	Mean anomaly.
10	LF	m/s	Semi-major axis rate.
11	LF	deg/s	Argument of perigee rate.
12	LF	deg/s	RAAN rate.
13	LF	deg/s	Mean anomaly rate (See Note 1 below).

Note 1: The Mean Anomaly Rate value is actually not strictly the mean anomaly rate but a combined rate for several of the orbit elements. For an exact definition of this rate computation, see Reference 10.

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 EOS_OE_TABLE 201 5 1996124.112233 \
1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 14610\n
2 53304000\n
3 0\n
4 7.0777342890E+06\n
5 1.5617505920E-04\n
6 9.8199550760E+01\n
7 8.9860345080E+01\n
8 7.8579580640E+01\n
9 9.0007101930E+01\n
10 0.0000000000E+00\n
11 0.0000000000E+00\n
12 1.1405481980E-05\n
13 6.0677612010E-02\n
```

3.13.4 Accuracy

The product is to maintain an accuracy of 50 kilometers in position for the propagation timespan. The product is usable for two days from the uplink time.

3.13.5 Delivery Schedule

The product is to be delivered daily for routine operations, after separation, and after each orbit adjust maneuver, for the mission lifetime.

3.13.6 Timespan

There is no timespan associated with this product.

3.13.7 Transmission Medium

3.13.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.13.7.2 Backup Medium

The backup transmission medium for this product is a 40GB Native DLTtape IV.

3.13.8 Volume Estimate

The volume of one full table is 488 (= 137 + 13*27) bytes.

3.14 Predicted TDRS Brouwer-Lyddane Elements

3.14.1 Description

FDS provides the EOC with four separate tables (one for each of four TDRSs).

3.14.2 Mission Phase

The product is to be delivered during the Launch/Acquisition, Checkout and Operational phases.

3.14.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: TDRS*k*_OE_TABLE (*k* = 1, 2, 3, 4 for TDRS 1, 2, 3, and 4)

b. Table Number: 202, 203, 204, and 205 for TDRS1 through TDRS4, respectively. (**Note:** "k" represents not the actual TDRS spacecraft name but an arbitrary assignment of a particular TDRS spacecraft to a slot in the flight software. A mapping is required between the actual spacecraft to be used in a slot and the slot number. This mapping is given in Section 4.12 and will change as the operational constellation of TDRS spacecraft changes.)

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	IT	days	Epoch day - Number of calendar days from January 1, 1958 00:00:00.000000.
2	LI	ms	milliseconds of day. Valid range of values is 0 - 86400999.
3	IT	μs	microseconds of millisecond. Valid range of values is 0 - 999.
4	LF	m	Semi-major axis.
5	LF	NU	Eccentricity.
6	LF	deg	Inclination.
7	LF	deg	Argument of perigee.
8	LF	deg	Right Ascension of Ascending Node (RAAN).
9	LF	deg	Mean anomaly.
10	LF	m/s	Semi-major axis rate.
11	LF	deg/s	Argument of perigee rate.
12	LF	deg/s	RAAN rate.
13	LF	deg/s	Mean anomaly rate (See Note 1 below).

Note 1: The Mean Anomaly Rate value is actually not strictly the mean anomaly rate but a combined rate for several of the orbit elements. For an exact definition of this rate computation, see Reference 10.

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 TDRS1_OE_TABLE 202 5 1996124.112233 \
1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 14610\n
2 53304000\n
3 0\n
4 4.2165348390E+07\n
5 9.4436410320E-06\n
6 6.9939923540E-02\n
7 3.2779684270E+02\n
8 3.1325746660E+02\n
9 1.1237285530E+00\n
10 0.0000000000E+00\n
11 0.0000000000E+00\n
12 0.0000000000E+00\n
13 4.1781842490E-03\n
```

3.14.4 Accuracy

The product is to maintain an accuracy of 120 kilometers in position for the propagation timespan. The product is usable for two days from the uplink time.

3.14.5 Delivery Schedule

The product is to be delivered daily during the Operational phase and after each TDRS maneuver, for the mission lifetime.

3.14.6 Timespan

There is no timespan associated with this product.

3.14.7 Transmission Medium

3.14.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.14.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.14.8 Volume Estimate

The volume of one full table is 488 (= 137 + 13*27) bytes.

3.15 (Deleted)

3.16 Simulated EOS Terra Spacecraft Ephemeris

3.16.1 Description

The FDS delivers to the EOC datasets containing ephemerides for the EOS Terra spacecraft as needed and specified by the EOC. The coordinate reference system for the ephemeris is in the Mean Equator and Equinox of J2000 frame. The ephemeris is to be used during prelaunch activities for simulations and testing.

3.16.2 Mission Phase

These ephemerides is delivered during all phases as needed.

3.16.3 Format

The format is the same as for Predicted EOS Terra ephemeris (see Section 3.21).

3.16.4 Accuracy

There is no accuracy requirement associated with this product.

3.16.5 Delivery Schedule

The delivery of this product is as needed and negotiated with the EOC.

3.16.6 Timespan

The timespan of this product is as requested and negotiated with the FOT.

3.16.7 Transmission Medium

3.16.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.16.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.16.8 Volume Estimate

The volume estimate is dependent on the timespan of the data requested. The estimate can be computed by taking the timespan, dividing by the propagation interval (the requested data point interval) and multiplying by the number of bytes per record.

3.17 Filter Tuning Parameters

3.17.1 Description

The FDS to deliver to the EOC parameters necessary to tune the onboard TONS navigation filter. The list of parameters required can be found in the EOS Terra spacecraft command and telemetry list.

3.17.2 Mission Phase

The product is to be delivered during the Launch/Acquisition, Checkout and Operational phases.

3.17.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: TUNING_PARAM_TABLE
b. Table Number: 261

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	m	Radial position covariance (cov) sigma
2	LF	m	Intrack position cov sigma
3	LF	m	Crosstrack position cov sigma
4	LF	m/s	Radial velocity cov sigma
5	LF	m/s	Intrack velocity cov sigma
6	LF	m/s	Crosstrack velocity cov sigma
7	LF	NU	Radial position/intrack velocity cov correlation
8	LF	NU	Radial velocity/intrack position cov correlation
9	LF	NU	Drag scale factor cov sigma
10	LF	Hz-S	MO frequency bias cov sigma
11	LF	Hz-S	TDRS measurement bias sigma
12	LF	s	Earth Gravity state noise radial correlation time
13	LF	s	Earth Gravity state noise intrack correlation time
14	LF	s	Earth Gravity state noise crosstrack correlation time
15	LF	$m/s^{3/2}$	Radial state noise spectral density square root
16	LF	$m/s^{3/2}$	Intrack state noise spectral density square root
17	LF	$m/s^{3/2}$	Crosstrack state noise spectral density square root
18	LF	$s^{-1/2}$	Drag scale factor state noise spectral density square root
19	LF	$Hz-S/s^{1/2}$	MO frequency bias state noise spectral density square root
20	LF	s	TDRS measurement bias correlation time
21	LF	Hz-S	Doppler measurement noise sigma.
22	LF	Hz-S	Maneuver measurement noise sigma.
23	LF	%	Thrust magnitude state noise uncertainty.
24	LF	deg	Thrust direction state noise uncertainty.

25	LF	%	MO frequency adjust state noise uncertainty.

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 TUNING_PARAM_TABLE \
261 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 1.0000000000E+03\n
2 1.0000000000E+03\n
3 1.0000000000E+03\n
4 1.0000000000E+00\n
5 1.0000000000E+00\n
6 1.0000000000E+00\n
7 -9.5000000000E-01\n
8 -9.5000000000E-01\n
9 3.0000000000E+00\n
10 4.2000000000E+02\n
11 1.0000000000E-01\n
12 9.0000000000E+01\n
13 1.0000000000E-01\n
14 1.8000000000E+02\n
15 4.0000000000E-05\n
16 1.0000000000E-07\n
17 1.5000000000E-04\n
18 7.0700000000E-03\n
19 2.5000000000E-03\n
20 9.0000000000E+02\n
21 2.5000000000E-02\n
22 1.0000000000E-01\n
23 1.0000000000E+01\n
24 3.0000000000E+00\n
25 1.5000000000E+01\n
```

3.17.4 Accuracy

There is no accuracy requirement associated with this product.

3.17.5 Delivery Schedule

The product is delivered to the EOC on an as-needed basis.

3.17.6 Timespan

There is no associated timespan with this product.

3.17.7 Transmission Medium

3.17.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.17.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.17.8 Volume Estimate

The volume of one full table is 812 (= 137 + 25*27) bytes.

3.18 Nadir Omni to TDRSS Viewing Times

3.18.1 Description

The FDS provides the EOC with viewing times for the nadir-pointing OMNI antenna to each of the operational TDRS used for EOS Terra. The view periods are specified as a pair of start and end times of the view in UTC format. The header record will specify the time span covered by the data in the file as start and end times. There is a data record for each possible view from each TDRS to the Terra nadir Omni antenna for the time span specified in the header record. This product is generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed. The data records are in time order based on the “AOS” field.

3.18.2 Mission Phase

This product is delivered during all phases of the mission.

3.18.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite ID of the Terra spacecraft (“AM1”).
File Type	14	The view indicator specifies the pair that the views are provided for. The only valid value is OMNINTDRS
File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS

Data Records: 48 bytes.

Field Name	Maximum Field Width	Description
TDRS ID	6	The ID of the TDRS that can be seen by the nadir Omni. The valid values are TDX with X = 1,3,4,5, 6,7,8,9,10,11,12,13, ... up to 99.
AOS	14	The start time of the view period in the form YYYYDDD.HHMMSS
LOS	14	The end time of the view period in the form YYYYDDD.HHMMSS
Orbit Number at AOS	6	Orbit number of AOS. Format is XXXXXX.
Orbit Number at LOS	6	Orbit number of LOS. Format is XXXXXX.

Sample Header Record

```
AM1 OMNINTDRS 1999225.123034 1999230.000000 1999232.235900\n
```

Sample Data Records

```
TD1 1999230.100000 1999230.105500 6043 6043\n
TD1 1999230.110100 1999230.114210 6043 6043\n
TD4 1999230.121400 1999230.150508 6043 6043\n
```

3.18.4 Accuracy

The products are to produce an accuracy of 60 seconds absolute UTC at the end of a 3 week prediction.

Constraints : The view periods are filtered so that the following constraints are not violated when the OMNI points to the TDRS:

a. Structural blockage: The Nadir Omni antenna is modeled as a 180 degree nadir pointing FOV sensor. No structural blockage is modeled.
b. Sun Interference: 4 degrees TDRS line of sight to Terra

3.18.5 Delivery Schedule

This product is to be delivered once per week for the 7-week product and once per day for the 7-day product.

3.18.6 Timespan

The timespan for the products is 7-weeks and 7-days.

3.18.7 Transmission Medium

3.18.7.1 Prime Medium

The products are delivered to the EOC via SFTP.

3.18.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.18.8 Volume Estimate

The volume estimate is based on 68 bytes for the header record and 48 bytes for each data record, which is based on the number of view periods for the delivery.

3.19 HGA to TDRSS Line of Sight Viewing Times

3.19.1 Description

The FDS provides the EOC with line of sight viewing times for the High Gain Antenna (HGA) to each TDRS operational for EOS Terra. The header record will specify the time span covered by the data in the file as start and end times. There is a data record for each possible view from any TDRS to the spacecraft HGA antenna for the time span specified in the header record. This product is to be generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed. The data records are in time order based on the “AOS” field.

3.19.2 Mission Phase

This product is delivered during all phases of the mission.

3.19.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite ID of the Terra spacecraft (“AM1”).
File Type	14	The view indicator specifies the pair that the views are provided for. The only valid value is HGA-TDRS.
File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.

Data Records: 48 bytes.

Field Name	Maximum Field Width	Description
TDRS ID	6	The ID of the TDRS that can be seen by the HGA. The valid values are TDX with X = 1,3,4,5, 6,7,8,9,10,11,12,13, ...up to 99.
AOS	14	The start time of the view period in the form YYYYDDD.HHMMSS.
LOS	14	The end time of the view period in the form YYYYDDD.HHMMSS.
Orbit Number at AOS	6	Orbit number of AOS. Format is XXXXXX.
Orbit Number at LOS	6	Orbit number of LOS. Format is XXXXXX.

Sample Header Record

```
AM1 HGA-TDRS 1999225.123034 1999230.000000 1999232.235900\n
```

Sample Data Records

```
TD1 1999230.100000 1999230.105500 6043 6043\n
```

```
TD1 1999230.110100 1999230.114210 6043 6043\n
TD4 1999230.121400 1999230.150508 6043 6043\n
```

3.19.4 Accuracy

The product is to produce an accuracy of 60 seconds absolute UTC at the end of a 3-week prediction.

Constraints : The view periods are filtered so that the following constraints are not violated when the HGA points to the TDRS.

- HGA Gimbal Position Limits:

  There are two sets of constraints on gimbal position limits, hard constraints and soft constraints. The soft constraints are used by FDS for planning purposes.

  The default values for the limits with respect to the HGA are:

	az. (deg)	el. (deg)
Hardware:	+/– 202.0	+97.0/–29.0
Firmware:	+/– 200.5	none
Software:	+/– 194.0	+90.0/–26.0

  Note: The software azimuth limits are found in locations 1 and 2 of the FSW table, HGA_TRACK_TABLE (table number = 135). The elevation limits are found in locations 3 and 4.

3.19.5 Delivery Schedule

This product is to be delivered once per week for the 7-week product and once daily for the 7-day product.

3.19.6 Timespan

The timespans for these products are 7-weeks and 7-days.

3.19.7 Transmission Medium

3.19.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.19.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.19.8 Volume Estimate

The volume estimates are based on 68 bytes for the header record and 48 bytes for each data record.

3.20 OMNI to Ground Station Viewing Times

3.20.1 Description

The FDS provides the EOC with viewing times of the EOS Terra nadir OMNI antenna by each Project specified ground stations and WOTS/AGS/SGS. The view periods are specified as a pair of start and end times of the view in UTC format. The header record specifies the time span covered by the data in the file as start and end times. There is a data record for each possible view from any ground station to the EOS Terra nadir Omni antenna for the time span specified in the header record. This product is to be generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed. The data records are in time order based on the "AOS" field.

3.20.2 Mission Phase

These products are delivered during all phases of the mission.

3.20.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite ID of the Terra spacecraft ("AM1").
File Type	14	The view indicator specifies the pair that the views are provided for. The only valid value is OMNIGRND.

File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.

Data Records: 48 bytes

Field Name	Maximum Field Width	Description
Ground Station Name	6	The ID of the Ground station that can be seen by the Omni.
AOS	14	The start time of the view period in the form YYYYDDD.HHMMSS.
LOS	14	The end time of the view period in the form YYYYDDD.HHMMSS.
Orbit Number at AOS	6	Orbit number of AOS. Format is XXXXXX.
Orbit Number at LOS	6	Orbit number of LOS. Format is XXXXXX.

Sample Header Record

```
AM1 OMNIGRND 1999225.123034 1999230.000000 1999232.235900\n
```

Sample Data Records

```
DS16 1999230.100000 1999230.105500 6043 6043\n
DS46 1999230.110100 1999230.114210 6043 6043\n
BMDA 1999230.121400 1999230.150508 6043 6043\n
```

3.20.4 Accuracy

The products is to produce an accuracy of 60 seconds absolute UTC at the end of a 3-week prediction. There are no viewing constraints for this product.

3.20.5 Delivery Schedule

The products are delivered weekly for the 7-week product and daily for the 7-day product.

3.20.6 Timespan

The timespans for the products are 7-weeks and 7-days.

3.20.7 Transmission Medium

3.20.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.20.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.20.8 Volume Estimate

The volume estimate is based on 68 bytes for the header record and 48 bytes per data record.

3.21 HGA Gimbal Angles

3.21.1 Description

The FDS provides to the EOC a table of HGA gimbal angles for each operational TDRS used for EOS Terra. The file provides the HGA elevation and azimuth angles at fixed time intervals. Nominally the gimbal angles are provided at 20 second intervals for those periods when the HGA can view the TDRS. Thus there may be time gaps in the data for those time periods when the HGA cannot view any TDRS. Data for all TDRS are included in a single file. This product is to be generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed. The data records are ordered by TDRS ID and within each TDRS grouping they are in time order.

3.21.2 Mission Phase

The product is to be delivered during all phases.

3.21.3 Format

Header Record: 74 bytes

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite id of the Terra spacecraft (“AM1”).
File Type	14	This field indicates the type of file. The only valid value is HGAGIMBAL.
File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS
Stepsize	5	The stepsize specifies the time interval (in seconds) between two consecutive data records.

Data Records: 48 bytes

Field Name	Maximum Field Width	Description
TDRS ID	6	The Id of the TDRS that can be seen by the HGA. The valid values are TDX with X = 1,3,4,5, 6,7,8,9,10,11,12,13, ...up to 99.
Time of data point	14	The time of the data point in the form YYYYDDD.HHMMSS
Orbit number	6	The orbit number at the time of data point. Format is XXXXXX.
Azimuth angle	10	The azimuth angle of the HGA in degrees (gimbal angle about the spacecraft +x axis). The valid range of values is from –202 to +202 degrees. The format is SXXX.XXXXX, where S = '–' for negative values.
Elevation angle	9	The elevation angle of the HGA in degrees (gimbal angle about the spacecraft +y axis). The valid range of values is from –29 to 97 degrees. The format is SXX.XXXXX, where S = '–' for negative values.

Sample Header Record

```
AM1 HGAGIMBAL 1999225.123034 1999230.000000 1999232.235900 1\n
```

Sample Data Records

```
TD1 1999230.100000 6043 78.13456 52.34567\n
TD1 1999230.100020 6043 78.43567 53.26784\n
```

3.21.4 Accuracy

The product is to be accurate to 0.5 degrees at the end of the 3 day timespan.

Constraints: The data should be filtered so that the following constraints are not violated when the HGA points to the TDRS.

- HGA Gimbal Position Limits:

There are two sets of constraints on gimbal position limits, hard constraints and soft constraints. The soft constraints are used by FDS for planning purposes.

The default values for the limits with respect to the HGA are:

	az. (deg)	el. (deg)
Hardware:	+/– 202.0	+97.0/–29.0
Firmware:	+/– 200.5	none
Software:	+/– 194.0	+90.0/–26.0

Note: The software azimuth limits are found in locations 1 and 2 of the FSW table, HGA_TRACK_TABLE (table number = 135). The elevation limits are found in locations 3 and 4.

3.21.5 Delivery Schedule

The product is delivered daily (7-day product) and weekly (7-week product).

3.21.6 Timespan

The timespan of the products are 7 days (7-day-product) and 7 weeks (7-week product).

3.21.7 Transmission Medium

3.21.7.1 Prime Medium

The products is transferred to the EOC via SFTP.

3.21.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.21.8 Volume Estimate

The volume estimate is based on a 74-byte header record and 48-bytes data record.

3.22 Predicted EOS Terra Ephemeris

3.22.1 Description

The FDS delivers to the EOS Terra spacecraft predicted ephemeris data. The coordinate reference system for the ephemerides is the Mean Equator and Equinox of J2000 frame. The time system used for generating the ephemerides is UTC.

3.22.2 Mission Phase

The FDS is to provide this product during all phases.

3.22.3 Format

Header Record: 132 bytes

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite id of the Terra spacecraft (“AM1”).
File Type	14	The type of file. Only valid value is “FDFEPHEM”.
File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS.
Start Time of Data File	18	Time of first data point in the file. Format is YYYYDDD.HHMMSS.SSS.
End Time of Data File	18	Time of last data point in the file. Format is YYYYDDD.HHMMSS.SSS.
Stepsize	7	Time interval between two consecutive data records. Format is SSS.SSS.
GHA at Ephem Start	8	Greenwich hour angle (GHA) at ephemeris start (in degrees). Format is SXXX.XXX, where S = “–” if negative.
GHA at Ephem End	8	Greenwich hour angle at ephemeris end.
Leap second indicator	1	Value is as follows: 1 = no leap second occurs; 2 = leap second occurs
Time of leap second	18	Format is YYYYDDD.HHMMSS.SSS. “0000000.000000.000” if no leap second occurs.
UTC Time Adjustment for Leap Second	8	Format is SXXX.XXX (in seconds) where S = “–” if negative. “0.000” if no leap second occurs.

Data Records: 111 bytes

Field Name	Maximum Field Width	Description
Time of data point	18	The time of the ephemeris data point that this record contains. Format is YYYYDDD.HHMMSS.SSS.
x-position	17	The x component of the position vector (in kilometers). Format is SXXXXXXXXXX.XXXXX, where S= "–" if negative.
y-position	17	y component of the position vector.
z-position	17	z component of the position vector.
x-velocity	12	The x component of the velocity vector (in kilometers per second). Format is SXXX.XXXXXXX, where S= "–" if negative.
y-velocity	12	y component of the velocity vector.
z-velocity	12	z component of the velocity vector.

Sample Header Record

```
AM1 FDFEPHEM 1998170.000.000 1998171.170000.000 1998.172.170100.000 \
60.000 12.867 125.874 1 0000000.000000.000 0.000\n
```

Sample Data Records

```
1998171.170000.000 853.96778 3555.52829 6056.24802 3.4854636 5.5191964 \
-3.7180224\n
```

3.22.4 Accuracy

The position accuracy of the products at the end of 40 hours, are to be the following:

a. 330 m along track
b. 50 m cross-track
c. 30 m radial

The velocity accuracy of the products at the end of 40 hours, is to be 2 m/s (three sigma).

3.22.5 Delivery Schedule

The FDS delivers this product according to the following schedule:

a. weekly for 7-week product
b. daily for 7-day product

3.22.6 Timespan

The timespan of the products are 7 weeks and 7 days.

3.22.7 Transmission Medium

3.22.7.1 Prime Medium

The products is transferred to the EOC via SFTP.

3.22.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.22.8 Volume Estimate

If the stepsize is 60 seconds, the data volume per day is approximately 160 KB.

3.23 Predicted TDRS Ephemeris

3.23.1 Description

The FDS provides the EOC with predicted TDRS ephemeris data for all operational TDRSs supporting the EOS Terra spacecraft. The FDS acquires the TDRS ephemeris data from the Flight Dynamics Facility (FDF) via SFTP and makes it available to the EOC in the format specified in this ICD. The time used for generating the ephemerides is UTC.

3.23.2 Mission Phase

This product is to be provided during all mission phases.

3.23.3 Format

The format for this product is the same as specified in Section 3.21.3. But the description for the “Satellite ID” field should read: “The ID of the TDRS. The valid values are TDX with X = 1, 3, 4, 5, 6, 7, 8, 9, 10...99.”

Sample Header Record

```
TD1 FDFEPHEM 1998170.000.000 1998171.170000.000 1998.172.170100.000 \
60.000 3.946 3.963 1 0000000.000000.000 0.000\n
```

Sample Data Records

```
1998171.170000.000 -41990.83028 -3812.18645 -19.01033 0.2772407 \
-3.0621834 0.0000590\n
```

3.23.4 Accuracy

The accuracy for this product is the best effort that can be generated for the timespan.

3.23.5 Delivery Schedule

The FDS delivers this product according to the following schedule:

a. weekly for seven-week product
b. daily for seven-day product

3.23.6 Timespan

The products is generated for a 7-week and a 7-day timespan.

3.23.7 Transmission Medium

3.23.7.1 Prime Medium

The products is transferred to the EOC via SFTP.

3.23.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.23.8 Volume Estimate

If the stepsize is 60 seconds, the data volume per day is approximately 160 KB.

3.24 (Deleted)

3.25 Orbit Adjust Maneuver Request

3.25.1 Description

The FDS monitors the EOS Terra orbital parameters for frozen orbit conditions, ground track limits, and sun synchronous orbit conditions. The FDS will notify the FOT if an orbit adjust is needed.

3.25.2 Mission Phase

The product is to be delivered during all phases.

3.25.3 Format

The report contains information on the frozen orbit condition, ground track, the sun synchronous orbit conditions and the approximate date and time of the maneuver.

Header Record: 76 bytes

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite id of the Terra spacecraft (“AM1”).
File Type	14	The file type is ORBITMANREQ.
File Creation Time	14	Format is YYYYDDD.HHMMSS.
Start Time of the file	18	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.SSS.
End Time of the file	18	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.SSS.

Data Records: 56 bytes

Field Name	Maximum Field Width	Description
Type of maneuver	2	Format is XX. 1 = ground track maintenance, 2 = inclination maintenance, 3 = frozen orbit maintenance, 4 = other orbit change,
Time of maneuver	18	Format is YYYYDDD.HHMMSS.SSS.
Burn duration	10	Format is HHMMSS.SSS
Orbit number	6	Format is XXXXXX
Type of constraint violation	2	Type of the constraint that can be violated if maneuver is not performed. Format is XX. 1 = eastern ground track boundary, 2 = western ground track boundary,* 3 = frozen orbit altitude variation 4 = mean local time upper boundary, 5 = mean local time lower boundary, 6 = no constraint violation
Time of constraint violation	14	Projected time of constraint violation. Format is YYYYDDD.HHMMSS.

* When a Terra mission violation of the western ground track boundary is predicted, this product will indicate that a ground track maneuver is needed, set the time of maneuver to the time of the constraint violation, and set the duration of the 'maneuver' to 00000.000 seconds. This is the expected product output, such that the constraint violation is accurately reported to the product user. The Terra mission cannot perform a maneuver to correct the western boundary violation, as this would require a retrograde, or orbit lowering maneuver. For this instance, the product is reporting the violation only, and using a 0-duration burn to indicate that no maneuver is planned.

Sample Header Record

```
AM1 ORBITMANREQ 1998034.103400 1998196.013715.286 1998196.013715.286\n
```

Sample Data Record

```
1 1998196.013715.286 000017.000 123 1 1998196.221015\n
```

3.25.4 Accuracy

There is no accuracy requirement associated with this product.

The accuracy requirements used to determine the orbits conditions are the following:

a. Ground track maintained to within ±20 kilometers
b. Descending node is maintained at 10:30 am (UTC) ±1 minutes
c. Radial orbit position repeatability for a given latitude is to be +10/–5 kilometers

3.25.5 Delivery Schedule

The product is delivered weekly.

3.25.6 Timespan

The timespan for this product is 7 weeks. If there is no maneuver within the seven weeks, the file is empty.

3.25.7 Transmission Medium

3.25.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.25.7.2 Backup Medium

The product is transferred via FAX to the EOC.

3.25.8 Volume Estimate

The volume estimate for this product is 132 (= 76 + 56) bytes per delivery.

3.26 Delta-V Parameters Table

3.26.1 Description

The FDS provides the EOC with the commanded ΔV maneuver burn duration (in milliseconds) required to maintain frozen orbit conditions, ground track repeat limits, and sun synchronous orbit conditions. .

3.26.2 Mission Phase

The product is to be delivered during the orbit Launch/Acquisition, Checkout and Operational phases.

3.26.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: DV_PARAMETERS_TBL
b. Table Number: 106

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
3	LI	ms	Commanded ΔV burn duration.

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 DV_PARAMETERS_TBL  106 5 1996124.112233 \
1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
3 0\n
```

3.26.4 Accuracy

There is no accuracy associated with this product.

3.26.5 Delivery Schedule

The product is a preliminary product delivered 48 hours prior to maneuver and a final update delivered 24 hours prior to the planned orbit maneuver.

For contingency operations the delivery is made 1 hour prior to the maneuver.

3.26.6 Timespan

There is no timespan associated with this product.

3.26.7 Transmission Medium

3.26.7.1 Prime Medium

The product is transferred to the EOC via SFTP

3.26.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.26.8 Volume Estimate

The volume of one full table is 164 (= 137 + 27) bytes.

3.27 Mass and Center of Mass Location Estimates

3.27.1 Description

The FDS delivers to the EOC an estimate of the EOS Terra mass and center of mass location.

3.27.2 Mission Phase

This product is to be delivered during the Launch/Acquisition and Operational phases.

3.27.3 Format

Header Record: 76 bytes

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite id of theTerra spacecraft (“AM1”)
File Type	14	This field indicates the type of file. The only valid value is MCMPROD
File Creation Time	14	The time when the file was created in the form. YYYYDDD.HHMMSS.
Start Time of the file	18	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.SSS.
End Time of the file	18	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.SSS.

Data Records: 50 bytes

Field Name	Maximum Field Width	Description
Time	18	Time of this data point. Format is YYYYDDD.HHMMSS.SSS.
Spacecraft Mass	4	Spacecraft mass in slugs. Format is XXXX.
CM x-coordinate	8	x-coordinate in feet of the spacecraft center of mass. Format is SX.XXXXX, where S = ‘–’ for negative value.
CM y-coordinate	8	y-coordinate in feet of the spacecraft center of mass. (SX.XXXXX).
CM z-coordinate	8	z-coordinate in feet of the spacecraft center of mass. (SX.XXXXX).

Sample Header Record

```
AM1 MCMPROD 1998172.123005 1998172.101325.000 1998172.101325.000\n
```

Sample Data Records

```
1998172.101325.000 4272 2.533015 -0.1102868 -0.2025142\n
```

3.27.4 Accuracy

The accuracy is the best available.

3.27.5 Delivery Schedule

The FDS delivers this product after each spacecraft orbit adjust.

3.27.6 Timespan

There is no timespan associated with this product.

3.27.6.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.27.6.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.27.7 Volume Estimate

The volume estimate is 126 (= 76 + 50) bytes per delivery.

3.28 Predicted EOS Terra Ranging Data File

3.28.1 Description

The spacecraft ranging data file contains measurements of the spacecraft's range from White Sands Ground Terminal (WSGT and Second TDRS Ground Terminal (STGT) through TDRS, with a best-effort accuracy. Each data file day is to begin sometime between 0000 hrs and the first AOS after 0000 hrs and end sometime after the LOS associated with the last AOS before 2400 hrs. The data records are ordered by first digit of the TDRS ID and within each TDRS grouping they are in time order.

3.28.2 Mission Phase

This product to be delivered during the Launch/Acquisition, Checkout and Operational phases.

3.28.3 Format

Header Record: 74 bytes

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite id of the Terra spacecraft (“AM1”).
File Type	14	This field indicates the type of file. The only valid value is FDFRANGE.
File Creation Time	14	The time when the file was created in the form YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.
Stepsize	5	The stepsize specifies the stepsize to be expected in the data in seconds. (Usually the stepsize is 60.)

Data Records: 45 bytes

Field Name	Maximum Field Width	Description
TDRS ID	6	The Id of the TDRS that is used for the relevant real-time contact. Valid values are TDX with X = 1,3,4,5, 6,7,8,9,10,11,12,13, ...up to 99.
Orbit Number	6	The orbit number at the time of the data point. Format is XXXXXX.
Time of data point	14	The time of the data point in the form YYYYDDD.HHMMSS.
TDRS range	8	The distance in meters from White Sands to TDRS.
Spacecraft Range	8	The distance in meters from TDRS to the EOS Terra Spacecraft. The format is XXXXXXXX.

Sample Header Record

```
AM1 FDFRANGE 1999016.123005 1999017.000000 1991017.010000 60\n
```

Sample Data Records

```
TD1 325 1999017.000000 40533298 37914908\n
TD1 325 1999017.000001 40533309 37917539\n
TD1 325 1999017.000002 40533319 37920176\n
TD1 325 1999017.000003 40533330 37922818\n
```

3.28.4 Accuracy

The accuracy is best effort.

3.28.5 Delivery Schedule

This product is generated daily.

3.28.6 Timespan

The timespan for this product is 1 day.

3.28.7 Transmission Medium

3.28.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.28.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.28.8 Volume Estimate

The volume is based on the sum of header record size (74 bytes) and data record size (45 bytes) times time interval (in seconds). A 1 day product at 60 second resolution will produce a file of approximately 73 KB.

3.29 Attitude Predictions

3.29.1 Description

The FDS provides the EOC with predicted spacecraft attitude angles and rates for FOT scheduled attitude maneuvers. The predicted attitude dataset reflects the attitude maneuver. The rotation sequence of the Euler angles is 3-1-2 (yaw-roll-pitch).

3.29.2 Mission Phase

This product is to be provided during all phases.

3.29.3 Format

Header Record: 74 bytes

Field Name	Maximum Field Width	Description
Satellite ID	8	The Satellite ID of the Terra spacecraft (“AM1”).
File Type	14	This field indicates the type of file. The only valid value is ATTITUDE.

Creation Date	14	Creation date of the file in the form: YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.
Stepsize	5	The stepsize specifies the stepsize to be expected in the data in seconds.

Data Records: 109 bytes

Field Name	Maximum Field Width	Description
Time of data point	14	The UTC time in the form : YYYYDDD.HHMMSS
Q1 Quaternion	8	Q1 Quaternion. Format is SX.XXXXX, where S = '–' if negative.
Q2 Quaternion	8	Q2 Quaternion (SX.XXXXX).
Q3 Quaternion	8	Q3 Quaternion (SX.XXXXX).
Q4 Quaternion	8	Q4 Quaternion (SX.XXXXX).
Roll	9	X-axis Euler angle (in degrees). Format is SXXX.XXXX, where S= '–' for negative values. Range is -180 to +180 degrees.
Pitch	9	Y-axis Euler angle (in degrees). Format is SXXX.XXXX, where S= '–' for negative values. Range is -180 to +180 degrees.
Yaw	9	Z-axis Euler angle (in degrees). Format is SXXX.XXXX, where S= '–' for negative values. Range is -180 to +180 degrees.
X rate	8	X rate (degrees per second). Format is SX.XXXXX, where S = '–' for negative values.
Y rate	8	Y rate (degrees per second). (SX.XXXXX).
Z rate	8	Z rate (degrees per second). (SX.XXXXX).
Maneuver Flag	1	Maneuver flag: 0 - no maneuver 1 - maneuver in progress

Sample Header Record

```
AM1 ATTITUDE 1996201.154000 1998181.1200 1998181.1202 60\n
```

Sample Data Records

```
1998181.120000 0.27059 -0.65328 0.27059 0.653281 0.0000 -89.9999 \
5.0000 0.000000 -0.06000 0.000000 0\n
1998181.120100  0.27201 -0.65669 0.26917 0.649851 0.0000 -90.5998 \
45.0001 0.000000 -0.06000 0.000000 0\n
1998181.120200  0.27341 -0.66009 0.26775 0.646405 -0.0001 -91.2002 \
44.9999 0.000000 -0.06000 0.000000 0\n
```

3.29.4 Accuracy

There is no associated accuracy with this product. The stated accuracy is best effort.

3.29.5 Delivery Schedule

The product is delivered as needed.

3.29.6 Timespan

There is no set timespan for this data.

3.29.7 Transmission Medium

3.29.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.29.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.29.8 Volume Estimate

The volume is based on a 74 byte header record and 109 bytes per data record. The volume is dependent on the time length. A one day prediction at a one minute resolution will produce a file containing approximately 157 KB.

3.30 Predicted Orbital Events

3.30.1 Description

The orbital events data file provides a time ordered set of orbital events, generated in the J2000 coordinate system:

a. Nadir Terminator Crossing (EOS AM-1 DMR: 7300-20)
b. S/C Day-to-Night and Night-to-Day transition times (EOS AM-1 DMR: 7300-8)
c. Time of S/C noon (EOS AM-1 DMR: 7300-17)
d. Time of S/C minimum and maximum latitudes (EOS AM-1 DMR: 7300-19)
e. S/C Ascending and Descending Nodes (EOS AM-1 DMR: 7300-14)
f. Solar Eclipse Entry/Exit (EOS AM-1 DMR: 7300-4)
g. South Atlantic Anomaly Entry/Exit (EOS AM-1 DMR: 7300-5)

All shadow times are to be computed relative to the umbra entrance/exit, not the penumbra entrance/exit.

The SAA is modeled as the rectangular region between 45° South latitude and 11° South latitude, and between 68° East longitude and 12° East longitude.

3.30.2 Mission Phase

This product is to be provided during all mission phases.

3.30.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description
Satellite ID	8	Satellite ID for the Terra spacecraft (“AM1”).
File Type	14	This field indicates the type of file. The only valid value is ORB_EVENT.
Creation Date	14	Creation date of the file in the form: YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.

Data Records: 65 bytes.

Field Name	Maximum Field Width	Description
Event Type	32	Valid values are : **S/C_Day/Night** - time of s/c transition from day to night **S/C_Night/Day** - time of s/c transition from night to day **Nadir_Term_Crossing_to_Day** - time of S/C nadir terminator crossing from night to day side **Nadir_Term_Crossing_to_Night** - time of S/C nadir terminator crossing from day to night side **S/C_Noon** - time of midpoint between start and end of spacecraft day **S/C_Minimum_Latitude** - time of crossing s/c minimum latitude **S/C_Maximum_Latitude** - time of crossing s/c maximum latitude **Node_Ascending** - S/C ascending node time of crossing and longitude (see below) **Node_Descending** - S/C descending node time of crossing and longitude (see below) **Solar_Eclipse_Entry** - predicted solar eclipse (lunar occultation) entry time of subsatellite point **Solar_Eclipse_Exit** - predicted solar eclipse (lunar occultation) exit time of subsatellite point **SAA_Entry** - South Atlantic Anomaly entrance time **SAA_Exit** - South Atlantic Anomaly exit time
Time	14	The time of the event in the form YYYYDDD.HHMMSS
Orbit Number	6	The number of the orbit in which this event takes place. Format is XXXXXX.

Sequence Number	4	The number in order of this type of event as it occurs within an orbit. First occurrence is marked as 1.
Longitude	6	Contains the longitude of the ascending or descending nodes in degrees East (0 - 360). For all other event types this value is filled with a blank character. Format is XXX.XX.

Sample Header Record

```
AM1 ORB_EVENT 1996151.143023 1998171.170000 1998171.220000\n
```

Sample Data Records

```
Node_Ascending 1998171.180557 151 1 62.00\n
S/C_Night/Day 1998171.181513 151 1  \n
Nadir_Term_Crossing_To_Day 1998171.182028 151 1  \n
S/C_Maximum_Latitude 1998171.183046 151 1  \n
S/C_Noon 1998171.183500 151 1  \n
Solar_Eclipse_Entry 1998171.183850 151 1  \n
Solar_Eclipse_Exit 1998171.184526 151 1  \n
Node_Descending 1998171.185519 151 1 230.00\n
Nadir_Term_Crossing_To_Night 1998171.191502 151 2  \n
S/C_Day/Night 1998171.191941 151 1  \n
S/C_Minimum Latitude 1998171.191946 151 1  \n
Node_Ascending 1998171.194450 152 1 38.00\n
SAA_Entry 1998171.211542 151 1  \n
SAA_Exit 1998171.212323 151 1  \n
```

Note: The records whose Event Type values are neither “Node_Ascending” nor “Node_Descending” have two blank characters (i.e., ‘ ’‘ ’) between the “Sequence Number” field and the record terminator (i.e., ‘\n’).

3.30.4 Accuracy

Accuracy requirements associated with each event are as follows:

a. Nadir terminator crossing to day (night) 1 second after 9 days
0.04 sec after 40 hours
b. S/C day/night and night/day transition 1 second after 9 days

c.	Time of S/C noon	1 second after 9 days
d.	Time of S/C minimum/maximum latitudes	1 second after 9 days; 0.04 sec after 40 hours
e.	S/C ascending and descending nodes	1 second after 9 days 0.01 degree in longitude after 9 days 0.04 seconds after 40 hours 0.0009 degree in longitude after 40 hours
f.	Solar eclipse entry/exit	best available
g.	South Atlantic Anomaly entry/exit	1 second after 9 days

3.30.5 Delivery Schedule

The seven-week product is to be delivered weekly; the seven-day product daily.

3.30.6 Timespan

The timespans are 7 weeks for a seven-week product and 7 days for a seven- day product.

3.30.7 Transmission Medium

3.30.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.30.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.30.8 Volume Estimate

The volume estimate is 68 bytes + (65 bytes * number of prediction records).

3.31 Planned Orbit Maneuver Dataset

3.31.1 Description

The FDS provides the EOC with predicted times of planned spacecraft orbit maneuvers.

3.31.2 Mission Phase

This product is to be delivered during all phases.

3.31.3 Format

Header Record: 76 bytes

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite id of the Terra spacecraft (“AM1”).
File Type	14	This field indicates the type of file. The only valid value is MNVRTIME.
File Creation Time	14	The time when the file was created in the form. YYYYDDD.HHMMSS.
Start Time of the file	18	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.SSS.
End Time of the file	18	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.SSS.

Data Records: 24 bytes

Field Name	Maximum Field Width	Description
Time of Maneuver	18	Format is YYYYDDD.HHMMSS.SSS.
Orbit Number	6	Orbit number at the time of maneuver. Format is XXXXXX.

Sample Header Record

```
AM1 MNVRTIME 1998202.000000 1998202.111031.604 1998233.111050.323\n
```

Sample Data Records

```
1998202.111031.604 12345\n
1998233.111050.323 12345\n
```

3.31.4 Accuracy

The accuracy is ±1 orbit for the weekly delivery and ±1 day at 6 months for the monthly delivery.

3.31.5 Delivery Schedule

The 7-week product is delivered weekly and the 78-week product is delivered monthly.

3.31.6 Timespan

The products have a 7 week and a 78 week timespan.

3.31.7 Transmission Medium

3.31.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.31.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.31.8 Volume Estimate

The volume estimate is based on a 76-byte header record and 24-byte data records.

3.32 Solar/Lunar Azimuth and Elevation Angles

3.32.1 Description

The Sun/Moon Azimuth and Elevation Angles data file provides a time ordered set of sun/moon azimuth and elevation angles in an instrument defined coordinate frame. The Sun Azimuth and Elevation Angles data are required for CERES, MOPITT and MODIS instrument planning. In the context of this product, MOPITT will share the MODIS coordinate frame. Therefore angles are provided for CERES and MODIS only. The Moon Azimuth and Elevation Angles data are required for MODIS and CERES. The same format applies to the data files for each instrument.

The coordinate frame for MODIS instrument was provided to FDS by Lockheed-Martin. For the CERES instrument, the azimuth angles of the sun (moon) are measured in the XY-plane of the Terra spacecraft. The angles are measured positive, as a right-handed rotation about the positive Z-axis from the negative Y-axis of the spacecraft. The CERES solar (lunar) elevation angles are positive when the sun (moon) is above the XY-plane.

The header record specifies the instrument for which the file applies and the time span covered by the data in the file as start and end times. This product is generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed.

3.32.2 Mission Phase

This product is to be delivered during the Checkout and Operational phases.

3.32.3 Format

Header Record: 83 bytes.

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite ID of the Terra spacecraft (“AM1”).
File Type	14	This field indicates the type of file. The only valid value is SUN_AZ_EL and MOON_AZ_EL.
File Creation Time	14	Creation date of the file in the form: YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.
Stepsize	5	The stepsize between data points. The value is in seconds. Nominal value is 30 for CERES solar/lunar azimuth and elevation angles.
Instrument	8	Instrument for which these angles apply. The only valid value is “CERES” or “MODIS”.

Data Records: 33 bytes

Field Name	Maximum Field Width	Description
Time	14	The time of data point that this record contains. Format is YYYYDDD.HHMMSS.
Azimuth	9	Azimuth angle for specified instrument (and corresponding defined coordinate frame) in degrees. It ranges from 0 to 360 for CERES and from –180 to +180 for MODIS. Format is SXXX.XXXX, where S = '–' for negative values.
Elevation	8	Elevation angle for specified instrument (and corresponding defined coordinate frame) in degrees (–90 to +90). Format is SXX.XXXX, where S = '–' for negative values.

Sample Header Record

```
AM1 SUN_AZ_EL 2000068.000000 2000070.000000 2000072.235900 60 CERES\n
```

Sample Data Records

```
2000070.100000 317.5437 83.7649\n
2000070.100100 318.8762 85.6745\n
```

3.32.4 Accuracy

The accuracy required is 0.07 degree at 9 days.

3.32.5 Delivery Schedule

The product is delivered weekly (7-week product) and daily (7-day product).

3.32.6 Timespan

The products have a 7 week and 7 day timespans.

3.32.7 Transmission Medium

3.32.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.32.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.32.8 Volume Estimate

The volume estimate is (83 + 33 * (number of data record)) bytes.

3.33 Solar Beta Angles

3.33.1 Description

The Solar Beta Angles file contains the data values of the solar beta angle for a given time span. The file is used as a planning aid for all AM1 instruments. The file contains a header record with attributes such as spacecraft ID, file type, file creation date and time, and the time span of the data in the file. Each data record will consist of a time tag and solar beta angle in degrees. **Note:** The solar beta angle is defined as the angle between the Earth-to-Sun vector and the orbital plane. The angle is measured in the plane formed by the Earth-to-Sun vector and the angular momentum vector.

3.33.2 Mission Phase

This product is to be delivered during the Checkout and Operational phases.

3.33.3 Format

Header Record: 74 bytes.

Field Name	Maximum Field Width	Description
Satellite ID	8	The Satellite ID of the Terra spacecraft (“AM1”).
File Type	14	The file type will determine file contents. The valid value for this field SOL_BETA.
File Creation Time	14	Format is YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.
Stepsize	5	The stepsize between data points. Value is in orbit periods (default is 1).

Data Records: 23 bytes.

Field Name	Maximum Field Width	Description
Time of data point	14	The time of the data point that this record contains. Format is YYYYDDD.HHMMSS.
Solar Beta angle	8	The solar beta angle in units of degrees. The valid range is –90 to +90 (for Terra the range is 13 to 31 degrees). Format is SXX.XXXX, where S = ‘–’ if negative.

Sample Header Record

```
AM1 SOL_BETA 1995226.162500 1999165.000000 1999199.000000 1\n
```

Sample Data Records

```
1999165.000000 17.3513\n
1999165.000100 17.3516\n
1999165.000200 17.3519\n
```

```
1999165.000300 17.3522\n
1999165.000400 17.3525\n
1999165.000500 17.3528\n
1999165.000600 17.3531\n
```

3.33.4 Accuracy

The accuracy for this product is 0.07 degrees after 9 days. The inter-record time interval is set at one orbit period. Angles are reported at the descending node.

3.33.5 Delivery Schedule

The product is to be delivered weekly (7-week product) and daily (7-day product).

3.33.6 Timespan

The timespans for the products are 7 weeks and 7 days.

3.33.7 Transmission Medium

3.33.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.33.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.33.8 Volume Estimate

The volumes estimate is (74 + 23 * (number of data records)) bytes.

3.34 Predicted Local Sun Time

3.34.1 Description

The FDS provides the EOC with the predicted local sun time at the ascending and descending nodes versus time.

3.34.2 Mission Phase

This product is delivered during the Checkout and Operational phases.

3.34.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description
Satellite ID	8	The Satellite ID of the Terra spacecraft (“AM1”).
File Type	14	The file type will determine file contents. The valid value for this field LOCALSUN.
File Creation Time	14	Format is YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.

Data Records: 23 bytes.

Field Name	Maximum Field Width	Description
Time of data point	14	The time of the data point that this record contains. Format is YYYYDDD.HHMMSS (in UTC).
Local sun time	6	Local sun time; Range from 0 to 24 hours format is HHMMSS.
AN/DN indicator	1	Indicator for ascending or descending node. Values are 0 = ascending, 1 = descending

Example of Header record:

```
AM1 LOCALSUN 1999256.123000 1999257.003000 1999264.003000\n
```

Example of Data record:

```
1999257.003002 123022 0\n
1999257.020112 140122 1\n
```

3.34.4 Accuracy

The product is to have an accuracy of 1 second at the end of a 9 day prediction.

3.34.5 Delivery Schedule

The product is delivered weekly (7 week product) and daily (7 day product).

3.34.6 Timespan

The timespans for this product are 7 weeks and 7 days.

3.34.7 Transmission Medium

3.34.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.34.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.34.8 Volume Estimate

The volume estimate is (68 + 23 * number of data records) bytes. For a seven-day product the volume estimate is 5.2 KB. For a seven week product the estimate is 36.1 KB.

3.35 Lunar Beta Angles

3.35.1 Description

The Lunar Beta Angles file contains the data values of the lunar beta angle for a given time span. The file is used as a planning aid for all Terra instruments. The file contains a header record with attributes such as

spacecraft ID, file type, file creation date and time, and the time span of the data in file. Each data record consists of a time tag and lunar beta angle in degrees. The stepsize is to be one angle output every 3600 sec.

Note: The lunar beta angle is defined as the celestial latitude of the Earth-to-Moon vector measured from the ecliptic plane, positive to the north, negative to the south.

3.35.2 Mission Phase

This product is delivered during the Checkout and Operational phases.

3.35.3 Format

Header Record: 72 bytes.

Field Name	Maximum Field Width	Description
Satellite ID	8	The Satellite ID of the Terra spacecraft ("AM1").
File Type	14	The file type will determine file contents. The valid value for this field LUN_BETA.
File Creation Time	14	Format is YYYYDDD.HHMMSS.
Start Time of the File	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the File	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.
Stepsize	5	The stepsize between data points. Value is in seconds.

Data Records: 23 bytes.

Field Name	Maximum Field Width	Description
Time of Data Point	14	The time of the data point that this record contains. Format is YYYYDDD.HHMMSS.
Lunar Beta Angle	8	The lunar beta angle in units of degrees. The valid range is –90 to +90. Format is SXX.XXXX, where S = '–' for negative values.

Sample Header Record

```
AM1 LUN_BETA 1995226.162500 1999165.000000 1999199.000000 3600\n
```

Sample Data Records

```
1999165.010000 27.3513\n
1999165.020000 27.7514\n
1999165.030000 28.1523\n
1999165.040000 28.2514\n
1999165.050000 28.6513\n
1999165.060000 29.0393\n
```

3.35.4 Accuracy

The accuracy of this product is such that the error is to be under 0.07 degree at the end of 9 days.

3.35.5 Delivery Schedule

The product is delivered weekly.

3.35.6 Timespan

The timespans for the product is 7 weeks.

3.35.7 Transmission Medium

3.35.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.35.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.35.8 Volume Estimate

The volumes estimate are based on 72 bytes header and 23 byte data records. For a one week prediction at a three minute resolution the volume for the file would be approximately 0.1 Mb.

3.36 MODIS Sun and Moon FOV Events

3.36.1 Description

The MODIS FOV Events data file provides a time ordered set of predicted instrument FOV events. The parameters defining the field of view were provided by Lockheed-Martin. The header record specifies the time span covered by the data in the file as start and end times. The data record contains the event type, time of the event, orbit number of the event, and sequence number of the event relative to other events of the same type within that orbit. This product is generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed.

3.36.2 Mission Phase

The product is to be provided during the Checkout and Operational phases.

3.36.3 Format

Header Record: 77 bytes.

Field Name	Maximum Field Width	Description
Satellite ID	8	8-character spacecraft identifier. The only valid value for this spacecraft is “AM1”.
File Type	14	This field indicates the type of file. The only valid value is SM_FOV_EVENT
Creation Date	14	Creation date of the file in the form: YYYYDDD.HHMMSS
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.
Instrument ID	8	5-character instrument identifier. The valid value is “MODIS”.

Data Records: 58 bytes.

Field Name	Maximum Field Width	Description
Instrument Viewport	32	Valid values are: **Spaceview, Diffuser**
Event Type	32	Valid values are : **Sun_Entry, Moon_Entry, Sun_Exit, Moon_Exit**
Time	14	The time of the event in the form YYYYDDD.HHMMSS
Orbit Number	6	The number of the orbit in which this event takes place. Format is XXXXXX.
Sequence Number	4	The number in order of this type of event as it occurs within an orbit.

Entry events pertain to predicted FOV entry time.
Exit events pertain to predicted FOV exit time.

Sample Header Record

```
AM1 SM_FOV_EVENT 1999230.000000 1999232.000000 1999234.235900 MODIS\n
```

Sample Data Records

```
Spaceview Sun_Entry 1999232.100000 72 1\n
```

3.36.4 Accuracy

The accuracy for these products is to be 1 sec at the end of 9 days.

3.36.5 Delivery Schedule

The delivery schedule for these products are weekly (7-week product) and daily (7-day product).

3.36.6 Timespan

The timespans for the products are 7 weeks and 7 days.

3.36.7 Transmission Medium

3.36.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.36.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.36.8 Volume Estimate

The volume estimate is (77 + 58 bytes * number of data records) bytes per instrument.

3.37 MODIS Planets and Stars FOV Events

3.37.1 Description

The MODIS FOV Events data file provides a time ordered set of predicted FOV events. The parameters defining the field of view were provided by Lockheed-Martin. The header record specifies the time span covered by the data in the file as start and end times. The data record contains the event type, time of the event, orbit number of the event, star name and sequence number of the event relative to other events of the same type within that orbit. This product is to be generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed.

3.37.2 Mission Phase

The product is provided during the Checkout and Operational phases.

3.37.3 Format

Header Record: 77 bytes.

Field Name	Maximum Field Width	Description
Satellite ID	8	8-character spacecraft identifier. The only valid value for this spacecraft is “AM1”.
File Type	14	This field indicates the type of file. The only valid value is “PS_FOV_EVENT”.
Creation Date	14	Creation date of the file in the form: YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.
Instrument ID	5	Instrument identifier. The valid value is “MODIS”.

Data Records: 67 bytes.

Field Name	Maximum Field Width	Description
Instrument Viewport	32	Valid values are: **Spaceview, Diffuser**
Event Type	32	Valid values are : **Star_Entry,** **Star_Exit,** **Mercury_Entry,** **Mercury_Exit,** **Venus_Entry,** **Venus_Exit,** **Mars_Entry,** **Mars_Exit,** **Jupiter_Entry,** **Jupiter_Exit,** **Saturn_Entry,** **Saturn_Exit,** **Uranus_Entry,** **Uranus_Exit,** **Neptune_Entry,** **Neptune_Exit,** **Pluto_Entry,** **Pluto_Exit**
Time	14	The time of the event in the form YYYYDDD.HHMMSS.
Orbit Number	6	The number of the orbit in which this event takes place. Format is XXXXXX.
Sequence Number	4	The number in order of this type of event as it occurs within an orbit.
Star Name	12	Valid values are: Alpha_Crucis, Antares, Arcturus, Betelgeuse, Canopus, Kent, Mira, Rigel, Sirius, or 0 if event is not a star.

Entry events pertain to predicted FOV entry time.
Exit events pertain to predicted FOV exit time.

Sample Header Record

```
AM1 PS_FOV_EVENT 1999230.000000 1999232.000000 1999234.235900 MODIS\n
```

Sample Data Records

```
Spaceview Star_Entry 1999232.110030 72 1 Sirius\n
Diffuser Mars_Entry 1999232.110100 72 5 0\n
Diffuser Mars_Exit 1999232.121400 72 7 0\n
```

3.37.4 Accuracy

The accuracy for these products is to be 1 sec at the end of 9 days.

3.37.5 Delivery Schedule

The delivery schedule for these products are weekly (7-week product) and daily (7-day product).

3.37.6 Timespan

The timespans for the products are 7 weeks and 7 days.

3.37.7 Transmission Medium

3.37.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.37.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.37.8 Volume Estimate

The volume estimate is 77 bytes + (67 bytes * number of data records) per instrument.

3.38 Predicted Sub-Satellite Point (Ground Track)

3.38.1 Description

The FDS provides the EOC with the EOS Terra predicted sub-satellite point on the earth's surface. This prediction produces a longitude and latitude for the spacecraft's nadir projection onto the earth's surface.

3.38.2 Mission Phase

This product is delivered during all phases.

3.38.3 Format

Header Record: 74 bytes.

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite ID of the Terra spacecraft ("AM1").
File Type	14	This field indicates the type of file. The only valid value is AM1GRNDTRCK.
File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.
Stepsize	5	The stepsize specifies the stepsize to be expected in the data in seconds.

Data Records: 38 bytes.

Field Name	Maximum Field Width	Description
Time of data point	14	The time of the data point in the form YYYYDDD.HHMMSS.
Orbit number	6	The orbit number at the time of data point. The format is XXXXXX.
Latitude	8	The latitude of the subsatellite point in degree. The valid range of values is –90 to +90. The format is SXX.XXXX, with S = '–' for negative values.

Longitude	8	The longitude of the subsatellite point in degree East. The valid range of values is 0 to 360. The format is XXX.XXXX.

Sample header record:

```
AM1 AM1GRNDTRCK 1996124.140025 1998171.170000 1998171.180000 120\n
```

Sample data record:

```
1998171.170000 150 59.0242 272.7583\n
```

3.38.4 Accuracy

The accuracies for this product are as follows:

a. 0.005 degree at 40 hours at the equator for latitude
b. 0.0009 degree at 40 hours at the equator for longitude

3.38.5 Delivery Schedule

The product is delivered weekly (7 week product) and daily (7 day product).

3.38.6 Timespan

The products is generated for a 7 weeks and a 7 day timespan.

3.38.7 Transmission Medium

3.38.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.38.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.38.8 Volume Estimate

The volume estimate is (74 + 38 bytes * number of data records) bytes. For a one minute resolution and for a 7 day product the volume is approximately

0.4 Mb. For a one minute resolution and for a 7 week product the volume would be approximately 2.9 Mb.

3.39 Predicted Spacecraft Altitude

3.39.1 Description

The spacecraft altitude file contains the altitude data values of the Terra spacecraft for a given time span. The file is used as a planning aid for the CERES instrument. Altitude data are with respect to geocentric coordinates.

3.39.2 Mission Phase

This product is to be delivered during all mission phases.

3.39.3 Format

Header Record: 74 bytes.

Field Name	Maximum Field Width	Description
Satellite Id	8	The Satellite Id of the Terra spacecraft ("AM1").
File Type	14	The file type will determine file contents. The valid value for this field AM1_ALT.
File Creation Time	14	Format is YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.
Stepsize	5	The stepsize between data points. Value is in seconds.

Data Records: 25 bytes.

Field Name	Maximum Field Width	Description
Time of data point	14	The time of the data point that this record contains. Format is YYYYDDD.HHMMSS.
Altitude	10	The altitude of the AM1 spacecraft in units of kilometers. The format is XXXXX.XXXX

Sample Header Record

```
AM1 AM1_ALT 1995226.162500 1999165.000000 1999168.000000 1\n
```

Sample Data Records

```
1999165.000000 787.3513\n
1999165.000001 787.7514\n
1999165.000002 788.1523\n
1999165.000003 788.2514\n
1999165.000004 788.6513\n
1999165.000005 789.0393\n
1999165.000006 789.4513\n
```

3.39.4 Accuracy

The accuracy for these products is 30 meters at the end of a 40 hours prediction.

3.39.5 Delivery Schedule

The products is delivered weekly (7-week product) and daily (7-day product).

3.39.6 Timespan

The products timespans are 7 weeks and 7 days.

3.39.7 Transmission Medium

3.39.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.39.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.39.8 Volume Estimate

The volume estimate is (74 + 25 bytes * number of data records). For a one minute resolution and a 7 day timespan the volume is approximately 0.3 Mb. For a one minute resolution and a 7 week timespan the volume is approximately 2.3 Mb.

3.40 Predicted Spacecraft Day/Night Length

3.40.1 Description

The FDS generates a product to be transferred to the EOC for the predicted length of the spacecraft day and night.

3.40.2 Mission Phase

This product is delivered during all mission phases. All times are computed relative to the umbra entrance/exit, not the penumbra entrance/exit. Products for only complete days and nights are provided. Products for incomplete day/night durations (due to ephemeris start or end time being in the middle of a day or night) will not be provided.

3.40.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description

Satellite ID	8	The Satellite ID of the Terra spacecraft ("AM1").
File Type	14	The file type will determine file contents. The valid value for this field DAYNIGHT.
File Creation Time	14	Format is YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.

Data Records: 55 bytes.

Field Name	Maximum Field Width	Description
Start Time of S/C Day	14	The time of the data point that this record contains. Format is YYYYDDD.HHMMSS.
Length of S/C Day	6	Range is 0 to 24 hours. Format is HHMMSS
Start Time of S/C Night	14	The time of the data point that this record contains. Format is YYYYDDD.HHMMSS.
Length of S/C Night	6	Range is 0 to 24 hours. Format is HHMMSS
Orbit Number at S/C Day	6	Orbit number of the start of S/C day. Format is XXXXXX.
Orbit Number at S/C Night	6	Orbit number of the start of S/C night. Format is XXXXXX.

Example of Header record:

```
AM1 DAYNIGHT 1999235.123001 1999236.000000 1999242.000000\n
```

Example of Data record:

```
1999236.0132 183225 1999236.2235 152735 123 123\n
```

3.40.4 Accuracy

The accuracy for these products is to be 1 second at the end of a 21 day prediction.

3.40.5 Delivery Schedule

The product is delivered weekly (7-week product) and daily (7-day product).

3.40.6 Timespans

The timespans for these products are 7 weeks and 7 days.

3.40.7 Transmission Medium

3.40.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.40.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.40.8 Volume Estimate

The volume estimate is 68 bytes + (55 bytes * number of data records). For a seven day product the estimate is 5.6 KB. For a seven week product the estimate is 39.2 KB.

3.41 Terra State Error Covariance Matrix

3.41.1 Description

The FDS will provide the EOC with the EOS Terra state error covariance matrix product, which together with the EOS Terra state vector product (Section 3.56) is used for initializing the TONS filter.

3.41.2 Mission Phase

This product is delivered during all mission phases.

3.41.3 Format

This table will contain a 9x9 matrix of the EOS Terra state error covariance.

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: STATE_ERROR_COV_TABLE
b. Table Number: 279

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1 through 81	LF	see ref. 8	(p, q) element of the error covariance matrix, where p = (N-1)/9 + 1, q = (N-1)%9 + 1, N = table field number (1,..., 81)

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 STATE_ERROR_COV_TABLE 279 5 \
1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 0.0000000000E+00\n
2 0.0000000000E+00\n
.
.
81 0.0000000000E+00\n
```

3.41.4 Accuracy

There is no accuracy requirement associated with this product.

3.41.5 Delivery Schedule

The product is delivered as needed during all mission phases.

3.41.6 Timespan

There is no timespan associated with this product.

3.41.7 Transmission Medium

3.41.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.41.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.41.8 Volume Estimate

The volume of one full table is 2,324 (= 137 + 81*27) bytes.

3.42 (Deleted)

3.43 (Deleted)

3.44 (Moved to Section 7)

3.45 (Deleted)

3.46 (Deleted)

3.47 (Deleted)

3.48 (Moved to Section 7)

3.49 Local Oscillator Frequency Report

3.49.1 Description

The FDS will provide the EOC with an independent estimate of the spacecraft Ku-band oscillator frequency bias and drift. This local oscillator frequency (LOF) report is generated by the Flight Dynamics Facility (FDF) and transferred to the FDS via SFTP. The FDS is responsible for forwarding this report to EMOS. The LOF report is generated whenever Ku-Band one-way tracking data is available. The LOF report will also include an estimate of the spacecraft S-Band oscillator frequency bias and drift whenever S-band one-way tracking data is received during the applicable time period.

3.49.2 Mission Phase

The product is delivered during the Checkout and Operational phases.

3.49.3 Format

The LOF report contains two separate reports that summarize one-way Doppler tracking data statistics. The first part of the LOF report provides a chronological event-by-event listing of all one-way Doppler tracking data with individual event means, standard deviations, and numbers of points. The format of this part of the LOF report is summarized in the following table:

Field Name	• Starting Column for Field	Variable Type and Length	Description
USER	1	Character 9	Satellite name
YYYYMMDD/HHMMSS	12	Character 15	Start date and time of event
TDRS	30	Integer 2	• TDRS number
RTN	33	Character 4	Return service type (KSA1, KSA2, SSA1, or SSA2)
UTT FREQUENCY	40	Character 12	User-to-TDRS frequency
MEAN (Hz)	53	Real 11	Doppler residual event mean
SD (Hz)	66	Real 9	Doppler residual event standard deviation
PTS	77	Integer 4	Number of points included in event statistics

The second part of the LOF report provides a group summary for all the one-way Doppler data according to the User-to-TDRS (UTT) frequency. The format of this part of the LOF report is summarized in the following table:

Field Name	Starting Column for Field	Variable Type and Length	Description
USER	1	Character 9	Satellite name
UTT FREQUENCY (MHz)	13	Character 12	User-to-TDRS frequency
MEAN (Hz)	27	Real 8	A weighted group mean of individual Doppler residual event means
DEV (Hz)	37	Real 7	A weighted 2-sigma group standard deviation of individual Doppler residual event means about the group mean (only computed for 4 or more events)
SD (Hz)	46	Real 6	A weighted group rms of event Doppler residual standard deviations
EVTS	55	Integer 4	Number of events used in group statistics
MIN (Hz)	60	Integer 6	Minimum event Doppler residual mean
MAX (Hz)	67	Integer 6	Maximum event Doppler residual mean

The following is an example of a sample LOF report:

Listing of Successful One-Way Events

USER	YYYYMMDD/HHMMSS	TDRS	RTN	UTT FREQUENCY	MEAN (Hz)	SD (Hz)	PTS
EOS-AM1	19990407/082427	1	KSA2	15003.405000	5017.406	1105.976	1540
EOS-AM1	19990408/082025	1	KSA2	15003.405000	5903.110	548.050	839
EOS-AM1	19990408/105235	1	KSA2	15003.405000	3792.400	687.624	626
EOS-AM1	19990408/134432	1	SSA2	2248.992000	7414.840	1141.611	2794
EOS-AM1	19990408/184732	1	SSA2	2248.992000	4291.171	169.766	3670
EOS-AM1	19990409/081625	1	KSA2	15003.405000	5776.071	1336.501	1482
EOS-AM1	19990409/202202	1	SSA2	2248.992000	4515.295	221.456	2807
EOS-AM1	19990409/213002	1	SSA2	2248.992000	4073.323	25.710	4451
EOS-AM1	19990410/081225	1	KSA2	15003.405000	5475.570	1416.609	1542
EOS-AM1	19990411/080826	1	KSA2	15003.405000	5168.880	1595.139	1542
EOS-AM1	19990412/080427	1	KSA2	15003.405000	5504.410	1393.299	1542
EOS-AM1	19990413/080026	1	KSA2	15003.405000	6150.104	1681.710	1543

USER	UTT FREQUENCY (MHz)	MEAN (Hz)	DEV (Hz)	SD (Hz)	EVTS	MIN (Hz)	MAX (Hz)
EOS-AM1	15003.405000	5443.4	1390.1	1351.2	8	3792	6150
EOS-AM1	2248.992000	4902.4	4703.7	532.3	4	4073	7415

3.49.4 Accuracy

The accuracy required is 5 Hz.

3.49.5 Delivery Schedule

The product is delivered once per day during the TONS checkout and once per week when TONS becomes operational.

3.49.6 Timespan

The daily report covers a 24 hour timespan from 000000Z to 000000Z. The weekly report includes seven days of data, from the previous Wednesday at 000000Z through the current Wednesday at 000000Z.

3.49.7 Transmission Medium

3.49.7.1 Prime Medium

The product is delivered to the EOC via SFTP.

3.49.7.2 Backup Medium

The backup transfer for this product is a FAX to the EOC.

3.49.8 Volume Estimate

The maximum size of the weekly product is estimated to be 7500 bytes.

3.50 (Deleted)

3.51 X-Band Interference Times

3.51.1 Description

The FDS will deliver to the EOC a table of X-band broadcast interference times for EOS Terra with all DSN sites. This product is generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed. The data records is in time order based on the "Start time of interference" field.

3.51.2 Mission Phase

This product is delivered during all mission phases.

3.51.3 Format

Header Record: 68 bytes

Field Name	Maximum Field Width	Description
Satellite ID	8	The Satellite ID of the Terra spacecraft ("AM1").
File Type	14	The file type is XBANDDSN.

File Creation Time	14	Format is YYYYDDD.HHMMSS.
Start time of data file	14	Time of first prediction point in file. Format is YYYYDDD.HHMMSS.
End time of data file	14	Time of last prediction point in file. Format is YYYYDDD.HHMMSS.

Data Records: 48 bytes

Field Name	**Maximum Field Width**	**Description**
Start time of interference	14	The time when X-band interference starts. Format is YYYYDDD.HHMMSS.
End time of interference	14	The time when X-band interference ends. Format is YYYYDDD.HHMMSS.
DSN ID	6	ID of the affected DSN site
Orbit Number at Interference Start	6	Orbit number of the start time of interference. Format is XXXXXX.
Orbit Number at Interference End	6	Orbit number of the end time of interference. Format is XXXXXX.

Example of Header record:

```
AM1 XBANDDSN 1999256.000000 1999257.120000 1999263.120000 \n
```

Example of Data record:

```
1999257.120030 1999257.120130 DS16 123 123\n
1999257.120025 1999257.120202 DS28 123 123\n
```

3.51.4 Accuracy

The accuracy is 1 second at 9 days.

3.51.5 Delivery Schedule

This product is delivered weekly (7-week product) and daily (7-day product).

3.51.6 Timespan

There are two products, one with a 7 week timespan and the other with a 7 day timespan.

3.51.7 Transmission Medium

3.51.7.1 Prime Medium

This product is transferred to the EOC via SFTP.

3.51.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.51.8 Volume Estimate

The volume estimate is (68 + 48 bytes * number of data records) bytes.

3.52 (Deleted)

3.53 (Moved to Section 7)

3.54 Predicted Orbit Number and Start Times

3.54.1 Description

The FDS will provide the EOC with the predicted orbit start (ascending node crossing) times with associated orbit numbers.

3.54.2 Mission Phase

This product is delivered during the Launch/Acquisition, Checkout and Operational phases.

3.54.3 Format

Header Record: 68 bytes

Field Name	Maximum Field Width	Description
Satellite ID	8	The Satellite ID of the Terra spacecraft (“AM1”).
File Type	14	The file type is ORBITNUM.
File Creation Time	14	Format is YYYYDDD.HHMMSS.
Start time of data file	14	Time of first prediction point in file. Format is YYYYDDD.HHMMSS.
End time of data file	14	Time of last prediction point in file. Format is YYYYDDD.HHMMSS.

Data Records: 20 bytes

Field Name	Maximum Field Width	Description
Start time of orbit	14	The orbit will start at each ascending node. (Orbit number 0 is at launch and orbit number 1 is the first ascending node after launch.) Format is YYYYDDD.HHMMSS.
Orbit Number	6	Orbit number. Format is XXXXXX.

Example of Header record:

```
AM1 ORBITNUM 1996124.143023 1998171.170000 1998172.010000\n
```

Example of Data record:

1998171.180557 150\n

3.54.4 Accuracy

The accuracy is the best available.

3.54.5 Delivery Schedule

The product is delivered weekly (7-week product) and daily (7-day product).

3.54.6 Timespan

The product timespans are 7 weeks (7-week product) and 7 days (7-day product).

3.54.7 Transmission Medium

3.54.7.1 Prime Medium

This product is transferred to the EOC via SFTP.

3.54.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.54.8 Volume Estimate

The volume estimate is (68 + 20 bytes * number of data records) bytes. For a seven-day product the estimate is 3 KB. For a seven-week product the estimate is 21 KB.

3.55 UTC to UT1 Timing Difference

3.55.1 Description

The FDS will provide the EOC with the UTC to UT1 timing difference. The FDS will acquire the timing difference from FDF and make it available to the EOC in the format specified in this ICD.

3.55.2 Mission Phase

This product is delivered during the Launch/Acquisition, Checkout, and Operational phases.

3.55.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: UT1_TABLE
b. Table Number: 251

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	s	UT1 offset from UTC.
2	LI	ms/day	Millisecond rollover counter

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 UT1_TABLE 251 5 1996124.112233 \
1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 0.0000000000E+00\n
2 86399999\n
```

3.55.4 Accuracy

The accuracy of this product is ±0.001 second.

3.55.5 Delivery Schedule

The product is delivered once per day.

3.55.6 Timespan

The product timespan is one day.

3.55.7 Transmission Medium

3.55.7.1 Prime Medium

This product is transferred to the EOC via SFTP.

3.55.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.55.8 Volume Estimate

The volume of one full table is 191 (= 137 + 2*27) bytes.

3.56 Predicted Instrument Orbit Events

3.56.1 Description

The FDS will provide the EOC with a time ordered set of instrument orbital events. This product is generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed.

3.56.2 Mission Phase

This product is provided during the Checkout and Operational phases.

3.56.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite ID of the Terra spacecraft (“AM1”).
File Type	14	This field indicates the type of file. The only valid value is INST_ORB_EVENT.
Creation Date	14	Creation date of the file in the form: YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.

Data Records: 53 bytes.

Field Name	Maximum Field Width	Description
Event Type	32	Valid values are : **MISRX_LOS_Term_Crossing_to_Day** - time of MISR Camera X (X=1,..., 9) line of sight terminator crossing from night to day side; **MISRX_LOS_Term_Crossing_to_Night** - time of MISR Camera X (X=1,..., 9) line of sight terminator crossing from day to night side; **MODIS_LOS_Term_Crossing_to_Day** - time of MODIS line of sight terminator crossing from night to day side; **MODIS_LOS_Term_Crossing_to_Night** - time of MODIS line of sight terminator crossing from day to night side.
Time	14	The time of the event in the form YYYYDDD.HHMMSS.
Orbit Number	6	The number of the orbit in which this event takes place. Format is XXXXXX.

Sample Header Record

```
AM1 INST_ORB_EVENT 1999230.000000 1999232.000000 1999234.235900\n
```

Sample Data Records

```
MISR1_LOS_Term_Crossing_to_Day 1999232.100000 72\n
MISR2_LOS_Term_Crossing_to_Day 1999232.100100 72\n
MISR3_LOS_Term_Crossing_to_Day 1999232.100200 72\n
MISR4_LOS_Term_Crossing_to_Day 1999232.100300 72\n
MODIS_LOS_Term_Crossing_to_Day 1999232.100400 72\n
```

3.56.4 Accuracy

The accuracy for this product is 1 second after 9 days.

3.56.5 Delivery Schedule

The seven-week product is delivered weekly and the seven-day product daily.

3.56.6 Timespan

The timespans are 7 weeks for a seven-week product and 7 days for a seven-day product.

3.56.7 Transmission Medium

3.56.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.56.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.56.8 Volume Estimate

The volume estimate per orbit is 1,128 Bytes (= 68 + 53 * 20).

3.57 Predicted EOS Terra State Vector

3.57.1 Description

The FDS will provide the EOC with predicted initial state vectors for the EOS Terra spacecraft.

3.57.2 Mission Phase

This product is provided during the Launch/Acquisition, Checkout, and Operational phases.

3.57.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: EOS_STATE_TABLE
b. Table Number: 276

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	IT	days	Number of calendar days from January 1, 1958 00:00:00.000000.
2	LI	ms	milliseconds of day. Valid range of values is 0 - 86400999.
3	IT	µs	microseconds of millisecond. Valid range of values is 0 - 999.
4	LF	m	x-component of the position vector.
5	LF	m	y-component of the position vector.
6	LF	m	z-component of the position vector.
7	LF	m/s	x-component of the velocity vector.
8	LF	m/s	y-component of the velocity vector.
9	LF	m/s	z-component of the velocity vector.

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 EOS_STATE_TABLE 276 5 1996124.112233 \
1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 12345\n
2 12345678\n
3 123\n
4 -1.4023886435E+07\n
5 -6.9430616641E+07\n
6 -3.0905939313E+03\n
7 -1.0502194183E+04\n
8 2.0323145049E+03\n
9 -7.4268210686E+04\n
```

3.57.4 Accuracy

The position accuracy is ±300 meters (3-sigma) and the velocity accuracy is ±0.33 meters/second (3-sigma). The state vector time tag is to be within +10 to +100 minutes ahead of the planned uplink time (i.e., tagged time minus planned uplink time is within the range of +10 to +100 minutes).

3.57.5 Delivery Schedule

This product is delivered as needed to initialize the TONS and daily while in TONS Propagate submode.

3.57.6 Timespan

No timespan is associated with this product.

3.57.7 Transmission Medium

3.57.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.57.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.57.8 Volume Estimate

The volume estimate is 380 (= 137 + 9*27) bytes.

3.58 Simulated TDRS State Vectors

3.58.1 Description

The FDS will provide the EOC with simulated state vectors for all operational TDRSS spacecraft.

3.58.2 Mission Phase

This product is delivered during all mission phases.

3.58.3 Format

The format for this product is identical with that of the Predicted TDRS State Vectors product (Section 3.11).

3.58.4 Accuracy

There is no accuracy requirement associated with this product.

3.58.5 Delivery Schedule

This product is delivered on an as-needed basis.

3.58.6 Timespan

There is no timespan associated with this product.

3.58.7 Transmission Medium

3.58.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.58.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.58.8 Volume Estimate

Refer to Section 3.11.

3.59 Simulated EOS Terra Brouwer-Lyddane Elements

3.59.1 Description

The FDS will provide the EOC with simulated EOS Terra Brouwer-Lyddane mean orbital elements.

3.59.2 Mission Phase

This product is delivered during all mission phases.

3.59.3 Format

The format of this product is identical with that of the Predicted EOS Terra Brouwer-Lyddane Elements product (Section 3.12).

3.59.4 Accuracy

There is no accuracy requirement associated with this product.

3.59.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.59.6 Timespan

There is no timespan associated with this product.

3.59.7 Transmission Medium

3.59.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.59.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.59.8 Volume Estimate

Refer to Section 3.12.

3.60 Simulated TDRS Brouwer-Lyddane Elements

3.60.1 Description

The FDS will provide the EOC with simulated Brouwer-Lyddane mean orbital elements for each operational TDRS.

3.60.2 Mission Phase

The product is delivered during the Launch/Acquisition, Checkout and Operational phases.

3.60.3 Format

The format of this product is identical with that of the Predicted TDRS Brouwer-Lyddane Elements product (Section 3.13).

3.60.4 Accuracy

There is no accuracy requirement associated with this product.

3.60.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.60.6 Timespan

There is no timespan associated with this product.

3.60.7 Transmission Medium

3.60.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.60.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.60.8 Volume Estimate

Refer to Section 3.13.

3.61 Simulated EOS Terra State Vectors

3.61.1 Description

The FDS will provide the EOC with simulated initial state vectors for the EOS Terra spacecraft.

3.61.2 Mission Phase

This product is provided during all mission phases.

3.61.3 Format

The format of this product is identical with that of the Predicted EOS AM-1 State Vectors product (Section 3.56).

3.61.4 Accuracy

There is no accuracy requirement associated with this product.

3.61.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.61.6 Timespan

There is no timespan associated with this product.

3.61.7 Transmission Medium

3.61.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.61.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.61.8 Volume Estimate

Refer to Section 3.56.

3.62 X-Band Ground Station Contact Times

3.62.1 Description

The FDS will provide the EOC with viewing entry and exit times and maximum elevation angle for the Project-specified X-band ground stations of the EOS Terra Direct Access System. The FDS will account for viewing constraints imposed on by the spacecraft environment. This product is generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed. The data records is in time order based on the “Start Time of View Period” field.

3.62.2 Mission Phase

This product is delivered during all mission phases.

3.62.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description
Satellite ID	8	The Satellite ID of the Terra spacecraft (“AM1”).
File Type	14	The file type will determine file contents. The valid value for this field GS_CONTACT.
File Creation Time	14	Format is YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.

Data Records: 55 bytes.

Field Name	Maximum Field Width	Description
X-Band Ground Station ID	5	The X-band ground station ID.
Start Time of View Period	14	The time when the X-band ground station antenna begins seeing the EOS Terra Direct Access antenna. Format is YYYYDDD.HHMMSS.
End Time of View Period	14	The time when the X-band ground station antenna begins losing the EOS Terra Direct Access antenna. Format is YYYYDDD.HHMMSS.
Maximum Elevation Angle	7	The maximum elevation angle (in degrees) of the X-band ground station antenna during the view period delimited by preceding two times. The valid range is 0 to 90 degrees. Format is XX.XXXX.
Orbit Number at Start Time	6	Orbit number at the start time of view period. Format is XXXXXX.
Orbit Number at End Time	6	Orbit number at the end time of view period. Format is XXXXXX.

Sample Header Record

```
AM1 GS_CONTACT 1998210.120000 1998214.120000 1998221.120000\n
```

Sample Data Records

```
DS16 1998215.120000 1998215.121200 45.1234 12345 12345\n
```

3.62.4 Accuracy

The accuracy for this product is 60 seconds absolute UTC at the end of 3-week prediction.

3.62.5 Delivery Schedule

The product is delivered weekly (7-week product) and daily (7-day product).

3.62.6 Timespan

The timespans for the products are 7 weeks and 7 days.

3.62.7 Transmission Medium

3.62.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.62.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.62.8 Volume Estimate

The volume estimate is based on a 38-byte header record and 55-byte data records.

3.63 MODIS FOV Target View Period

3.63.1 Description

The FDS will provide the EOC with viewing entry exit times for the MODIS field-of-view (FOV) of the project-specified MODIS field campaign sites. This product is generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed.

3.63.2 Mission Phase

This product is delivered during all mission phases.

3.63.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description
Satellite ID	8	The Satellite ID of the Terra spacecraft (“AM1”).
File Type	14	The file type will determine file contents. The valid value for this field MODIS_VU_TIME.
File Creation Time	14	Format is YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.

Data Records: 35 bytes.

Field Name	Maximum Field Width	Description
Start Time of View Period	14	The time when the MODIS field campaign site enters the MODIS FOV. Format is YYYYDDD.HHMMSS.
End Time of View Period	14	The time when the MODIS field campaign site exits the MODIS FOV. Format is YYYYDDD.HHMMSS.
Orbit Number at Start Time	6	Orbit number at the start time of view period. Format is XXXXXX.
Orbit Number at End Time	6	Orbit number at the end time of view period. Format is XXXXXX.

Sample Header Record

```
AM1 MODIS_VU_TIME 1998120.120000 1998122.120000 1998129.120000\n
```

Sample Data Records

```
1998123.120000 1998123.120500 156 157\n
```

3.63.4 Accuracy

The accuracy for this product is 60 seconds absolute UTC at the end of 3-week prediction.

3.63.5 Delivery Schedule

The product is delivered on a per-request basis.

3.63.6 Timespan

The timespan for the products is up to 7 weeks. Any timespan exceeding 7 weeks is negotiated between FDS and ESDIS Project, as a longer predicted ephemeris is required than is available for the routine products.

3.63.7 Transmission Medium

3.63.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.63.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.63.8 Volume Estimate

The volume estimate is based on a 38-byte header record and 35-byte data records.

3.64 Earth Gravity Model Spherical Harmonic Coefficients

3.64.1 Description

The FDS will provide the EOC with Earth gravity model spherical harmonic coefficients used by the EOS Terra TONS flight software.

3.64.2 Mission Phase

This product is provided during all mission phases.

3.64.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: HARMONIC_COEFFICIENTS_TABLE
b. Table Number: 254

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
2n - 1 (n = 1 through 961)	LF	NU	Harmonic coefficient, C (p, q), where p = N/62 and q = (N%62)/2. N is the table field number. (The division operation truncates fractional part.)
2n (n = 1 through 961)	LF	NU	Harmonic coefficient, S (p, q), where p = (N-1)/62 and q = ((N-1)%62)/2. N is the table field number.

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 HARMONIC_COEFFICIENTS_TABLE 254 5 \
1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 0.0000000000E+00\n
.
.
125 -1.0826260746E+22\n
.
.
129 1.5744102040E+19\n
```

3.64.4 Accuracy

There is no accuracy requirement associated with this product.

3.64.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.64.6 Timespan

There is no timespan associated with this product.

3.64.7 Transmission Medium

3.64.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.64.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.64.8 Volume Estimate

The volume of one full table is 52,031 (= 137 + 1922*27) bytes.

3.65 Earth Gravity Model Degree Variance

3.65.1 Description

The FDS will provide the EOC with Earth gravity model degree variance used by the EOS Terra TONS flight software.

3.65.2 Mission Phase

This product is provided during all mission phases.

3.65.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: DEGREE_VARIANCE_TABLE
b. Table Number: 280

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
n (n = 1 through 50)	LF	m^2/s^4	n-th degree variance (n = 1 through 50).

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 DEGREE_VARIANCE_TABLE \
280 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 0.0000000000E+00\n
2 0.0000001120E-10\n
.
```

.
50 2.0761641288E-10\n

3.65.4 Accuracy

There is no accuracy requirement associated with this product.

3.65.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.65.6 Timespan

There is no timespan associated with this product.

3.65.7 Transmission Medium

3.65.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.65.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.65.8 Volume Estimate

The volume of one full table is 1,487 (= 137 + 50*27) bytes.

3.66 Harris-Priester Atmospheric Density Model Data

3.66.1 Description

The FDS will provide the EOC with Harris-Priester atmospheric density data used by the EOS Terra TONS flight software.

3.66.2 Mission Phase

This product is provided during all mission phases.

3.66.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: MIN_DENSITY_COEFFS_TABLE (for minimum density coefficient table) or MAX_DENSITY_COEFFS_TABLE (for maximum density coefficient table)
b. Table Number: 255 for minimum density coefficient table and 256 for maximum density coefficient table

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records. Both tables have the identical format.

Table Field Number	Data Type	Unit	Description
1	LF	m	Altitude.
2	LF	kg/m^3	A
3	LF	NU	Alpha
4	LF	kg/m^3	B
5	LF	NU	Beta
Preceding 5 records are repeated 25 more times (there are total 130 records).			

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 MIN_DENSITY_COEFFS_TABLE 255 5 \
1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 3.0000000000E+05\n
2 2.7122000000E-14\n
3 1.3533000000E+00\n
4 5.7190000000E-12\n
5 0.0000000000E+00\n
```

3.66.4 Accuracy

There is no accuracy requirement associated with this product.

3.66.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.66.6 Timespan

There is no timespan associated with this product.

3.66.7 Transmission Medium

3.66.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.66.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.66.8 Volume Estimate

The volume one full table is 3,647 (= 137 + 130*27) bytes.

3.67 Solar Ephemeris Modification Data

3.67.1 Description

The FDS will provide the EOC with solar ephemeris modification data used by the EOS Terra TONS flight software.

3.67.2 Mission Phase

This product is provided during all mission phases.

3.67.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: SOLAR_EPHEM_MOD_TABLE
b. Table Number: 253

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	days	Reference Julian day.
2	LF	cycles/day	RIGHT_ASC(0).FREQUENCY
3	LF	arc-sec	RIGHT_ASC(0).COS_COEFF
4	LF	arc-sec	RIGHT_ASC(0).SIN_COEFF
5 through 46	Preceding three records are repeated 14 more times.		
47	LF	cycles/day	DECLINATION(0).FREQUENCY
48	LF	arc-sec	DECLINATION(0).COS_COEFF
49	LF	arc-sec	DECLINATION(0).SIN_COEFF
50 through 70	Preceding three records are repeated 7 more times		

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 SOLAR_EPHEM_MOD_TABLE  253 5 \
1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 2.4490680160E+06\n
2 0.0000000000E+00\n
3 2.1550000000E+01\n
4 0.0000000000E+00\n
.
.
46 2.3741000000E+00\n
47 0.0000000000E+00\n
48 -1.5208000000E-01\n
49 0.0000000000E+00\n
.
```

.
70 9.4685000000E-01\n

3.67.4 Accuracy

There is no accuracy requirement associated with this product.

3.67.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.67.6 Timespan

There is no timespan associated with this product.

3.67.7 Transmission Medium

3.67.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.67.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.67.8 Volume Estimate

The volume of one full table is 2,027 (= 137 + 70*27) bytes.

3.68 EOS Terra Modeling Data

3.68.1 Description

The FDS will provide the EOC with EOS Terra modeling data required by the EOS Terra for navigation flight software.

3.68.2 Mission Phase

This product is provided during all mission phases.

3.68.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: EOS_MODEL_TABLE
b. Table Number: 263

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	kg	EOS Terra mass.
2	LF	m^2	Orbit average drag area.
3	LF	NU	Drag coefficient.
4	LF	m^2	Solar pressure area
5	LF	NU	Solar Pressure coefficient.
6	IT	NU	EOS AM-1 Earth gravity model size (zonals).

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 EOS_MODEL_TABLE \
263 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 4.1700000000E+03\n
2 4.0500000000E+01\n
3 2.2000000000E+00\n
4 5.4500000000E+00\n
5 1.5000000000E+00\n
6 30\n
```

3.68.4 Accuracy

There is no accuracy requirement associated with this product.

3.68.5 Delivery Schedule

The product is delivered following each delta-V maneuver and on an as-needed basis for TONS startup.

3.68.6 Timespan

There is no timespan associated with this product.

3.68.7 Transmission Medium

3.68.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.68.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.68.8 Volume Estimate

The volume of one full table is 299 (= 137 + 6*27) bytes.

3.69 TDRS Modeling Data

3.69.1 Description

The FDS will provide the EOC with TDRS modeling data required by the EOS Terra for navigation flight software.

3.69.2 Mission Phase

This product is provided during all mission phases.

3.69.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: TDRS_MODEL_TABLE
b. Table Number: 264

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	kg	TDRS 1 mass.
2	LF	m^2	TDRS 1 solar pressure area.
3	LF	NU	TDRS 1 solar pressure coefficient.
4 - 12	Preceding three records are repeated three more times for TDRS 2, 3, and 4.		
13	IT	NU	TDRS Earth gravity model size (zonals)

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 TDRS_MODEL_TABLE \
264 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 1.9000000000E+03\n
2 4.0000000000E+01\n
3 1.4000000000E+00\n
.
.
13 8\n
```

3.69.4 Accuracy

There is no accuracy requirement associated with this product.

3.69.5 Delivery Schedule

The product is delivered daily and after each TDRS maneuver.

3.69.6 Timespan

There is no timespan associated with this product.

3.69.7 Transmission Medium

3.69.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.69.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.69.8 Volume Estimate

The volume of one full table is 488 (= 137 + 13*27) bytes.

3.70 Ground Antenna Modeling Data

3.70.1 Description

The FDS will provide the EOC with TDRS ground antenna modeling data required by the EOS Terra for navigation flight software.

3.70.2 Mission Phase

This product is provided during all mission phases.

3.70.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: TDRS*k*_GRD_STN_TABLE (*k* = 1, 2, 3, 4 for TDRS 1, 2, 3, and 4)

b. Table Number: 265, 266, 267, and 268 for TDRS1 through TDRS4, respectively. (**Note:** "k" represents not the actual TDRS spacecraft name but an arbitrary assignment of a particular TDRS spacecraft to a slot in the flight software. A mapping is required between the actual spacecraft to be used in a slot and the slot number. This mapping is given in Section 4.12 and will change as the operational constellation of TDRS spacecraft changes.)

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	m	x-coordinate in WGS-84 Earth-Centered Earth-Fixed (ECEF) coordinate system.
2	LF	m	y-coordinate.
3	LF	m	z-coordinate.

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 TDRS1_GRD_STN_TABLE \
265 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 -1.5393857000E+06\n
2 -5.1609531000E+06\n
3 3.4082022000E+06\n
```

3.70.4 Accuracy

There is no accuracy requirement associated with this product.

3.70.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.70.6 Timespan

There is no timespan associated with this product.

3.70.7 Transmission Medium

3.70.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.70.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.70.8 Volume Estimate

The volume of one full table is 218 (= 137 + 3*27) bytes.

3.71 State Tolerance Data

3.71.1 Description

The FDS will provide the EOC with EOS AM-1 state tolerance data required by the EOS Terra for navigation flight software.

3.71.2 Mission Phase

This product is provided during all mission phases.

3.71.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: STATE_TOLER_TABLE
b. Table Number: 269

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	m	EOS Terra position tolerance.
2	LF	m/s	EOS Terra velocity tolerance.
3	LF	s	Clock offset from UTC tolerance.
4	LF	Hz-S	MO frequency bias tolerance.
5	LF	NU	Minimum drag scale factor.
6	LF	NU	Maximum drag scale factor.
7	LF	s	UT1 offset from UTC tolerance
8	LF	m	TDRS position tolerance.
9	LF	m/s	TDRS velocity tolerance.
10	LF	Hz-S	TDRS measurement bias tolerance.
11	LF	s	Measurement time step correction tolerance
12	LF	s	Clock time step correction tolerance.
13	LF	s	Synchronization leap second tolerance.
14	LF	NU	Divide by zero tolerance.

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 STATE_TOLER_TABLE \
269 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 6.0000000000E+02\n
2 6.6000000000E-01\n
3 1.0000000000E-02\n
4 4.2000000000E+02\n
5 -1.0000000000E+00\n
6 8.5000000000E+00\n
7 1.0000000000E-02\n
8 3.0000000000E+02\n
9 2.2000000000E-02\n
10 4.0000000000E-01\n
11 1.0240000000E+00\n
12 1.0240000000E+00\n
```

```
13 6.5536000000E+01\n
14 1.0000000000E-36\n
```

3.71.4 Accuracy

There is no accuracy requirement associated with this product.

3.71.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.71.6 Timespan

There is no timespan associated with this product.

3.71.7 Transmission Medium

3.71.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.71.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.71.8 Volume Estimate

The volume of one full table is 515 (= 137 + 14*27) bytes.

3.72 Doppler Measurement Tolerance Data

3.72.1 Description

The FDS will provide the EOC with Doppler measurement tolerance data required by the EOS Terra for navigation flight software.

3.72.2 Mission Phase

This product is provided during all mission phases.

3.72.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: MEAS_TOLER_TABLE
b. Table Number: 270

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	NU	Measurement residual edit ratio
2	LF	Hz-S	Maximum Doppler tolerance
3	LF	deg	Elevation limit for ionospheric editing of Doppler
4	LF	%	Ionosphere edit percentage tolerance
5	LF	s	Light time iteration tolerance
6	LF	%	Measurement edit percentage tolerance
7	LF	s	Time without measurement update
8	IT	μs	Frequency sum time tag tolerance
9	IT	s	Light time iteration limit
10	IT	count	Cycle slip threshold
11	IT	count	Carrier drop pending threshold

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 MEAS_TOLER_TABLE \
270 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 3.0000000000E+00\n
2 5.5000000000E+04\n
3 0.0000000000E+00\n
4 1.5000000000E+00\n
```

```
5 1.0000000000E-08\n
6 1.5000000000E+01\n
7 1.0800000000E+04\n
8 10\n
9 5\n
10 1\n
11 1\n
```

3.72.4 Accuracy

There is no accuracy requirement associated with this product.

3.72.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.72.6 Timespan

There is no timespan associated with this product.

3.72.7 Transmission Medium

3.72.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.72.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.72.8 Volume Estimate

The volume of one full table is 434 (= 137 + 11*27) bytes.

3.73 Covariance Tolerance Data

3.73.1 Description

The FDS will provide the EOC with tolerance data for EOS Terra state error covariance required by the EOS AM-1 for navigation flight software.

3.73.2 Mission Phase

This product is provided during all mission phases.

3.73.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: COV_TOLER_TABLE
b. Table Number: *271*

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	m	Root sum square (RSS) position sigma maximum tolerance
2	LF	m	RSS position sigma convergence tolerance
3	LF	m/s	RSS velocity sigma convergence tolerance
4	LF	Hz-S	MO frequency bias sigma convergence tolerance
5	LF	m	Semi-major axis sigma convergence tolerance

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 COV_TOLER_TABLE \
271 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 3.0000000000E+02\n
2 1.0000000000E+02\n
3 1.1000000000E-01\n
```

```
4 4.0000000000E-01\n
5 5.0000000000E+00\n
```

3.73.4 Accuracy

There is no accuracy requirement associated with this product.

3.73.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.73.6 Timespan

There is no timespan associated with this product.

3.73.7 Transmission Medium

3.73.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.73.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.73.8 Volume Estimate

The volume of one full table is 272 (= 137 + 5*27) bytes.

3.74 Navigation Time Step Data

3.74.1 Description

The FDS will provide the EOC with navigation time step data required by the EOS Terra for navigation flight software.

3.74.2 Mission Phase

This product is provided during all mission phases.

3.74.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: TIME_STEP_TABLE
b. Table Number: 259

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	s	EOS maximum synchronization time step
2	LF	s	EOS minimum synchronization time step
3	LF	s	TDRS maximum synchronization time step
4	LF	s	TDRS minimum synchronization time step

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 TIME_STEP_TABLE \
259 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 3.2768000000E+01\n
2 1.6384000000E+01\n
3 3.2768000000E+01\n
4 1.6384000000E+01\n
```

3.74.4 Accuracy

There is no accuracy requirement associated with this product.

3.74.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.74.6 Timespan

There is no timespan associated with this product.

3.74.7 Transmission Medium

3.74.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.74.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.74.8 Volume Estimate

The volume of one full table is 245 (= 137 + 4*27) bytes.

3.75 Physical and Mathematical Constants

3.75.1 Description

The FDS will provide the EOC with physical, Earth, solar system, and mathematical constants required by the EOS Terra for navigation flight software.

3.75.2 Mission Phase

This product is provided during all mission phases.

3.75.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: PHYS_CONST_TABLE
b. Table Number: 260

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	m/s	Speed of light.
2	LF	m^3/s^2	Earth gravitational constant.
3	LF	m	Earth equatorial radius.
4	LF	NU	Earth gravity scale factor.
5	LF	rad/s	Earth rotation rate.
6	LF	m^3/s^2	Sun gravitational constant.
7	LF	m^3/s^2	Moon gravitational constant.
8	LF	m	Mean distance between Sun and Earth
9	LF	$kg/s^2/m$	Mean solar pressure flux.
10	LF	NU	Earth flattening factor.
11	LF	deg	Lag angle of diurnal bulge.
12	LF	NU	Cosine power in bulge.
13	LF	days	J2000 Julian date.
14	LF	days	CCSDS reference Julian date
15	LF	rad	π
16	LF	rad	two π
17	LF	rad/deg	Degree-to-radian conversion factor
18	LF	deg/rad	Radian-to-degree conversion factor
19	LF	rad/arcsec	Arcsec-to-radian conversion factor
20	LF	rad/ttarcsec	ten thousandths of an arcsec to radian conversion factor
21	LF	NU	J2 coefficient

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 PHYS_CONST_TABLE \
260 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 2.9979245800E+08\n
2 3.9860043600E+14\n
3 6.3781370000E+06\n
4 1.0000000000E-25\n
5 7.2921151467E-05\n
6 1.3271240000E+21\n
```

```
7 4.9027990000E+12\n
8 1.4959789300E+11\n
9 4.5700000000E-06\n
10 3.3528130000E-03\n
11 3.0000000000E+01\n
12 6.0000000000E+00\n
13 2.4515450000E+06\n
14 2.4362045000E+06\n
15 3.1415926536E+00\n
16 6.2831853072E+00\n
17 1.7453292520E-02\n
18 5.7295779513E+01\n
19 4.8481368111E-06\n
19 4.8481368111E-10\n
21 1.0826260746E-03\n
```

3.75.4 Accuracy

There is no accuracy requirement associated with this product.

3.75.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.75.6 Timespan

There is no timespan associated with this product.

3.75.7 Transmission Medium

3.75.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.75.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.75.8 Volume Estimate

The volume of one full table is 704 (= 137 + 21*27) bytes.

3.76 (Deleted)

3.77 (Deleted)

3.78 Atmospheric Drag Data

3.78.1 Description

The FDS will provide the EOC with atmospheric drag data required by the EOS Terra for navigation flight software.

3.78.2 Mission Phase

This product is provided during all mission phases.

3.78.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: ATMOS_DRAG_TABLE
b. Table Number: 258

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	NU	Drag scale factor.
2	LF	10^{-22} W / m^2/Hz	10.7 cm flux.

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 ATMOS_DRAG_TABLE \
258 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 0.0000000000E+00\n
2 2.0000000000E+02\n
```

3.78.4 Accuracy

There is no accuracy requirement associated with this product.

3.78.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.78.6 Timespan

There is no timespan associated with this product.

3.78.7 Transmission Medium

3.78.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.78.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.78.8 Volume Estimate

The volume of one full table is 191 (= 137 + 2*27) bytes.

3.79 TDRS Measurement Bias Data

3.79.1 Description

The FDS will provide the EOC with TDRS measurement bias data required by the EOS Terra for navigation flight software.

3.79.2 Mission Phase

This product is provided during all mission phases.

3.79.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: TDRS_MEAS_BIAS_TABLE
b. Table Number: 278

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	Hz-S	TDRS measurement bias data.

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 TDRS_MEAS_BIAS_TABLE \
278 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 0.0000000000E+00\n
```

3.79.4 Accuracy

There is no accuracy requirement associated with this product.

3.79.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.79.6 Timespan

There is no timespan associated with this product.

3.79.7 Transmission Medium

3.79.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.79.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.79.8 Volume Estimate

The volume of one full table is 164 (= 137 + 27) bytes.

3.80 Simulated UTC to UT1 Timing Difference

3.80.1 Description

The FDS will provide the EOC with simulated UTC to UT1 timing differences.

3.80.2 Mission Phase

This product is delivered during all mission phases.

3.80.3 Format

The format for this product is identical with that of the UTC to UT1 Timing Difference (Section 3.54).

3.80.4 Accuracy

There is no accuracy requirement associated with this product.

3.80.5 Delivery Schedule

The product is delivered on an as-needed basis.

3.80.6 Timespan

The timespan depend on user's need.

3.80.7 Transmission Medium

3.80.7.1 Prime Medium

This product is transferred to the EOC via SFTP.

3.80.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.80.8 Volume Estimate

Refer to Section 3.54.

3.81 Navigation Thruster Table

3.81.1 Description

The FDS will provide the EOC with the thruster forces and direction cosines required by the EOS Terra navigation flight software. Actual thruster forces are calculated pre maneuver based on reconstruction of the previous maneuver and used by TONS to better navigate through the following maneuver. Thrusters are numbered 1-8 with 1 and 2 being the delta-V thrusters and 3-8 being the attitude thrusters. The even or odd set of thrusters may be used interchangeably with the same numbering system. The direction cosines are constant and have been provided by the FOT; they are documented in Section 3.80.3. FDS will not be responsible for updating the direction cosines if they change during the mission.

3.81.2 Mission Phase

This product is provided during all mission phases.

3.81.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: THRUSTER_TABLE
b. Table Number: 257

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	Newton	THRUSTER_TBL(1).FORCE
2	LF	NU	THRUSTER_TBL(1).DCX The only valid value is 0.99747.
3	LF	NU	THRUSTER_TBL(1).DCY The only valid value is 6.3221×10^{-2}.
4	LF	NU	THRUSTER_TBL(1).DCZ The only valid value is -3.2511×10^{-2}.
5	LF	Newton	THRUSTER_TBL(2).FORCE
6	LF	NU	THRUSTER_TBL(2).DCX The only valid value is 0.99746.
7	LF	NU	THRUSTER_TBL(2).DCY The only valid value is -6.403×10^{-2}.
8	LF	NU	THRUSTER_TBL(2).DCZ The only valid value is 3.11×10^{-2}.
9	LF	Newton	THRUSTER_TBL(3).FORCE
10	LF	NU	THRUSTER_TBL(3).DCX The only valid value is 1.13×10^{-3}.
11	LF	NU	THRUSTER_TBL(3).DCY The only valid value is 1.0
12	LF	NU	THRUSTER_TBL(3).DCZ The only valid value is 1.09×10^{-3}.
13	LF	Newton	THRUSTER_TBL(4).FORCE
14	LF	NU	THRUSTER_TBL(4).DCX The only valid value is 5.62×10^{-4}.
15	LF	NU	THRUSTER_TBL(4).DCY The only valid value is 0.865859.
16	LF	NU	THRUSTER_TBL(4).DCZ The only valid value is 0.500289.
17	LF	Newton	THRUSTER_TBL(5).FORCE
18	LF	NU	THRUSTER_TBL(5).DCX The only valid value is 1.079×10^{-3}.
19	LF	NU	THRUSTER_TBL(5).DCY The only valid value is -0.866316.
20	LF	NU	THRUSTER_TBL(5).DCZ The only valid value is 0.499495.
21	LF	Newton	THRUSTER_TBL(6).FORCE
22	LF	NU	THRUSTER_TBL(6).DCX The only valid value is 4.82×10^{-4}.
23	LF	NU	THRUSTER_TBL(6).DCY The only valid value is -1.0.
24	LF	NU	THRUSTER_TBL(6).DCZ The only valid value is 6.49×10^{-4}.

25	LF	Newton	THRUSTER_TBL(7).FORCE
26	LF	NU	THRUSTER_TBL(7).DCX The only valid value is $-2.7x10^{-4}$.
27	LF	NU	THRUSTER_TBL(7).DCY The only valid value is -0.86595.
28	LF	NU	THRUSTER_TBL(7).DCZ The only valid value is -0.50013.
29	LF	Newton	THRUSTER_TBL(8).FORCE
30	LF	NU	THRUSTER_TBL(8).DCX The only valid value is $-1.91x10^{-3}$.
31	LF	NU	THRUSTER_TBL(8).DCY The only valid value is 0.86657.
32	LF	NU	THRUSTER_TBL(8).DCZ The only valid value is -0.49904.

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 THRUSTER_TABLE \
257 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 2.2240000000E+01\n
2 9.9747000000E-01\n
3 6.3221000000E-02\n
4 -3.2511000000E-02\n
5 2.2240000000E+01\n
6 9.9746000000E-01\n
7 -6.4030000000E-02\n
8 3.1100000000E-02\n
9 4.4480000000E+00\n
10 1.1300000000E-03\n
11 1.0000000000E+00\n
12 1.0900000000E-03\n
13 4.4480000000E+00\n
14 5.6200000000E-04\n
15 8.6585900000E-01\n
16 5.0028900000E-01\n
17 4.4480000000E+00\n
18 1.0790000000E-03\n
19 -8.6631600000E-01\n
20 4.9949500000E-01\n
21 4.4480000000E+00\n
22 4.8200000000E-04\n
23 -1.0000000000E+00\n
24 6.4900000000E-04\n
25 4.4480000000E+00\n
26 -2.7000000000E-04\n
27 -8.6595000000E-01\n
```

```
28 -5.0013000000E-01\n
29 4.4480000000E+00\n
30 -1.9100000000E-03\n
31 8.6657000000E-01\n
32 -4.9904000000E-01\n
```

3.81.4 Accuracy

There is no accuracy requirement associated with this product.

3.81.5 Delivery Schedule

The product is delivered pre maneuver at burn – 48 hours and burn – 24 hours.

3.81.6 Timespan

There is no timespan associated with this product.

3.81.7 Transmission Medium

3.81.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.81.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.81.8 Volume Estimate

The volume of one full table is 1001 (= 137 + 27*32) bytes.

3.82 HGA to TDRSS S-Band Viewing Times

3.82.1 Description

The FDS will provide the EOC with S-band viewing times for the High Gain Antenna (HGA) to each TDRS operational for EOS Terra. The FDS will account for S-band altitude constraints. The header record will specify the time span covered by the data in the file as start and end times. There is a data record for each possible view from any TDRS to the spacecraft HGA antenna for the time span specified in the header record. This product is

generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed. The data records is in time order based on the “AOS” field.

3.82.2 Mission Phase

This product is delivered during all phases of the mission.

3.82.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite ID of the Terra spacecraft (“AM1”).
File Type	14	The view indicator specifies the pair that the views are provided for. The only valid value is HGAS-TDRS.
File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.

Data Records: 48 bytes.

Field Name	Maximum Field Width	Description
TDRS ID	6	The ID of the TDRS that can be seen by the HGA. The valid values are TDX with X = 1,3,4,5, 6,7,8,9,10,11,12,13, ...up to 99.
AOS	14	The start time of the view period in the form YYYYDDD.HHMMSS.
LOS	14	The end time of the view period in the form YYYYDDD.HHMMSS.
Orbit Number at AOS	6	Orbit number of AOS. Format is XXXXXX.
Orbit Number at LOS	6	Orbit number of LOS. Format is XXXXXX.

Sample Header Record

```
AM1 HGAS-TDRS 1999225.123034 1999230.000000 1999232.235900\n
```

Sample Data Records

```
TD1 1999230.100000 1999230.105500 6043 6043\n
TD1 1999230.110100 1999230.114210 6043 6043\n
TD4 1999230.121400 1999230.150508 6043 6043\n
```

3.82.4 Accuracy

The product will produce an accuracy of 60 seconds absolute UTC at the end of a 3-week prediction.

Constraints : The view periods are filtered so that the following constraints are not violated when the HGA points to the TDRS:

a. Structural blockage: Solar array modeled as 206 in. diameter cylindrical swept volume. The blockage is modeled consistent with the spacecraft RF Inhibit map found in the FSW table, HGA_RF_INHIB_TABLE (table number = 138). An additional

margin of +0.5 degrees in elevation angle has been included in the FDS.

b. Earth Atmosphere blockage in the line of sight between HGA and TDRS:

Earth Radius + 404 km for S-band communication

c. Sun Interference:

7 degrees AM1 line of sight to TDRS
4 degrees TDRS line of sight to AM1

d. Azimuth/Elevation Rate Limits:

Keyhole passes, flying directly under TDRS, that violate the HGA azimuth or elevation rate limits of 0.6 degrees/second have been modeled as a Latitude/Longitude exclusion zone. The zone is characterized separately for both ascending node and descending node contacts and are defined in a memo titled “HGA Contact Gaps due to Keyhole Passages”.

e. HGA Gimbal Position Limits:

There are two sets of constraints on gimbal position limits, hard constraints and soft constraints. The soft constraints is used by FDS for planning purposes. The default values for the limits with respect to the HGA are:

	az. (deg)	el. (deg)
Hardware:	+/– 202.0	+97.0/–29.0
Firmware:	+/– 200.5	none
Software:	+/– 194.0	+90.0/–26.0

Note: The software azimuth limits are found in locations 1 and 2 of the FSW table, HGA_TRACK_TABLE (table number = 135). The elevation limits are found in locations 3 and 4.

3.82.5 Delivery Schedule

This product is delivered once per week for the 7-week product and once daily for the 7-day product.

3.82.6 Timespan

The timespans for these products are 7-weeks and 7-days.

3.82.7 Transmission Medium

3.82.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.82.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.82.8 Volume Estimate

The volume estimates are based on 68 bytes for the header record and 48 bytes for each data record.

3.83 HGA to TDRSS TONS-Based Viewing Times

3.83.1 Description

The FDS will provide the EOC with TONS-based viewing times for the High Gain Antenna (HGA) to each TDRS operational for EOS Terra. The FDS will account for TONS elevation constraints. The header record will specify the time span covered by the data in the file as start and end times. There is a data record for each possible view from any TDRS to the spacecraft HGA antenna for the time span specified in the header record. This product is generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed. The data records is in time order based on the “AOS” field.

3.83.2 Mission Phase

This product is delivered during all phases of the mission.

3.83.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite ID of the Terra spacecraft (“AM1”).
File Type	14	The view indicator specifies the pair that the views are provided for. The only valid value is HGAT-TDRS.
File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.

Data Records: 48 bytes.

Field Name	Maximum Field Width	Description
TDRS ID	6	The ID of the TDRS that can be seen by the HGA. The valid values are TDX with X = 1,3,4,5, 6,7,8,9,10,11,12,13, ...up to 99.
AOS	14	The start time of the view period in the form YYYYDDD.HHMMSS.
LOS	14	The end time of the view period in the form YYYYDDD.HHMMSS.
Orbit Number at AOS	6	Orbit number of AOS. Format is XXXXXX.
Orbit Number at LOS	6	Orbit number of LOS. Format is XXXXXX.

Sample Header Record

```
AM1 HGAT-TDRS 1999225.123034 1999230.000000 1999232.235900\n
```

Sample Data Records

```
TD1 1999230.100000 1999230.105500 6043 6043\n
TD1 1999230.110100 1999230.114210 6043 6043\n
TD4 1999230.121400 1999230.150508 6043 6043\n
```

3.83.4 Accuracy

The product will produce an accuracy of 60 seconds absolute UTC at the end of a 3-week prediction.

Constraints : The view periods are filtered so that the following constraints are not violated when the HGA points to the TDRS:

a. Structural blockage:
   Solar array modeled as 206 in. diameter cylindrical swept volume. The blockage is modeled consistent with the spacecraft RF Inhibit map found in the FSW table, HGA_RF_INHIB_TABLE (table number = 138). An additional margin of +0.5 degrees in elevation angle has been included in the FDS.
b. TONS Limit:
   Elevation angle greater than – 5 degrees
c. Sun Interference:
   7 degrees AM1 line of sight to TDRS
   4 degrees TDRS line of sight to AM1
d. Azimuth/Elevation Rate Limits:
   Keyhole passes, flying directly under TDRS, that violate the HGA azimuth or elevation rate limits of 0.6 degrees/second have been modeled as a Latitude/Longitude exclusion zone. The zone is characterized separately for both ascending node and descending node contacts and are defined in a memo titled “HGA Contact Gaps due to Keyhole Passages”.
e. HGA Gimbal Position Limits:
   There are two sets of constraints on gimbal position limits, hard constraints and soft constraints. The soft constraints is used by FDS for planning purposes.
   The default values for the limits with respect to the HGA are:

	az. (deg)	el. (deg)
Hardware:	+/– 202.0	+97.0/–29.0
Firmware:	+/– 200.5	none

Software:	+/– 194.0	+90.0/–26.0

Note: The software azimuth limits are found in locations 1 and 2 of the FSW table, HGA_TRACK_TABLE (table number = 135). The elevation limits are found in locations 3 and 4.

3.83.5 Delivery Schedule

This product is delivered once per week for the 7-week product and once daily for the 7-day product.

3.83.6 Timespan

The timespans for these products are 7-weeks and 7-days.

3.83.7 Transmission Medium

3.83.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.83.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.83.8 Volume Estimate

The volume estimates are based on 68 bytes for the header record and 48 bytes for each data record.

3.84 Zenith Omni to TDRSS Viewing Times

3.84.1 Description

The FDS will provide the EOC with viewing times for the zenith-pointing OMNI antenna to each of the operational TDRS used for EOS Terra. The view periods are specified as a pair of start and end times of the view in UTC format. The header record will specify the time span covered by the data in the file as start and end times. There is a data record for each

possible view from each TDRS to the Terra zenith Omni antenna for the time span specified in the header record. This product is generated using a nominal predicted mission attitude, unless attitude maneuvers are to be performed. The data records is in time order based on the “AOS” field.

3.84.2 Mission Phase

This product is delivered during all phases of the mission.

3.84.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite ID of the Terra spacecraft (“AM1”).
File Type	14	The view indicator specifies the pair that the views are provided for. The only valid value is OMNIZTDRS
File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS

Data Records: 48 bytes.

Field Name	Maximum Field Width	Description
TDRS ID	6	The ID of the TDRS that can be seen by the zenith Omni. The valid values are TDX with X = 1,3,4,5, 6,7,8,9,10,11,12,13, ...up to 99.
AOS	14	The start time of the view period in the form YYYYDDD.HHMMSS
LOS	14	The end time of the view period in the form YYYYDDD.HHMMSS
Orbit Number at AOS	6	Orbit number of AOS. Format is XXXXXX.
Orbit Number at LOS	6	Orbit number of LOS. Format is XXXXXX.

Sample Header Record

```
AM1 OMNIZTDRS 1999225.123034 1999230.000000 1999232.235900\n
```

Sample Data Records

```
TD1 1999230.100000 1999230.105500 6043 6043\n
TD1 1999230.110100 1999230.114210 6043 6043\n
TD4 1999230.121400 1999230.150508 6043 6043\n
```

3.84.4 Accuracy

The products will produce an accuracy of 60 seconds absolute UTC at the end of a 3 week prediction.

Constraints : The view periods are filtered so that the following constraints are not violated when the OMNI points to the TDRS:

a. Structural blockage: An azimuth/elevation map that account for HGA and average Solar Array blockage in addition to the zenith/nadir omni antenna cross interference region is applied to the Zenith Omni antenna sensor.
b. Sun Interference: 4 degrees TDRS line of sight to Terra

3.84.5 Delivery Schedule

This product is delivered once per week for the 7-week product and once per day for the 7-day product.

3.84.6 Timespan

The timespan for the products is 7-weeks and 7-days.

3.84.7 Transmission Medium

3.84.7.1 Prime Medium

The products is delivered to the EOC via SFTP.

3.84.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.84.8 Volume Estimate

The volume estimate is based on 68 bytes for the header record and 48 bytes for each data record, which is based on the number of view periods for the delivery.

3.85 TAM FDIR Predict Table

3.85.1 Description

The FDD will provide the EOC with Three-Axis Magnetometer (TAM) fault detection isolation and recovery (FDIR) predict tables required for onboard fault detection during attitude maneuvers.

3.85.2 Mission Phase

The TAM FDIR predict table is delivered during the Checkout and Operational phase.

3.85.3 Format

The table consists of the following:

a. The epoch time of the first predict in the table
b. The time interval between predicts in the table (between 1 and 3600 seconds)
c. A set of 200 geomagnetic field vectors in the J2000 ECI frame. If fewer than 200 vectors are provided, the remaining records is zero filled.

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: FDIR_TAM_PREDICTS_TBL
b. Table Number: 152

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	IT	days	Number of days from January 1, 1958. Maximum value is 65635.
2	LI	ms	Milliseconds of day. Normally the value is less than 86400000.
3	IT	µs	Microseconds of millisecond.
4	LF	s	Data interval
5	LF	milliGauss	ECI X component of the magnetic field
6	LF	milliGauss	ECI Y component of the magnetic field
7	LF	milliGauss	ECI Z component of the magnetic field
8 – 604	LF	milliGauss	Preceding 3 records are repeated 199 times more.

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 FDIR_TAM_PREDICTS_TBL 152 5\
 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 14689\n
2 43527680\n
3 0000\n
4 65.5360\n
5 291.58\n
6 -134.43\n
7 -125.27\n
8 284.20\n
9 -138.42\n
10 –171.06\n
.
.
.
602 128.22\n
603 –205.34\n
604 –155.40\n
```

3.85.4 Accuracy

There is no accuracy requirement for this product.

3.85.5 Delivery Schedule

The product is delivered as needed during the Checkout and Operational phases.

3.85.6 Timespan

The nominal timespan for this product is 13042 seconds.

3.85.7 Transmission Medium

3.85.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.85.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.85.8 Volume Estimate

The volume of one full table is 16455 (= 137 + 604*27) bytes.

3.86 Thruster Control Parameters Table

3.86.1 Description

This table contains the values for the torque level for each axis (roll, pitch, and yaw).

3.86.2 Mission Phase

This product is provided during all mission phases.

3.86.3 Format

Header Record: 137 bytes

Details for the format are given in Appendix F.2.

Values for the fields that are unique to this product are as follows:

a. Table Name: THRUSTER_CONTROL_PARS_TBL
b. Table Number: 105

Data Records: 27 bytes

Detailed format for a data record is given in Appendix F.2. The following provides additional details regarding the contents of the data records.

Table Field Number	Data Type	Unit	Description
1	LF	1/ft-lb	Roll torque level
2	LF	1/ft-lb	Pitch torque level
3	LF	1/ft-lb	Yaw torque level

Sample Header Record

```
AM1 TABLELOAD 1996123.001122 THRUSTER_CONTROL_PARS_TBL \
105 5 1996124.112233 1996124.221133 1996124.123344 1996124.213344\n
```

Sample Data Records

```
1 2.6942544800E-01\n
2 1.2178167800E-01\n
3 1.2175651700E-01\n
```

3.86.4 Accuracy

The accuracy for this product is best effort.

3.86.5 Delivery Schedule

The product is delivered pre maneuver at burn-48 hours and burn-24 hours.

3.86.6 Timespan

There is no timespan associated with this product.

3.86.7 Transmission Medium

3.86.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.86.7.2 Backup Medium

The backup transmission medium for this product is a 40GB Native DLTtape IV.

3.86.8 Volume Estimate

The volume of one full table is 218 (=137 + 3*27) bytes.

3.87 CERES FOV Moon Intrusion Times

3.87.1 Description

The FDS provides the EOC with the CERES FOV moon intrusion times that are used for CERES activity scheduling. The CERES FOV moon intrusion times are defined in terms of the moon-avoidance zone whose concept is similar to that of the Sun-avoidance zone. The lunar avoidance zone is defined by two lunar elevation angles that encompass the region of the orbit between the limb of the Earth with respect to the moon and the horizon of the spacecraft – near moonrise or moonset. It is independent of the moon's azimuth angle.
The following values for the upper and lower bounds of the moon elevation angles are used for the CERES planning purposes:

a. Lower bound of moon avoidance zone = –30 degrees (moon elevation angle)
b. Upper bound of moon avoidance zone = 5 degrees (moon elevation angle)

3.87.2 Mission Phase

This product is delivered during the Checkout and Operational phases.

3.87.3 Format

Header Record: 68 bytes.

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite ID of the Terra spacecraft ("AM1").
File Type	14	This field indicates the type of file. The only valid value is CER_MOON_ENTRY.
File Creation Time	14	Creation date of the file in the form: YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.

Data Records: 29 bytes

Field Name	Maximum Field Width	Description
Entry Time of Moon-avoidance Zone	14	The time when the CERES will enter the moon-avoidance zone. Format is YYYYDDD.HHMMSS.
Exit Time of Moon-Avoidance Zone	14	The time when the CERES will leave the moon-avoidance zone. Format is YYYYDDD.HHMMSS.

Sample Header Record

```
AM1 CER_MOON_ENTRY 2000068.000000 2000070.000000 2000072.235900\n
```

Sample Data Records

```
2000070.100000 2000070.101000\n
```

3.87.4 Accuracy

The accuracy required is 30 seconds after 9 days.

3.87.5 Delivery Schedule

The product is delivered weekly (7-week product) and daily (7-day product).

3.87.6 Timespan

The products have a 7 week and 7 day timespans.

3.87.7 Transmission Medium

3.87.7.1 Prime Medium

The product are transferred to the EOC via SFTP.

3.87.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

3.87.8 Volume Estimate

The volume estimate is (68 + 29 * (number of data record)) bytes.

3.88 TDRS Minimum Ray Path Height

3.88.1 Description

FDS delivers to the EOC a table of Terra to all operational TDRSS line of sight viewing entrance and exit times, where any path through the atmosphere below 680 km (this height can be adjusted as necessary) is considered obstructed. The records in the table are the obstructed times and is time ordered.

3.88.2 Format

Header Record

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite ID of the Terra spacecraft (“AM1”).
File Type	14	The view indicator specifies the pair that the views are provided for. The only valid value is “MINRAYPATH”.
File Creation Time	14	Time when the file was created in the form, YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the span of the file in the form, YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the span of the file in the form, YYYYDDD.HHMMSS.

Data Records

Field Name	Maximum Field Width	Description
TDRS ID	6	The ID of the TDRS that has a view of the Terra spacecraft. The valid values are TDX with X = 1,3,4,5,6,7,8,9,10,11,12,13, ...up to 99.
AOS	14	The start time where the line of sight between a TDRS and Terra travels below the specified atmosphere height in the form, YYYYDDD.HHMMSS.
LOS	14	The end time where the line of sight between a TDRS and Terra travels above the specified atmosphere height in the form, YYYYDDD.HHMMSS.
Orbit Number at AOS	6	Orbit number of AOS. Format is XXXXXX.
Orbit Number at LOS	6	Orbit number of LOS. Format is XXXXXX.

Sample Header Record:

AM1 MINRAYPATH 2008353.153208 2008354.000000 2008361.000000\n

Sample Data Records:

TD3 2008354.002218 2008354.003527 35253 35253\n
TD10 2008354.003608 2008354.004705 35253 35253\n
TD4 2008354.003618 2008354.004820 35253 35253\n
TD5 2008354.003816 2008354.004427 35253 35253\n

3.88.3 Delivery

The product is delivered during all phases of the mission. There are two time spans of the product, 7 day and 7 week, and they are delivered daily and weekly, respectively.

3.88.4 Accuracy

After 3 weeks the product is to have an accuracy of ±60 seconds.

3.88.5 End Users

This product is needed by FOT.

3.89 HGA Hotzone Times

3.89.1 Description

FDS delivers to the FOT a table of all operational TDRSS time intervals during which the angle between the TDRSS-Earth and Earth-Sun vectors (projected onto the Earth's equatorial plane) is between the critical values of 155 degrees and 240 degrees. The times exclude when Terra is in spacecraft night (penumbral shadow).

3.89.2 Format

Header Record

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite ID of the Terra spacecraft (“AM1”)
File Type	7	The file descriptor. The only valid value is “HOTZONE”.
File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the file contents in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the file contents in the form YYYYDDD.HHMMSS.

Data Records

Field Name	Maximum Field Width	Description
TDRS ID	6	The ID of the TDRS. The valid values are TDX with X = 1,3,4,5,6,7,8,9,10,11,12,13, ...up to 99.
AOS	14	The start time when the angle between a TDRSS, the Earth and the Sun is between the specified angle range in the form, YYYYDDD.HHMMSS.
LOS	14	The end time when the angle between TDRSS, the Earth and the Sun is between the specified angle range in the form, YYYYDDD.HHMMSS.
Orbit Number at AOS	6	Orbit number of AOS. Format is XXXXXX.
Orbit Number at LOS	6	Orbit number of LOS. Format is XXXXXX.

Sample Header Record:

```
AM1 HOTZONE 2017268.170833 2017268.000000 2017317.000000\n
```

Sample Data Records:

```
TD6 2017268.012934 2017268.023434 94521 94521\n
TD12 2017268.013012 2017268.023412 94521 94521\n
TD6 2017268.030834 2017268.041334 94522 94522\n
```

3.89.3 Delivery

The product is delivered during the operational phase of the mission. The time span of the product is 7 weeks, delivered weekly. The product will be transferred to the EOC via SFTP.

3.89.4 Accuracy

The product will produce an accuracy of 60 seconds absolute UTC at the end of a 3-week prediction.

3.89.5 End Users

This product is used by the FOT.

3.90 HGA to TDRS Azimuth Keyhole

3.90.1 Description

FDS delivers to the EOC a table of all operational TDRSS azimuth keyhole start and end times, where azimuth keyhole passes are defined as Terra flying directly under TDRS that potentially violate the HGA azimuth and elevation rate limits of 0.6 degrees/second. The records in the table are the obstructed times and will be time ordered.

3.90.2 Format

Header Record

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite ID of the Terra spacecraft (“AM1”)
File Type	10	The file descriptor. The only valid value is “AZIKEYHOLE.”

File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the file contents in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the file contents in the form YYYYDDD.HHMMSS.

Data Records

Field Name	Maximum Field Width	Description
TDRS ID	6	The ID of the TDRS. The valid values are TDX with X = 1,3,4,5,6,7,8,9,10,11,12,13, ...up to 99.
AOS	14	The start time of the keyhole interval in the form YYYYDDD.HHMMSS.
LOS	14	The end time of the keyhole interval in the form YYYYDDD.HHMMSS.
Orbit Number at AOS	6	Orbit number of AOS. Format is XXXXXX.
Orbit Number at LOS	6	Orbit number of LOS. Format is XXXXXX.

Sample Header Record:

```
AM1 AZIKEYHOLE 2017268.170712 2017268.000000 2017317.000000\n
```

Sample Data Records:

```
TD7 2017272.045952 2017272.051831 94581 94581\n
TD6 2017275.134445 2017275.140334 94630 94630\n
TD6 2017280.014204 2017280.020051 94696 94696\n
```

3.90.3 Delivery

The product is delivered during the operational phase of the mission. The time span of the product is 7 weeks, delivered weekly. The product will be transferred to the EOC via SFTP.

3.90.4 Accuracy

The product will produce an accuracy of 60 seconds absolute UTC at the end of a 3-week prediction.

*0 Azimuth/Elevation Rate Limits:

Keyhole passes, flying directly under TDRS, that violate the HGA azimuth or elevation rate limits of 0.6 degrees/second have been modeled as a Latitude/Longitude exclusion zone. The zone is characterized separately for both ascending node and descending node contacts and is defined in a memo titled “HGA Contact Gaps due to Keyhole Passages”.

*1 HGA Gimbal Position Limits:

There are two sets of constraints on gimbal position limits, hard constraints and soft constraints. The soft constraints will be used by FDS for planning purposes. The default values for the limits with respect to the HGA are:

	az. (deg)	el. (deg)
Hardware:	+/– 202.0	+97.0/–29.0
Firmware:	+/– 200.5	none
Software:	+/– 194.0	+90.0/–26.0

Note: The software azimuth limits are found in locations 1 and 2 of the FSW table, HGA_TRACK_TABLE (table number = 135). The elevation limits are found in locations 3 and 4.

3.90.5 End Users

This product is used by the FOT.

3.91 HGA to TDRS Elevation Keyhole

3.91.1 Description

FDS delivers to the EOC a table of all operational TDRSS elevation-only keyhole start and end times, where elevation keyhole passes are defined as Terra flying directly under TDRS that potentially violate the HGA elevation rate limits of 0.6 degrees/second. The records in the table are the obstructed times and will be time ordered.

3.91.2 Format

Header Record

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite ID of the Terra spacecraft (“AM1”)
File Type	11	The file descriptor. The only valid value is “ELEVKEYHOLE”.
File Creation Time	14	Time when the file was created in the form, YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the file contents in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the file contents in the form YYYYDDD.HHMMSS.

Data Records

Field Name	Maximum Field Width	Description
TDRS ID	6	The ID of the TDRS. The valid values are TDX with X = 1,3,4,5,6,7,8,9,10,11,12,13, ...up to 99.
AOS	14	The start time of the keyhole interval in the form YYYYDDD.HHMMSS.
LOS	14	The end time of the keyhole interval in the form YYYYDDD.HHMMSS.
Orbit Number at AOS	6	Orbit number of AOS. Format is XXXXXX.
Orbit Number at LOS	6	Orbit number of LOS. Format is XXXXXX.

Sample Header Record:

```
AM1 ELEVKEYHOLE 2017268.170724 2017268.000000 2017317.000000\n
```

Sample Data Records:

```
TD6 2017268.011540 2017268.013518 94521 94521\n
TD12 2017268.012300 2017268.013804 94521 94521\n
TD11 2017268.092812 2017268.095236 94526 94526\n
```

3.91.3 Delivery

The product is delivered during the operational phase of the mission. The time span of the product is 7 weeks, delivered weekly. The product will be transferred to the EOC via SFTP.

3.91.4 Accuracy

The product will produce an accuracy of 60 seconds absolute UTC at the end of a 3-week prediction.

*2 Azimuth/Elevation Rate Limits:

Keyhole passes, flying directly under TDRS, that violate the HGA azimuth or elevation rate limits of 0.6 degrees/second have been modeled as a Latitude/Longitude exclusion zone. The zone is characterized separately for both ascending node and descending node contacts and is defined in a memo titled “HGA Contact Gaps due to Keyhole Passages”.

*3 HGA Gimbal Position Limits:

There are two sets of constraints on gimbal position limits, hard constraints and soft constraints. The soft constraints will be used by FDS for planning purposes. The default values for the limits with respect to the HGA are:

	az. (deg)	el. (deg)
Hardware:	+/– 202.0	+97.0/–29.0
Firmware:	+/– 200.5	none
Software:	+/– 194.0	+90.0/–26.0

Note: The software azimuth limits are found in locations 1 and 2 of the FSW table, HGA_TRACK_TABLE (table number = 135). The elevation limits are found in locations 3 and 4.

3.91.5 End Users

This product is used by the FOT.

3.92 HGA Keyhole Sun Interference Times

3.92.1 Description

FDS delivers to the EOC a table of intervals in which the angle between all operational TDRSS and Terra HGA and the Terra HGA-Sun vectors is less than 7 degrees (inspected at 60-second intervals). These periods are considered times in which Terra must stop tracking the TDRS and park its HGA. The records in the table are the obstructed times and will be time ordered.

3.92.2 Format

Header Record

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite ID of the Terra spacecraft (“AM1”)
File Type	12	The file descriptor. The only valid value is “SOLARKEYHOLE”.
File Creation Time	14	Time when the file was created in the form, YYYYDDD.HHMMSS.
Start Time of the file	14	The start time of the file contents in the form YYYYDDD.HHMMSS.
End Time of the file	14	The end time of the file contents in the form YYYYDDD.HHMMSS.

Data Records

Field Name	Maximum Field Width	Description
TDRS ID	6	The ID of the TDRS. The valid values are TDX with X = 1,3,4,5,6,7,8,9,10,11,12,13, ...up to 99.
AOS	14	The start time where the TDRS-Terra-Sun angle travels below the specified angle in the form, YYYYDDD.HHMMSS.

LOS	14	The end time where the TDRS-Terra-Sun angle travels above the specified angle in the form, YYYYDDD.HHMMSS.
Orbit Number at AOS	6	Orbit number of AOS. Format is XXXXXX.
Orbit Number at LOS	6	Orbit number of LOS. Format is XXXXXX.

Sample Header Record:

```
AM1 SOLARKEYHOLE 2017268.170736 2017268.000000 2017317.000000\n
```

Sample Data Records:

```
TD7 2017268.062732 2017268.063132 94524 94524\n
TD6 2017268.144122 2017268.150722 94529 94529\n
TD10 2017268.230726 2017268.232726 94534 94534\n
```

3.92.3 Delivery

The product is delivered during the operational phase of the mission. The time span of the product is 7 weeks, delivered weekly. The product will be transferred to the EOC via SFTP.

3.92.4 Accuracy

The product will produce an accuracy of 60 seconds absolute UTC at the end of a 3-week prediction.

3.92.5 End Users

This product is used by the FOT.

3.93 FDS Checklist

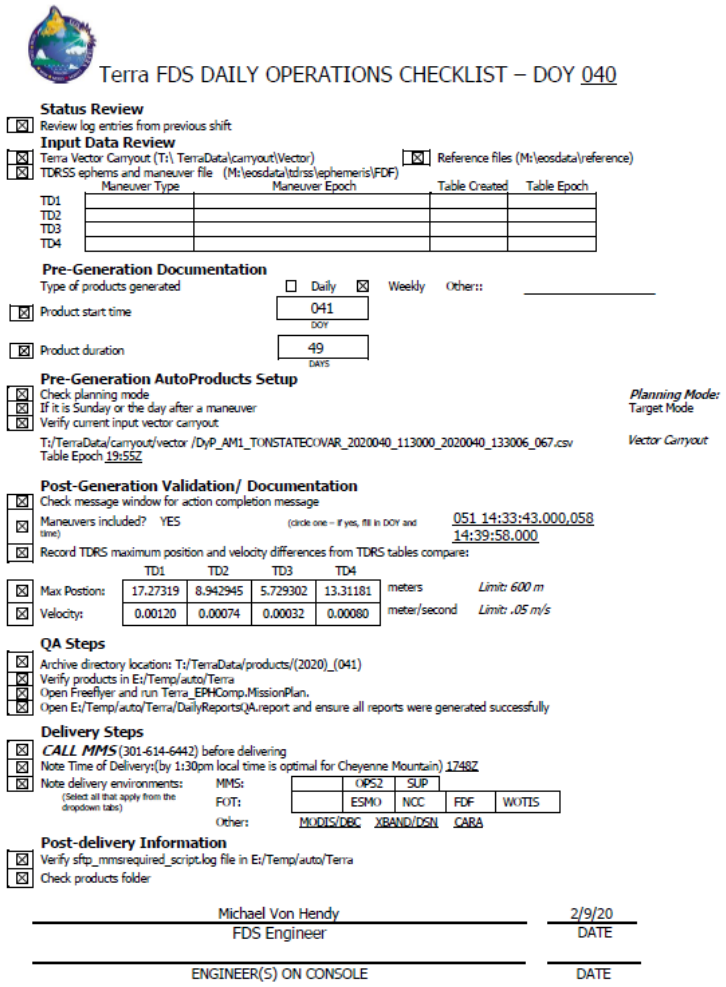
3.93.1 Description

FDS delivers to the EOC the daily FDS checklist. This checklist contains the steps and quality checks performed by the FDS team each day in conjunction with product generation. It includes input data review, AutoProducts setup, post-generation validation including TDRSS maximum

position and velocity compares, quality assurance steps, and pre- and post-delivery checks.

3.93.2 Format

The file is a PDF file with the following structure:



Terra FDS DAILY OPERATIONS CHECKLIST – DOY 040

Status Review
☒ Review log entries from previous shift

Input Data Review
☒ Terra Vector Carryout (T:\ TerraData\carryout\Vector) ☒ Reference files (M:\eosdata\reference)
☒ TDRSS ephems and maneuver file (M:\eosdata\tdrss\ephemeris\FDF)

	Maneuver Type	Maneuver Epoch	Table Created	Table Epoch
TD1				
TD2				
TD3				
TD4				

Pre-Generation Documentation
Type of products generated ☐ Daily ☒ Weekly Other::
☒ Product start time 041 DOY
☒ Product duration 49 DAYS

Pre-Generation AutoProducts Setup
☒ Check planning mode
☒ If it is Sunday or the day after a maneuver
☒ Verify current input vector carryout
Planning Mode: Target Mode
T:/TerraData/carryout/vector /DyP_AM1_TONSTATECOVAR_2020040_113000_2020040_133006_067.csv
Vector Carryout
Table Epoch 19:55Z

Post-Generation Validation/ Documentation
☒ Check message window for action completion message
☒ Maneuvers included? YES (circle one – if yes, fill in DOY and time) 051 14:33:43.000,058 14:39:58.000
☒ Record TDRS maximum position and velocity differences from TDRS tables compare:

	TD1	TD2	TD3	TD4		
☒ Max Postion:	17.27319	8.942945	5.729302	13.31181	meters	*Limit: 600 m*
☒ Velocity:	0.00120	0.00074	0.00032	0.00080	meter/second	*Limit: .05 m/s*

QA Steps
☒ Archive directory location: T:/TerraData/products/(2020)_(041)
☒ Verify products in E:/Temp/auto/Terra
☒ Open Freeflyer and run Terra_EPHComp.MissionPlan.
☒ Open E:/Temp/auto/Terra/DailyReports\A.report and ensure all reports were generated successfully

Delivery Steps
☒ *CALL MMS* (301-614-6442) before delivering
☒ Note Time of Delivery:(by 1:30pm local time is optimal for Cheyenne Mountain) 1748Z
☒ Note delivery environments: (Select all that apply from the dropdown tabs)

MMS:		OPS2	SUP		
FOT:		ESMO	NCC	FDF	WOTIS
Other:	MODIS/DBC	XBAND/DSN	CARA		

Post-delivery Information
☒ Verify sftp_mmsrequired_script.log file in E:/Temp/auto/Terra
☒ Check products folder

Michael Von Hendy, FDS Engineer — 2/9/20 DATE
ENGINEER(S) ON CONSOLE — DATE

3.93.3 Delivery

The product is delivered during all phases of the mission. The file is delivered nominally once per day for both daily and weekly product sets. If a second set of products is generated and delivered, a second checklist will also be delivered. The product will be transferred to the EOC via SFTP.

i. File name. We prefer the timestamp option. This will avoid the need for versioning. There is rarely a second checklist delivered. We will adjust the expected filename to the following:
1. [Aqua|Aura|Terra]_CHECKLIST_DOY_YYYY_HHMMSS.pdf
2. The extension is .PDF
3. There is nominally only one delivery. If products are generated in the morning and an RMM is executed, we may regenerate products and a corresponding checklist. This condition is pretty rare, but still possible.
ii. The delivery locations are:
1. Aqua: /mms_pm/<system>/pm1/external/fdf/
2. Aura: /mms_ch/<system>/ch1/external/fdf/
3. Terra: /mms/<system>/am1/external/fdf/
Where <system> is ops1, ops2, or sup1

3.93.4 Accuracy

Best available.

3.93.5 End Users

This product is used by the FOT.

3.94 Inclination (Yaw) Data File

3.94.1 Description

The FDS models inclination and retrograde maneuvers that occur in the predicted ephemeris span. They provide a product called INCDATA* whenever an inclination or retro burn is included in the product span. The product records are time ordered.

*Although the product name is INCDATA, it contains the yaw angle and offsets that are applicable to both inclination and retrograde maneuvers.

3.94.2 Mission Phase

The product is to be delivered during all phases.

3.94.3 Format

The report contains information on the inclination or retrograde burn including planned burn time, yaw angle, and angle offset.

Header Record: 76 bytes

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite id of the Terra spacecraft (“AM1”).
File Type	14	The file type is INCDATA.
File Creation Time	14	Format is YYYYDDD.HHMMSS.
Start Time of the file	18	The start time of the creation span of the file in the form YYYYDDD.HHMMSS.SSS.
End Time of the file	18	The end time of the creation span of the file in the form YYYYDDD.HHMMSS.SSS.

Data Records: 56 bytes

Field Name	Maximum Field Width	Description
IAM Number	2	Format is XX
Time of maneuver	18	Format is YYYYDDD.HHMMSS.SSS
Burn duration	7	Format is SSS.SSS
Commanded yaw angle	6	Commanded yaw angle. Format is XXX.XX
Yaw angle offset	4	Difference between commanded yaw and FDS predicted yaw. Format is XXX.XX

Sample Header Record

```
AM1 INCDATA 2020047.154928 2020048.000000 2020097.000000\n
```

Sample Data Record

```
57 2020051.143343.000 320.000 -91.04 0.24\n
```

3.94.4 Accuracy

There is no accuracy requirement associated with this product.

3.94.5 Delivery Schedule

The product is delivered weekly.

3.94.6 Timespan

The timespan for this product is 7 weeks. If there is no inclination or retrograde maneuver within the seven weeks, the file is empty.

3.94.7 Transmission Medium

3.94.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

3.94.7.2 Backup Medium

The product is transferred via FAX to the EOC.

3.94.8 Volume Estimate

The volume estimate for this product is 448 bytes per delivery (if there are 8 maneuvers).

Section 4. EOC to FDS Products

4.1 Product Summary Chart

Table 4-1 summarizes all products that is transferred from the EOC to the FDS. The following sections give more detail about each product.

Table 4-1. Summary of EOC to FDS Products

Product Name	ICD Sec	Purpose	Delivery Schedule	Timespan	Medium (Prime/Bkup)
Real-Time Attitude Telemetry	4.1	RTADS ops	Each real-time pass	Length of pass	via Eclipse/ (N/A)
Non-Real-Time Attitude Telemetry	4.2	Calibration/Trending	As requested by FDS	As requested by FDS	SFTP/Tape
Real-Time TONS Telemetry	4.3	TONS monitoring	Each real-time pass	Length of pass	via Eclipse/ (N/A)
Non-Real-Time TONS Telemetry	4.4	TONS assessment	As requested by FDS	As requested by FDS	SFTP/Tape
TONS Parameter Change Report	4.5	TONS assessment	As needed	N/A	Hardcopy/FAX
Master Oscillator Frequency Adjustment Report	4.6	Analysis	Two days prior to event; One hour prior to event;	N/A	Hardcopy/FAX

Product Name	ICD Sec	Purpose	Delivery Schedule	Timespan	Medium (Prime/Bkup)
Tracking Schedule	4.7	Maneuver Planning	One week prior to time of first entry	1 week	SFTP/Hardcopy
Onboard Navigation System Flight Software Updates	4.8	TONS S/W evaluation	Every 6 months during Operations Phase	N/A	SFTP/(N/A)
Real-Time Propulsion Telemetry	4.10	Maneuver Calibration	As needed during Operations Phase	N/A	via Eclipse/(N/A)
TDRS Naming Convention Map	4.12	Product Generation	Once prelaunch and whenever updated	N/A	SFTP/Hardcopy
Non-Real-Time Propulsion Telemetry	4.13	Maneuver calibration	As requested by FDS	As requested by FDS	SFTP/Tape
TONS State with Covariance Data	4.14	Product Generation	Daily/As requested by FDS	As requested by FDS	SFTP

4.2 Real-Time Attitude Telemetry

4.2.1 Description

The EOC will deliver to the FDS real-time telemetry using Eclipse. Refer to Appendix B for detailed about the real-time telemetry interface between the FDS and the EOC.

4.2.2 Mission Phase

The product is delivered during all phases of the mission. Prelaunch deliveries is negotiated to obtain realistic telemetry from the EOS Terra spacecraft and/or a spacecraft simulation, whenever possible for the purpose of interface testing. All other times prelaunch simulated telemetry data is used for training and testing.

4.2.3 Format

Refer to Appendix B.

4.2.4 Accuracy

The accuracy of each telemetry entry is as defined by the least significant bit as established in Reference 3.

4.2.5 Delivery Schedule

The real-time telemetry delivery schedule during the prelaunch phase is negotiated each time as requests are made.

The real-time telemetry delivery schedule during the Launch/Acquisition through the Checkout phases is for passes scheduled at the request of either the FDS or EOC for monitoring purposes.

4.2.6 Timespan

The timespan of each delivery is defined by simulation duration or allotted time with the actual spacecraft during the prelaunch phase.

For all other phases the timespan of each delivery is determined by the length of each real-time pass.

4.2.7 Transmission Medium

4.2.7.1 Prime Medium

Refer to Appendix B.

4.2.7.2 Backup Medium

There is no backup medium for this product.

4.2.8 Volume Estimate

The volume estimate is based on the parameters which are selected by FDS, which is variable.

4.3 Non-Real-time Attitude Telemetry

4.3.1 Description

The EOC will deliver to the FDS non-real-time telemetry for the purpose of calibration of the attitude sensors and other analysis relating to attitude determination. The playback data is an SFTP transfer of a carryout file at a prescribed schedule for nominal operations. This extraction and transfer of the needed telemetry is part of the EOC's daily standing order request.

4.3.2 Mission Phase

This product is delivered starting at the Launch/Acquisition phase and continuing for the mission lifetime.

4.3.3 Format

The format for the non-real time telemetry will contain information necessary to calibrate the attitude sensors as required. The detailed contents and format of this product is defined in Appendix G.

4.3.4 Accuracy

The accuracy for the non-real-time telemetry is the same as stated for the real-time attitude telemetry product outlined in section 4.1.

4.3.5 Delivery Schedule

The delivery schedule is as requested by FDS to meet calibration needs.

4.3.6 Timespan

The timespan is as requested by FDS to meet calibration needs.

4.3.7 Transmission Medium

4.3.7.1 Prime Medium

The product is a SFTP from EOC to FDS.

4.3.7.2 Backup Medium

The backup medium for the playback attitude telemetry is using a 40GB Native DLTtape IV.

4.3.8 Volume Estimate

The volume estimate is variable.

4.4 Real-Time TONS Telemetry

4.4.1 Description

The EOC will provide real-time TONS telemetry by locating EMOS real time workstations near the FDS equipment, one workstation near the primary FDS equipment and one workstation near the secondary FDS equipment.

4.4.2 Mission Phase

The product is delivered during all phases of the mission. Prelaunch deliveries is negotiated to obtain realistic telemetry from the EOS Terra spacecraft and/or spacecraft simulations, whenever possible for the purpose of interface testing. All other times prelaunch simulated telemetry data is used for training and testing.

4.4.3 Format

The real-time telemetry stream from the EOC will include:

a. TONS performance statistics
b. TONS SCC parameters
c. Transponder data

4.4.4 Accuracy

The accuracy of each telemetry entry is as defined by the least significant bit as established in Reference 3.

4.4.5 Delivery Schedule

The real-time telemetry delivery schedule during the prelaunch phase is negotiated each time as requests are made.

The real-time telemetry delivery schedule during the Launch/Acquisition through the Checkout phases is for passes scheduled at the request of either the FDS or EOC for monitoring purposes.

4.4.6 Timespan

The timespan of each delivery is defined by simulation duration or allotted time with the actual spacecraft during the prelaunch phase.

For all other phases the timespan of each delivery is determined by the length of each real-time pass.

4.4.7 Transmission Medium

4.4.7.1 Prime Medium

Real-time TONS telemetry is available on EMOS real-time workstations located near the FDS equipment.

4.4.7.2 Backup Medium

There is no backup medium for this product.

4.4.8 Volume Estimate

The volume estimate is variable.

4.5 Non-Real-Time TONS Telemetry

4.5.1 Description

The EOC will provide the FDS with non-real-time TONS telemetry for the purpose of TONS calibration and other analysis relating to navigation validation. The playback data is an SFTP transfer of a carryout file at a prescribed schedule for nominal operations. This extraction and transfer of the needed telemetry is part of the EOC's daily standing order request. Two specific carryout file types have been identified: ORBIT_CO file that will include TONS telemetry, and TONSSTATE_CO file that will include a state vector and related verification parameters. Other telemetry items may be identified in another carryout file type as determined to be needed. Also, the request times indicated are the nominal plans to be used for information purposes; however, these plans may change as determined by the team needs."

4.5.2 Mission Phase

This product is delivered starting at the Launch/Acquisition phase and continuing for the mission lifetime.

4.5.3 Format

The detailed contents and format of this product are defined in Appendix G.

4.5.4 Accuracy

The accuracy for the playback telemetry is the same as stated for the real-time TONS telemetry product outlined in section 4.3.

4.5.5 Delivery Schedule

The delivery schedule for the two carry out file types depends on mission phases as described below:

a. During the Launch/Acquisition and Checkout phases (prior to TONS operational initialization plus 7 days):
   ORBIT_CO files are delivered as requested after relevant events such as, but not limited to, post-launch, first TDRSS contact, NAV mode switches, MO frequency adjusts. These files are expected to be delivered within 15 minutes of the request. Additionally, a daily carryout file requested at 8 a.m. local, covering the previous 24 hours, is delivered within 30 minutes of the request.
   TONSSTATE_CO files are delivered as frequently as requested.
b. During the Operational phase:
   Daily ORBIT_CO files is requested at 9 a.m. local, covering the previous 24 hours. These carryout files is delivered within 30 minutes of the request. Additionally, a carryout file may be requested after special events relevant to NAV. These carryout files is delivered within 15 minutes of the request. Daily TONSSTATE_CO files spanning 6:52 a.m. – 8:30 a.m. local (to include a state at epoch 8:30 a.m. local and covering the previous 98 minutes) is delivered at 9:30 a.m. local. Additionally, a carryout file may be requested as needed.

4.5.6 Timespan

The timespan is as requested by FDS to meet calibration needs.

4.5.7 Transmission Medium

4.5.7.1 Prime Medium

The prime medium for transfer of this product from EOC to FDS is SFTP.

4.5.7.2 Backup Medium

The backup medium for the playback attitude telemetry is a 40GB Native DLTtape IV.

4.5.8 Volume Estimate

The volume estimate is variable.

4.6 Onboard Navigation Operating Parameter Changes Report

4.6.1 Description

The FOT will provide the FDS with a report which outlines the changes to the onboard navigation system. This report is used to adjust the ground based navigation system accordingly.

4.6.2 Mission Phase

This report is delivered beginning with the Orbit Acquisition phase through the mission lifetime as needed.

4.6.3 Format

The format for this product is not fixed, but dependent on the change requested.

The file is a text file containing the following information:

a. Parameter Name
b. Parameter Value From
c. Parameter Value To
d. Time Sent
e. How sent (upload table, FSW update, etc.)

f. Validity time
g. Originator of request for change

4.6.4 Accuracy

The accuracy for this product is best effort.

4.6.5 Delivery Schedule

This report is generated and delivered as needed.

4.6.6 Timespan

There is no associated timespan with this product.

4.6.7 Transmission Medium

4.6.7.1 Description

The product is delivered to the FDS whenever the EOC makes updates to the onboard navigation system (TONS). This product is a hardcopy printout and is Faxed or hand delivered to the FDS.

4.7 Master Oscillator Frequency Adjustment Report

4.7.1 Description

The FOT will deliver to the FDS an oscillator frequency report that contains planned adjustments. This is a hardcopy report.

4.7.2 Mission Phase

This product is delivered beginning with the Launch/Acquisition phase for the duration of the mission lifetime whenever events are planned.

4.7.3 Format

The product is a hard copy report containing planned master oscillator frequency adjustments. Therefore there is no predefined format associated with this product.

4.7.4 Accuracy

There is no associated accuracy with this product.

4.7.5 Delivery Schedule

The product is delivered to the FDS two days prior to the event and again one hour before the actual event.

4.7.6 Timespan

There is no associated timespan with this product.

4.7.7 Transmission Medium

4.7.7.1 Prime Medium

The product is a hardcopy report that is either Faxed or hand delivered to the FDS.

4.7.7.2 Backup Medium

There is no backup medium for this product.

4.7.8 Volume Estimate

There is no volume estimate for this product.

4.8 Tracking Schedule (Deleted)

4.9 Onboard Navigation System Flight Software Updates

4.9.1 Description

The EOC will provide the FDS with the updated SUN version of the navigation system flight software when needed.

4.9.2 Mission Phase

This product is to be delivered during the operational phase.

4.9.3 Format

There is no format associated with this product.

4.9.4 Accuracy

There is no accuracy associated with this product.

4.9.5 Delivery Schedule

The EOC will provide this product when needed.

4.9.6 Timespan

There is no timespan associated with this product.

4.9.7 Transmission Medium

The SUN version of the updated flight software is to be transferred to the FDS via SFTP.

4.9.8 Volume Estimate

There is no volume estimate for this product.

4.10 (Deleted)

4.11 Real-Time Propulsion Telemetry

4.11.1 Description

The EOC can provide the FDS with real-time propulsion telemetry using Eclipse. Refer to Appendix B for details about the real time telemetry interface between the EOC and FDS.

4.11.2 Mission Phase

The product is delivered to the FDS during the Operational phase.

4.11.3 Format

This is a real time telemetry stream. For more information, refer to Appendix B.

4.11.4 Accuracy

The accuracy of each telemetry entry is as defined by the least significant bit as established in Reference 3.

4.11.5 Delivery Schedule

The real-time telemetry delivery schedule during the prelaunch phase was negotiated each time as requests were made.

The real-time telemetry delivery schedule during the Launch/Acquisition through the Checkout phases were for passes scheduled at the request of either the FDS or EOC for monitoring purposes. The FOT and FDS team (FDT) will coordinate when real-time telemetry delivery is needed during the Operations phase.

4.11.6 Timespan

There is no timespan associated with this product.

4.11.7 Transmission Medium

4.11.7.1 Prime Medium

Refer to Appendix B.

4.11.7.2 Backup Medium

There is no backup medium for this product.

4.11.8 Volume Estimate

There is no volume Estimate for this product.

4.12 (Deleted)

4.13 TDRS Naming Convention Map

4.13.1 Description

The EOC can provide the FDT with a report which maps the operational TDRS names to the designated FSW slot to which that data is uploaded.

4.13.2 Mission Phase

This product was delivered once pre-launch and can be redelivered as the mapping changes throughout the mission lifetime.

4.13.3 Format

Fields in this report are delimited by ASCII tabs.

Data Records: 21 bytes

Field Name	Maximum Field Width	Description
TDRS FSW Slot Number	5	The FSW ID of the TDRS. The valid values are TDRSX with X = 1,3,4,5, 6,7,8,9,10,11,12,13, ...up to 99.
TDRS Name	3	The Operational ID of the TDRS. The valid values are TDX with X = 1,3,4,5, 6,7,8,9,10,11,12,13, ...up to 99.
Ground Station Antenna Name	6	Name of the antenna tracking the associated TDRS. Valid values will change during the mission. The FOT is responsible for providing valid values.
NCC TDRS Name	3	The current NCC ID of the TDRS. Valid values are TDE, TDW, TDS, or ### with ### = the TDRS longitude. NOTE: These will change under the future NCC98 update

Sample Data Records

```
TDRS1 TD4   SGLT-1      TDE\n
TDRS2 TD5   SGLT-2      TDW\n
TDRS3 TD3   RGRT        TDS\n
TDRS4 TD1   SGLT-3      047\n
```

4.13.4 Accuracy

There is no accuracy associated with this product.

4.13.5 Delivery Schedule

The product was delivered once pre-launch and is delivered as needed during all mission phases.

4.13.6 Timespan

There is no timespan associated with this product.

4.13.7 Transmission Medium

4.13.7.1 Prime Medium

The prime medium for transfer of this product from EOC to FDS is SFTP.

4.13.7.2 Backup Medium

The backup medium for this product is a hardcopy report that will either be faxed or hand delivered to the FDT.

4.13.8 Volume Estimate

The volume estimate for this product is 84 bytes, maximum.

4.14 Non-Real-Time Propulsion Telemetry

4.14.1 Description

The EOC can provide the FDS with non-real-time propulsion telemetry for the purpose of maneuver calibration and other analysis relating to maneuver planning.

4.14.2 Mission Phase

This product was delivered starting at the Launch/Acquisition phase and continues for the mission lifetime.

4.14.3 Format

The detailed contents and format of this product are defined in Appendix G.

4.14.4 Accuracy

The accuracy for the playback telemetry is the same as stated for the real-time propulsion telemetry product outlined in section 4.10.

4.14.5 Delivery Schedule

The product is requested once per scheduled orbit maneuver.

4.14.6 Timespan

The timespan is as requested by FDS to meet calibration needs.

4.14.7 Transmission Medium

4.14.7.1 Prime Medium

The prime medium for transfer of this product from EOC to FDS is SFTP.

4.14.7.2 Backup Medium

The backup medium for the playback telemetry is a 40GB Native DLTtape IV.

4.14.8 Volume Estimate

The volume estimate is variable.

4.15 TONS State with Covariance Data

Description

Definitive position velocity and covariance data from the TONS filter

Format:

Header Record

Field Name	Maximum Field Width	Description
ASCII Report	18	Name of Satellite (Terra)
Input Definition File	60	Name of input TONS file
Report Date	22	Date of report
DMDB file (s)	60	File generated from mnemonic database
Decom start Data start	48	User trend start time Data start time
Decom stop Data stop	48	User trend stop time Data stop time

Data Records

Field Name	Maximum Field Width	Description
Year (4-digit)	6	Start year of data
Spacecraft Time (DOY-hh:mm:ss.sss)	18	Sart time of data
FS1_SSMSMT_UP_IN	2	MSMT_UP (1-digit value)
FS1_SS_DSF_AMU	18	Drag Scale Factor (floating point number)
FS1_SS_EOS_POSX_AMU	18	X-Position (floating point)
FS1_SS_EOS_POSY_AMU	18	Y-Position (floating point)
FS1_SS_EOS_POSZ_AMU	18	Z-Position (floating point)
FS1_SS_EOS_VELX_AMU	18	X-Position (floating point)
FS1_SS_EOS_VELY_AMU	18	Y-Position (floating point)
FS1_SS_EOS_VELZ_AMU	18	Z-Position (floating point)
FS1_SS_FILT_CONV_IN	18	Filter Convergence (string)
FS1_SS_NAV_MODE_ST	10	Nav Mode (String)
FS1_SS_NRML_OUT_ST	8	Normal Out (string)
FS1_SS_TON_TAG_DAYS	8	Days (digit)
FS1_SS_TON_TAG_MSEC	10	Milliseconds (digit)
FS1_SS_TON_TAG_USEC	2	Usec (digit)
FS1_SS_TONS_SUB_ST	10	TONS Sub (string)
The rows below represent the **Covariance Matrix** for the remaining 28 columns in data file (all are floating point numbers)		
FS1_SS_EOSPVARX_AMU	18	Matrix Position 1,1
FS1_SS_COV_1_2_AMU	18	Matrix Position 1.2
FS1_SS_EOSPVARY_AMU	18	Matrix Position 2,2
FS1_SS_COV_1_3_AMU	18	Matrix Position 1,3
FS1_SS_COV_2_3_AMU	18	Matrix Position 2,3
FS1_SS_EOSPVARZ_AMU	18	Matrix Position 3,3
FS1_SS_COV_1_4_AMU	18	Matrix Position 1,4
FS1_SS_COV_2_4_AMU	18	Matrix Position 2,4
FS1_SS_COV_3_4_AMU	18	Matrix Position 3,4
FS1_SS_EOSVVARX_AMU	18	Matrix Position 4,4
FS1_SS_COV_1_5_AMU	18	Matrix Position 1,5
FS1_SS_COV_2_5_AMU	18	Matrix Position 2,5
FS1_SS_COV_3_5_AMU	18	Matrix Position 3,5
FS1_SS_COV_4_5_AMU	18	Matrix Position 4,5
FS1_SS_EOSVVARY_AMU	18	Matrix Position 5,5
FS1_SS_COV_1_6_AMU	18	Matrix Position 1,6
FS1_SS_COV_2_6_AMU	18	Matrix Position 2,6
FS1_SS_COV_3_6_AMU	18	Matrix Position 3,6
FS1_SS_COV_4_6_AMU	18	Matrix Position 4,6
FS1_SS_COV_5_6_AMU	18	Matrix Position 5,6
FS1_SS_EOSVVARZ_AMU	18	Matrix Position 6,6
FS1_SS_COV_1_7_AMU	18	Matrix Position 1,7
FS1_SS_COV_2_7_AMU	18	Matrix Position 2,7
FS1_SS_COV_3_7_AMU	18	Matrix Position 3,7
FS1_SS_COV_4_7_AMU	18	Matrix Position 4,7
FS1_SS_COV_5_7_AMU	18	Matrix Position 5,7

Field Name	Maximum Field Width	Description
FS1_SS_COV_6_7_AMU	18	Matrix Position 6,7
FS1_SS_DSF_VAR_AMU	18	Matrix Position 7,7

Sample Header Record

ASCII Report TERRA\n
Input Definition File:
C:\ITPS\data\IDF\User\MISC\AM1_TONSTATECOVAR.idf\n
Report Date: 05/11/2016 13:32:57\n
DMDB file(s): C:\ITPS\data\dmdb\terra314.dmdb\n
Decom start: 2016/115/12:30:00 Data start:
2016/115/12:30:10.748\n
Decom stop: 2016/115/12:40:00 Data stop:
2016/115/12:39:59.548\n

Sample Data Records

```
2016    115-12:30:10.748        1       -0.329435       -5881768.108   -1605767.331   -3612747.46
        -3959.223158   206.530782     6362.919653    TONS_FILT_CONV      NORMAL       TONS
        21298   45010748       0       FILTER 79.779624      -16.694737          221.19586
        -86.51836       -38.841583     184.993991     -0.099185       -0.036004       0.153122
              0.000166          0.008951
           -0.024454     0.015096             -0.000021          0.000187       -0.038227       -
0.000827        0.109825
            0.000087          -0.000008         0.000083             -1.741166  -0.185348
3.880089
            0.003492          0.000726        0.002575     0.706717\n
.
.
.
2016    115-12:39:59.548
        NORMAL       TONS                          FILTER                        \n
```

Delivery

This product will be delivered during all phases of the mission.

Accuracy

The accuracy of this product is the best available.

End Users

This product is needed by Terra, FOT and spacecraft engineers.

Section 5. FDS to DAACs Products

5.1 Product Summary

The EOS Terra Flight Dynamics Team (FDT) provides the DAACs with the following information (see Reference Document 1 DMR Section 7210-13):

a. Attitude Interpolation Algorithm
b. Orbit Interpolation Algorithm

The FDS provides the DAACs with the following products (see Reference Document 1 DMR Section 7210-13):

a. Definitive Orbit Data
b. Definitive Attitude Data

The following sections provide details on each of these items.

5.2 (Deleted)

5.3 Orbit Interpolation Algorithm

5.3.1 Description

This product is a software delivery to the DAACs which contains an interpolation algorithm needed for the repair of orbit data. The repair of position and velocity data is accomplished by filling in gaps of 60 seconds or less using this algorithm.

5.3.2 Mission Phase

This product is delivered prelaunch and maintained as necessary for the duration of the mission.

5.3.3 Format

The usage description of the orbit interpolation program and source listing are given in Appendix E.

5.3.4 Accuracy

There is no accuracy associated with this product.

5.3.5 Delivery Schedule

This is a one time delivery before launch, with maintenance by FDT as needed throughout the mission.

5.3.6 Timespan

There is no timespan associated with this product

5.3.7 Transmission Medium

The software is delivered via an electronic file transfer.

5.3.8 Volume Estimate

There is no volume estimate associated with this product.

5.4 Definitive Orbit Data

5.4.1 Description

When the time gap in the TONS-determined orbit data exceeds the maximum allowable for the FDT-provided orbit interpolation algorithm, the FDS is requested to provide the DAACs with definitive orbit data which covers that time gap.

5.4.2 Mission Phase

This product is delivered during the Operational phase.

5.4.3 Format

Data records of this product are those of a standard FDS ephemeris product in the 2800-byte block binary format as specified in Reference 5. The

Polling Ingest without Product Delivery Record data transfer mechanism is used for delivery of the ephemeris file using the procedure detailed in Section A.3.7 of Appendix A.

5.4.4 Accuracy

The accuracy requirement is 150 meters per axis (3 sigma).

5.4.5 Delivery Schedule

This product is delivered whenever the FDS receives a request from the DAACs.

5.4.6 Timespan

Start time and stop time is as requested by the DAACs. Step size is 1 second.

5.4.7 Transmission Medium

The product is delivered via SFTP.

5.4.8 Volume Estimate

The volume estimate is 402 kb.

5.5 Definitive Attitude Data

5.5.1 Description

The FDS provides the DAACs with definitive attitude data. The data file will include a header record and a variable number of data records.

5.5.2 Mission Phase

This product is delivered during the Operational phase.

5.5.3 Format

The header record contains the metadata used to identify the file and its contents. All metadata fields is in ASCII format. All fields are right-justified

and are preceded with ASCII blanks where necessary to fill the specified Field Size. The Polling Ingest without Product Delivery Record data transfer mechanism is used for delivery of the Definitive Attitude Data.

Header Record: 256 bytes

Field Name	Field Size (bytes)	Data Type	Description
File Name	40	ASCII	Data Set filename
Spacecraft ID	8	ASCII	Defined as the following string: "EOSAM1"
Time of Completion of Data Set	32	ASCII	Time of data set completion; format is YYYY-DDDThh:mm:ss.dddddd
Start Time of Data	32	ASCII	Time of the first Data Record; format is YYYY-DDDThh:mm:ss.dddddd. Start time is the time of the first data point at or after the nominal start time. Nominal start times are: 00:00:00, 02:00:00, 04:00:00, 06:00:00, 08:00:00, 10:00:00, 12:00:00, 14:00:00, 16:00:00, 18:00:00, 20:00:00, 22:00:00, respectively.
End Time of Data	32	ASCII	Time of the last Data Record; format is YYYY-DDDThh:mm:ss.dddddd. Stop time is the time of the last data point before the nominal stop time. . Nominal stop times are: 02:00:00, 04:00:00, 06:00:00, 08:00:00, 10:00:00, 12:00:00, 14:00:00, 16:00:00, 18:00:00, 20:00:00, 22:00:00, 24:00:00, respectively.
Start Orbit Number	8	ASCII	Orbit number corresponding to the first Data Record. Format is XXXXXXXX.
End Orbit Number	8	ASCII	Orbit number corresponding to the last Data Record. Format is XXXXXXXX.
Number of Data Records	8	ASCII	The number of Data Records in the file

Spare Fields	87	ASCII	Reserved for future use; currently blank-filled
End of Header	1	ASCII	NULL (hexadecimal value of '00')

Sample Header Record

```
       AM1_DEFATT_010000_181_1998_01.FDD  EOSAM1        \
1998-181T13:13:13.123456        1998-181T01:00:00.000001\
        1998-181T01:15:20.576900     352     353     900\
                                                        \
                              NULL\n
```

Field Name	Field Size (bytes)	Data Type	Units	Description
Days	2	IT	days	Days since 1958 January 1
Millisecond of Day	4	LI	msec	Millisecond of Day
Microsecond of Millisecond	2	IT	μsec	Microsecond of Millisecond
Roll Angle	4	FL	radian	Roll Euler Angle
Pitch Angle	4	FL	radian	Pitch Euler Angle
Yaw Angle	4	FL	radian	Yaw Euler Angle
Roll Rate	4	FL	radian/sec	Inertial Angular Velocity Component on Body Roll Axis
Pitch Rate	4	FL	radian/sec	Inertial Angular Velocity Component on Body Pitch Axis
Yaw Rate	4	FL	radian/sec	Inertial Angular Velocity Component on Body Yaw Axis

5.5.4 Accuracy

The accuracy requirement is 0.0002 radians per axis (3 sigma).

5.5.5 Delivery Schedule

This product is delivered approximately every 2 hours.

5.5.6 Timespan

The timespan is approximately 2 hours. Step size is 0.512 sec.

5.5.7 Transmission Medium

The product is delivered via SFTP.

5.5.8 Volume Estimate

The volume estimate is 550 Kbytes.

Section 6. FDS to CRMS Products

6.1 Product Summary Chart

The following table summarizes the flight dynamics products transferred between FDS and CRMS:

Table 6-1. Summary of Product Transfer between FDS and CRMS

Product (with naming convention) *	**ICD Section**	**Contents**	**From/To**	**Size**	**Mission Phase**
Force Model Data AM1_SCDATA_DOY_YYYY_VV.report	6.1	Spacecraft mass, Drag area, SRP area, Coefficient of Reflectivity (Cr), Coefficient of drag (Cd)	FDS/CRMS	1 KB	Entire Mission
Predicted Maneuver Reports Information AM1_PREDMAN_DOY_YYYY_VV.report	6.2	Maneuver Type (DMU or INC), Maneuver centroid time, Maneuver RIC vector	FDS/CRMS	1 KB	Entire Mission
Historical Maneuver Performance Data AM1_MANPERFDATA_DOY_YYYY_VV.report	6.3	Maneuver Name (DMU## or INC##), Maneuver date/time, Delta v predicted, Delta v actual, Delta v units, Percent hot/cold.	FDS/CRMS	1 KB	Entire Mission
Maneuver Constraint Information AM1_DELBUF1_DOY_YYYY_VV.report	6.4	Delta v buffer to center, SMA buffer to center, Delta v buffer to const lim, SMA buffer to const lim, Delta v buffer to sci req, SMA buffer to sci req	FDS/CRMS	1 KB	Entire Mission
Terra NOMINAL Predicted Ephemeris and Covariance Data Terra_YYYYDOY_HHMMSS_ PREDEPHEM__MJ2K_ NOMINAL.S00	6.7	Ephemeris data, Covariance data (contains planned maneuvers)	FDS/CRMS	2.5 M	Entire Mission
Terra NO-BURN	6.8	Ephemeris data,	FDS/CRM	2.5	Entire

Product (with naming convention) *	**ICD Section**	**Contents**	**From/To**	**Size**	**Mission Phase**
Predicted Ephemeris and Covariance Data Terra_YYYYDOY_HHMMSS_ PREDEPHEM__MJ2K_ NOBURN.S00		Covariance data (has no planned maneuvers)	S	M	Mission
Earth Orientation Parameters (EOP) UT1UTC.dat.YYYYDOY_HHMMSS	6.5	Earth Orientation, Polar Motion components, timing correction	FDS/CRMS	2 KB	Entire Mission
EOP UTCTAI.dat.YYYYDOY_HHMMSS	6.6	Leap second correction	FDS/CRMS	1 KB	Entire Mission
Orbit Parameter Message (OPM) Maneuver Data Terra_OPM_YYYY-MM-DD_HHMMSS.opm	8.1	Epoch of ignition, Maneuver duration, Reference frame, 1st, 2nd, and 3rd component of the velocity increment	CRMS/FDS	3 KB	Entire Mission

*See "File Naming Convention" (Appendix C) for greater detail

6.2 Force Model Data

Description

FD will provide CRMS with a spacecraft data file containing the spacecraft mass, drag area, SRP area, Cr, Cd, and Cd variance.

Format:

Header Record

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite ID of the Terra spacecraft (“AM1”).
File type	14	This field indicates the type of file. The only valid value is “SCDATA”.
Ephemeris start epoch (UTC)	16	Ephemeris start epoch time, YYYYDDD.HHMMSS
Ephemeris end epoch (UTC)	16	Ephemeris end epoch time, YYYYDDD.HHMMSS

Data Records

Field Name	Maximum Field Width	Description
Spacecraft mass	18	Spacecraft mass (kg). Format is XXXXXX.XXXX
Spacecraft Drag area	8	Spacecraft Drag area (m^2). Format is XX.XX
Spacecraft Solar Radiation Pressure (SRP) area	8	Spacecraft SRP area (m^2). Format is XX.XX
Spacecraft Coefficient of	6	Coefficient of reflectivity. Format is X.XX

reflectivity (Cr)		
Spacecraft Coefficient of drag (Cd)	6	Coefficient of drag. Format is X.XX
Spacecraft Cd variance	10	Coefficient of drag variance. Format is X.XXXXXX

Sample Header Record

AM1 SCDATA 2015175.000000 2015182.000000\n

Sample Data Records

296800.0000 kg\n
40.95 m^2\n
40.95 m^2\n
1.40\n
1.92\n
0.000747\n

Delivery

This product will be delivered during all phases of the mission.

Accuracy

The accuracy of this product is the best available.

End Users

This product is needed by Terra, FOT and spacecraft engineers.

6.3 Predicted Maneuver Report Information

Description

FD will provide CRMS with a predicted maneuver report file.

Format:

Header Record

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite ID of the Terra spacecraft (“AM1”).
File type	14	This field indicates the type of file. The only valid value is “PREDMAN”.
Ephemeris start epoch (UTC)	16	Ephemeris start epoch time, YYYYDDD.HHMMSS.
Ephemeris end epoch (UTC)	16	Ephemeris end epoch time, YYYYDDD.HHMMSS

Data Records

Field Name	Maximum Field Width	Description
Type of maneuver	6	Maneuver type (DMU or INC)
Maneuver_centroid_ date_ time (UTC)	26	Maneuver centroid date time. Format is MMM DD YYYY HH:MM:SS.SSS
Delta_v_radial	8	Format is XX.XX
Delta_v_intrack	8	Format is XX.XX
Delta_v_crosstrack	8	Format is XX.XX
Delta_v_units	6	Delta v units (cm/s). Format is xx/x

Sample Header Record

AM1 PREDMAN 2015175.000000 2015182.000000\n

Sample Data Records

DMU Jan 07 2015 15:20:35.000 4.00 0.25 0.18 (cm/s)\n

Delivery

This product will be delivered during all phases of the mission.

Accuracy

The accuracy of this product is the best available.

End Users

This product is needed by Terra, FOT and spacecraft engineers.

6.4 Historical Maneuver Performance Data

Description

FDS will provide CRMS with a historical maneuver performance data file.

Format:

Header Record

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite ID of the Terra spacecraft (“AM1”).
File type	14	This field indicates the type of file. The only valid value is “MANPERFDATA”.
Ephemeris start time (UTC)	16	Ephemeris start epoch time, YYYYDDD.HHMMSS.
Ephemeris end time (UTC)	16	Ephemeris end epoch time, YYYYDDD.HHMMSS

Data Records

Field Name	Maximum Field Width	Description
Maneuver name	10	Maneuver name (DMU## or INC##). Format is either DMU#X, DMU#XX, DMU#XXX or INC#X, INC#XX, INC#XXX
Maneuver_date_time (UTC)	26	Maneuver date/time. Format is MMM DD YYYY HH:MM:SS.SSS
Delta_v_predicted	8	Format is XX.XX
Delta_v_actual	8	Format is XX.XX
Delta_v_units	6	Delta v units (cm/s). Format is (xx/x)
Percent_hot_cold	8	Format is XX.XX%

Sample Header Record

AM1 MANPERFDATA 2015175.000000 2015182.000000\n

Sample Data Records

DMU#1 Jul 11 2002 15:08:00.000 13.52 14.37 (cm/s) 6.29%\n
DMU#2 Aug 22 2002 15:32:00.000 23.03 20.85 (cm/s) -9.47%\n
.
.
DMU#102 Oct 15 2015 15:01:41.501 4.53 5.64 (cm/s) 24.50%\n

Delivery

This product will be delivered during all phases of the mission.

Accuracy

The accuracy of this product is the best available.

End Users

This product is needed by Terra, FOT and spacecraft engineers.

6.5 Maneuver Constraint Information

Description

FDS will provide CRMS with the maneuver constraint information.

Format:

Header Record

Field Name	Maximum Field Width	Description
Satellite ID	8	The satellite ID of the Terra spacecraft (“AM1”).
File type	14	This field indicates the type of file. The only valid value is “DELTAVBUF”.
Generation_Epoch (UTC)	16	Generation epoch time, YYYYDDD.HHMMSS
Buffer_Epoch (UTC)	16	Buffer epoch time, YYYYDDD.HHMMSS

Data Records

Field Name*	Maximum Field Width	Description
Delta_V_Buffer_to_Center	6	Delta V units (cm/s). Format is X.XX
SMA_Buffer_to Center	8	SMA units (m). Format is XX.XX
Delta_V_Buffer_to_Const_Lim	6	Delta V units (cm/s). Format is X.XX
SMA_Buffer_to_Const_Lim	8	SMA units (m). Format is XX.XX
Delta_V_Buffer_to_Sci_Req	6	Delta v units (cm/s). Format is X.XX
SMA_Buffer_to_Sci_Req	8	SMA units (m). Format is XXX.XX

*Any entry with 0.0 means a delta-v buffer cannot be calculated because the mission is already predicted to turn around below that limit or the mission is already below that limit,

Sample Header Record

AM1 DELTAVBUF 2015175.144343 2015176.120000\n

Sample Data Records

```
0.00  (cm/s)        0.00    (m) \n
3.96  (cm/s)        77.63   (m) \n
5.87  (cm/s)        112.46  (m) \n
```

Delivery

This product will be delivered during all phases of the mission.

Accuracy

The accuracy of this product is the best available.

End Users

This product is needed by Terra, FOT and spacecraft engineers.

6.6 EOP (Earth Orientation Parameters) Data

FDS will provide CRMS with the predicted earth orientation data, including polar drift corrections and timing corrections.

Format:

Header Record

This file has no header record.

Data Records

Field Name	Maximum Field Width	Description
UTC Julian (GSFC) Date *	10	Format is XXXXX.X
Definitive (I) or Predicted (P)	2	The only valid value is either "I" or "P"
Polar Drift Correction Angle-x (arcsec)	4	Format is X
Polar Drift Correction Angle-y (arcsec)	4	Format is X
UT1-UTC Correction Time (sec)	10	Format is X.XXXXXX

*Modified Julian Date (MJD) used by GSFC which uses a reference epoch of 05 Jan 1941 12:00:00.000

Sample Header Record

N/A

Sample Data Records

27246.5 P 0 0 0.291602\n
27247.5 P 0 0 0.291158\n
.
.
27426.5 P 0 0 0.112215\n

Delivery

This product will be delivered during all phases of the mission.

Accuracy

The accuracy of this product is the best available.

End Users

This product is needed by Terra, FOT and spacecraft engineers.

6.7 Leap Second Correction Data

Description

FDS will provide CRMS with the definitive and predicted dates of leap second corrections between UTC and TAI (International Atomic Time).

Format:

Header Record

This file has no header record

Data Records

Field Name	Maximum Field Width	Description
UTC Julian (GSFC) Date *	10	Format is XXXXX.X
Leap Second Gregorian Calendar Date	20	Format is MMMMMMM D, YYYY

*Modified Julian Date (MJD) used by GSFC which uses a reference epoch of 05 Jan 1941 12:00:00.000

Sample Header Record

N/A

Sample Data Records

```
11317.5        // January 1, 1972\n
11499.5        // July    1, 1972\n
.
.
27204.5        // July    1, 2015\n
```

Delivery

This product will be delivered during all phases of the mission.

Accuracy

The accuracy of this product is the best available.

End Users

This product is needed by Terra, FOT and spacecraft engineers.

6.8 Terra Nominal Predicted Ephemeris and Covariance Data

Description

FDS will provide CRMS with predicted ephemeris and covariance data, including any planned maneuvers.

Format:

For the header format and data format description tables, see "Orbit Ephemeris Messages (OEM)", CCSDS 502.0-B-2 Orbit Data Messages, Blue Book, Section 5, pages 5-3 to 5-6, November 2009.

Sample Header Record

CCSDS_OEM_VERS = 2.0
CREATION_DATE = 2015-12-16T20:06:56.273
ORIGINATOR = EOS FDS

Sample Data Record

META_START
OBJECT_NAME = scCovariance
OBJECT_ID = 1
CENTER_NAME = Earth
REF_FRAME = EME2000
TIME_SYSTEM = UTC
START_TIME = 2015-12-17T00:00:00.000
STOP_TIME = 2015-12-24T00:00:00.000
INTERPOLATION = 5th Order Spline
INTERPOLATION_DEGREE = 5
META_STOP
2015-12-17T00:00:00.000 -2376.61450637796 6644.13717996525
619.918654722152 0.780449804823426 0.979613292185362
-7.39776449999317\n

2015-12-17T00:01:00.000 -2325.01738214366 6689.45095270888
175.096869001844 0.938869823350350 0.530351653912444
-7.42461995275086\n
.
.

EPOCH = 2015-12-24T00:00:00.000\n
COV_REF_FRAME = EME2000\n
0.259722106459751\n
-1.37657979743889 7.30540794788494\n
2.57432692732117 -13.6615631734177 25.5498368694212
-0.00138269454225695 0.00733746777180691 -0.0137221919049384
7.37012766282903e-006\n

0.00238651490652007 -0.0126644784773836 0.0236842186145920
-1.27204726400668e-005 2.19555327079128e-005\n

0.00142648276256995 -0.00757067226431696 0.0141591122595521
-7.60448536511309e-006 1.31251497637170e-005 7.84689595384931e-006\n
COVARIANCE_STOP

Delivery

This product will be delivered daily during all phases of the mission.

Accuracy

The accuracy of this product is the best available.

End Users

This product is needed by Terra, FOT and spacecraft engineers.

6.9 Terra No-Burn Predicted Ephemeris and Covariance Data

Description

FDS will provide CRMS with predicted ephemeris and covariance data, not including any planned maneuvers.

Format:

For the header format and data format description tables, see "Orbit Ephemeris Messages (OEM)", CCSDS 502.0-B-2 Orbit Data Messages, Blue Book, Section 5, pages 5-3 to 5-6, November 2009.

Sample Header Record

CCSDS_OEM_VERS = 2.0
CREATION_DATE = 2015-12-16T20:06:56.881
ORIGINATOR = EOS FDS

Sample Data Record

META_START
OBJECT_NAME = scCovarianceNoBurn
OBJECT_ID = 1
CENTER_NAME = Earth
REF_FRAME = EME2000
TIME_SYSTEM = UTC
START_TIME = 2015-12-17T00:00:00.000
STOP_TIME = 2015-12-24T00:00:00.000
INTERPOLATION = 5th Order Spline
INTERPOLATION_DEGREE = 5
META_STOP
2015-12-17T00:00:00.000 -2376.61450637796 6644.13717996525
619.918654722152 0.780449804823426 0.979613292185362
-7.39776449999317\n

2015-12-17T00:01:00.000 -2325.01738214366 6689.45095270888
175.096869001844 0.938869823350350 0.530351653912444
-7.42461995275086
.
.
EPOCH = 2015-12-24T00:00:00.000\n

COV_REF_FRAME = EME2000\n
0.192463074315810\n
-1.03281150461315 5.55169957163835\n
1.94656409946147 -10.4630323483478 19.7208178448504\n

-0.00104534679517772 0.00561865331842272 -0.0105898580284254 5.68687267912876e-006\n

0.00180775901160192 -0.00971667294934742 0.0183133862708586 -9.83427187624265e-006 1.70069743253801e-005\n

0.00106684010256936 -0.00573494715555748 0.0108097197015625 -5.80467718163789e-006 1.00381830477127e-005 5.92546495246884e-006\n

COVARIANCE_STOP

Delivery

This product will be delivered daily during all phases of the mission.

Accuracy

The accuracy of this product is the best available.

6.10 Terra Risk Mitigation Maneuver Predicted Ephemeris and Covariance Data

Description

FDS will provide CRMS with predicted ephemeris and covariance data, including maneuver options planned by the FDS system based on CRMS provided OPMs.

Format:

For the header format and data format description tables, see "Orbit Ephemeris Messages (OEM)", CCSDS 502.0-B-2 Orbit Data Messages, Blue Book, Section 5, pages 5-3 to 5-6, November 2009.

Sample Header Record

CCSDS_OEM_VERS = 2.0
CREATION_DATE = 2019-12-04T12:12:35.332
ORIGINATOR = EOS FDS

Sample Data Record

META_START
OBJECT_NAME = Terra
OBJECT_ID = 1122334
CENTER_NAME = Earth
REF_FRAME = EME2000
TIME_SYSTEM = UTC
START_TIME = 2019-12-04T08:33:00.000
STOP_TIME = 2019-12-12T00:00:00.000
INTERPOLATION = 5th Order Spline
INTERPOLATION_DEGREE = 5
META_STOP
2019-12-04T08:33:00.000 -4194.50680918294 -5422.50345918309 1775.27067080720 -2.02847981155596 -0.794981395297040 -7.18141520627016
2019-12-04T08:34:00.000 -4307.65481198873 -5459.20896814403 1341.07901303720 -1.74185266716252 -0.428127831704021 -7.28674786640542.
.

.
.
COVARIANCE_START
EPOCH = 2019-12-04T08:33:00.000
COV_REF_FRAME = EME2000
1.21720483201368e-006
-5.69422195721098e-007 1.13500003136095e-006
6.36915038889281e-007 1.38628407469323e-006 6.88580718553158e-006
-3.33308822829560e-010 -8.99006260212736e-010 -3.80479479370656e-009 3.76011458403167e-012
-6.10341080123280e-010 -8.62126050606790e-010 -4.65703588838161e-009 1.36946768193533e-012 4.30516489073163e-012
1.85929402014961e-011 1.34589236066272e-010 1.85625151717768e-009
-1.25897185945686e-012 -9.83903255293346e-013 8.37408048310196e-013
EPOCH = 2019-12-04T08:34:00.000
COV_REF_FRAME = EME2000
1.18691937081963e-006
-6.51205920589348e-007 1.04455178609107e-006
4.01993964206417e-007 1.10488705936335e-006 7.08391195257924e-006
-1.69882378391069e-010 -7.49095713507465e-010 -3.94226131404587e-009 3.83699704120681e-012
-4.62784967445454e-010 -6.42192938542484e-010 -4.83494567807942e-009 1.47514900838212e-012 4.47320918477373e-012
-9.17838707134696e-011 -9.62080131772378e-012 1.44046381714475e-009 -1.04469489534383e-012 -7.24777853236580e-013
6.46286833678454e-013
.
.
.
COVARIANCE_STOP

Delivery

This product will be delivered during all phases of the mission, whenever an OPM is received that includes valid maneuver options. .

Accuracy

The accuracy of this product is the best available.

Section 7. FDS to FOT Reports

7.1 Product Summary Chart

Table 7-1 summarizes all reports that are provided directly to the FOT by the FDS. These reports are not utilized in any way by EMOS software and EMOS software will have no knowledge of their locations. The following sections give more detail about each product.

Table 7-1. Summary of FDS to FOT Reports

Product Name	ICD Sec	Purpose	Delivery Schedule	Timespan	Medium (Prime/Bkup)	DMR No.
Sensor Calibration Trend Reports	7.1	Reports for FOT	Monthly	Cumulative for mission lifetime	SFTP/FAX	7120-1, 7120-2, 7120-9
Onboard Navigation Evaluation	7.2	Report for FOT	(See Sec 7.2.5)	N/A	SFTP/FAX	7210-1, 7210-2, 7210-3, 7210-4
EOS Terra Post Maneuver Report	7.3	Report for FOT	After each orbit maneuver	N/A	SFTP/FAX	7210-22
SCC Attitude Validation Report	7.4	Report for FOT	(See Sec 7.4.5)	N/A	SFTP/FAX	7140-1
EOS Terra Pre-Maneuver Report	7.5	Report for FOT	24 hours and 48 hours before maneuver	N/A	SFTP/FAX	7220-2
Solar Eclipse Shadow Prediction Report	7.6	Report for FOT	Weekly	Eclipse duration	SFTP/Tape	TBS
Star Catalog Update Report	7.7	Report for FOT	As needed	N/A	e-mail/FAX	7140-2
Deleted	7.8	N/A	N/A	N/A	N/A	N/A
Moved to	7.9	N/A	N/A	N/A	N/A	N/A

Section 3.3						
Deleted	7.10	N/A	N/A	N/A	N/A	N/A
Daily Report	7.11	Report for FOT	Daily	N/A	SFTP/FAX	N/A (FOT Request)
Low Elevation Angle Contacts Report	7.12	Report for FOT	Daily Weekly	7 or 49 days	SFTP/FAX	N/A (FOT Request)
Solar RFI Report	7.13	Report for FOT	Weekly	49 days	SFTP/FAX	N/A (FOT Request)

7.2 Sensor Calibration Trend Reports

7.2.1 Description

The FDS provides the EOC with reports of the trend analysis done for the Solid State Star Trackers (SSST), the Fine Sun Sensor (FSS), and the Inertial Reference Units (IRU).

These trend analysis reports will include:

a. SSSTs - alignment, star magnitude sensitivity, and scale factors
b. IRUs - alignment and scale factors
c. FSS - alignment and field-of-view (FOV) parameters

This information is generated during the routine calibration activities provided by the FDS. These reports consist of plots of calibration data over the timespan mentioned above. These reports also consist of a summary of calibration activities and the results, as well as any observations about the current trend.

7.2.2 Mission Phase

These reports are generated during the Checkout and Operational mission phase.

7.2.3 Format

Sample reports are given below. Individual field descriptions are as follows:

a. All time fields are in the format YYYYDDD.HHMMSS
b. All quaternion components (q1, q2, q3, q4) are dimensionless and represent the alignment from the spacecraft frame to the sensor frame
c. All scale factors are dimensionless
d. SSST sensitivity is in terms of instrumental magnitude
e. FSS field-of-view coefficients # 1, 3, and 6 are dimensionless
f. FSS field-of-view coefficients # 5, 8, and 9 are in radians
g. FSS field-of-view coefficients # 4 and 7 are in radian/count
h. FSS field-of-view coefficient # 2 is in count $^{-1}$

SSST-1 Calibration Trend Report

TIME	q1	q2	q3	q4	Sensitivity	h scale factor	v scale factor
1998181.000001	0.365241	-0.509084	0.496547	0.60072753	0.0245	1.034	1.031
1998212.000001	0.362451	-0.507703	0.496887	0.60329947	0.0459	1.023	0.998
1999243.000001	0.365278	-0.509081	0.496543	0.60071088	0.0234	1.112	1.021
1998273.000001	0.365236	-0.509032	0.496594	0.60073579	0.0255	1.031	1.124
1998303.000001	0.365245	-0.509082	0.496543	0.6007301	0.0198	0.998	1.014
1998334.000001	0.365294	-0.50908	0.496545	0.60070035	0.0334	1.021	0.997
1998365.000001	0.365259	-0.509032	0.496542	0.60076479	0.0258	1.124	1.112
1999030.000001	0.365204	-0.509085	0.496534	0.60075993	0.0243	1.014	1.021
1999058.000001	0.365223	-0.509081	0.496542	0.60074515	0.0223	1.055	1.024

IRU-1 Calibration Trend Report

TIME	q1	q2	q3	q4	X scale factor	Y scale factor	Z scale factor
1998181.000001	0.496543	0.6007301	0.365245	-0.509082	1.034	1.031	1.021
1998212.000001	0.496545	0.6007003	0.365294	-0.50908	1.023	0.998	1.124
1999243.000001	0.496542	0.6007648	0.365259	-0.509032	1.112	1.021	1.014
1998273.000001	0.496534	0.6007599	0.365204	-0.509085	1.031	1.124	1.055
1998303.000001	0.496542	0.6007452	0.365223	-0.509081	0.998	1.014	1.031
1998334.000001	0.496547	0.6007275	0.365241	-0.509084	1.021	0.997	0.998
1998365.000001	0.496887	0.6032995	0.362451	-0.507703	1.124	1.112	1.021
1999030.000001	0.496543	0.6007109	0.365278	-0.509081	1.014	1.021	1.124
1999058.000001	0.496594	0.6007358	0.365236	-0.509032	1.122	1.024	1.014

FSS Calibration Trend Report

Quaternion

TIME	q1	q2	q3	q4
1998181.000001	-0.509032	0.6007358	0.496594	0.365236
1998212.000001	-0.509082	0.6007301	0.496543	0.365245
1999243.000001	-0.50908	0.6007003	0.496545	0.365294
1998273.000001	-0.509032	0.6007648	0.496542	0.365259
1998303.000001	-0.509085	0.6007599	0.496534	0.365204
1998334.000001	-0.509081	0.6007452	0.496542	0.365223
1998365.000001	-0.509084	0.6007275	0.496547	0.365241
1999030.000001	-0.507703	0.6032995	0.496887	0.362451
1999058.000001	-0.509081	0.6007109	0.496543	0.365278

FSS Alpha-Angle FOV Parameters

TIME	A1	A2	A3	A4	A5	A6	A7	A8	A9
1998181.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1998212.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1999243.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1998273.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1998303.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1998334.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1998365.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1999030.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1999058.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

FSS Beta-Angle FOV Parameters

TIME	B1	B2	B3	B4	B5	B6	B7	B8	B9
1998181.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1998212.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1999243.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1998273.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1998303.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1998334.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1998365.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1999030.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
1999058.000001	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

7.2.4 Accuracy

There is no accuracy requirement for any of these reports.

7.2.5 Delivery Schedule

These products were delivered to the EOC on an as-needed basis during the Checkout phase. During the Operational phase, the delivery occurs on a frequency of once per month after the initial calibration is complete and upon detection of anomalies in the attitude sensors.

7.2.6 Timespan

These trend analysis reports are comprehensive reports that augment the previous reports with the current data, which starts when the first calibration is completed and covers to the current report date.

7.2.7 Transmission Medium

7.2.7.1 Prime Medium

The reports are delivered to the EOC via SFTP.

7.2.7.2 Backup Medium

The reports are faxed or hand delivered to the EOC areas if necessary.

7.2.8 Volume Estimate

The volume estimate for each of these reports is 25 Kbytes.

7.3 Onboard Navigation Evaluation/Quality Assurance

7.3.1 Description

The FDS maintains the TGSS that has the capability of emulating the onboard navigation system to evaluate its performance. This emulator is also used to perform diagnostics and to test proposed modifications. A report is generated from this emulator for delivery to the EOC. The EOS Terra onboard navigation requirement is 150 meters and velocities 0.160 m/sec (both per axis, 3 sigma). These are the criteria used in evaluating the onboard system and when testing modifications to the system.

7.3.2 Mission Phase

The emulator is used during all phases of the mission. Reports are issued during all mission phases, following TONS initialization, which is when TONS output is commanded.

7.3.3 Format

The format of this report is an EXCEL spreadsheet as shown in the sample report given below.

TONS Performance Evaluation / Quality Assurance Report

Report Created: 4/25/97 9:05:37 EST Version: 1

Data Time Span: Start: 7/15/96 0:00:00 EST Stop: 7/21/96 11:59:59 EST

Onboard FCW from: [ ] Orbit Elements [ ] TONS

Onboard FCW vs. Observed Doppler: Max: 23 Hz RMS: 14 Hz

Ephem Comparison (all units in meters or meters/second)

TONS Comparison to: [ ] Independent Ephem [ ] TONS-Propagated Ephem

Maximum Differences by Component:

	X	Y	Z	R	I	C
Position	5	3	1	1	7	3
Velocity	0.007	0.01	0.001	0.001	0.009	0.004

Detailed Statistics:

	MAX D	MEAN D	1-s	RMS
Crosstrack Velocity	0.004	0.0005	0.001	na
RSS Position	15	0	3	3
RSS Velocity	0.01	0	0.0008	0.0014

Daily Statistics:		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Drag Coefficient (C_D):	Max	2.1	2.22	2.1	2	2.2	2.3	2.2
	RMS	2	2	2.1	2	2	2.1	2.2
TDRS Bias		0	0	0	0	0	0	0
Frequency Bias (S-Hz)		-116	-115.93	-115.87	-115.84	-115.82	-115.78	-115.76

Measurement Statistics (Residuals):

			Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Edit	T1	Max (Hz)	0.06	0.06	0.06	0.06	0.06	0.06	0.06
		Mean (Hz)	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
		Sigma (Hz)	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038
		% Edited	1	1	1	1	1	1	1
	T2	Max (Hz)	0.06	0.06	0.06	0.06	0.06	0.06	0.06
		Mean (Hz)	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
		Sigma (Hz)	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038
		% Edited	1	1	1	1	1	1	1
	T3	Max (Hz)	na	na	na	na	na	na	na
		Mean (Hz)	na	na	na	na	na	na	na
		Sigma (Hz)	na	na	na	na	na	na	na
		% Edited	na	na	na	na	na	na	na
	T4	Max (Hz)	na	na	na	na	na	na	na
		Mean (Hz)	na	na	na	na	na	na	na
		Sigma (Hz)	na	na	na	na	na	na	na
		% Edited	na	na	na	na	na	na	na
Unedit	T1	Max (Hz)	0.6	0.6	0.6	0.6	0.6	0.6	0.6
		Mean (Hz)	0.04	0.04	0.04	0.04	0.04	0.04	0.04
		Sigma (Hz)	0.38	0.38	0.38	0.38	0.38	0.38	0.38
	T2	Max (Hz)	0.6	0.6	0.6	0.6	0.6	0.6	0.6
		Mean (Hz)	0.04	0.04	0.04	0.04	0.04	0.04	0.04
		Sigma (Hz)	0.38	0.38	0.38	0.38	0.38	0.38	0.38
	T3	Max (Hz)	na	na	na	na	na	na	na
		Mean (Hz)	na	na	na	na	na	na	na
		Sigma (Hz)	na	na	na	na	na	na	na

	T4	Max (Hz)	na	na	na	na	na	na	na
		Mean (Hz)	na	na	na	na	na	na	na
		Sigma (Hz)	na	na	na	na	na	na	na

MAXimum VDNA for the period: 0.0034 Hz

7.3.4 Accuracy

There is no accuracy requirement for this report.

7.3.5 Delivery Schedule

The report is generated as follows:

a. After first 2 orbits and then two times per day from TONS initialization (TI) to
   TI + 2 days
b. Once per day from TI + 2 days to TI + 7 days
c. Once per week from TI + 7 days to deactivation

7.3.6 Timespan

There is no timespan associated with this product.

7.3.7 Transmission Medium

7.3.7.1 Prime Medium

The product is a one page summary of navigation performance and is transferred to the FOT via SFTP.

7.3.8 Volume Estimate

There is no volume estimate for this product.

7.4 EOS Terra Post Maneuver Report

7.4.1 Description

After each EOS Terra orbit maneuver, the FDS will provide the EOC with a report containing the post maneuver status of the spacecraft.

7.4.2 Mission Phase

This product is delivered during the Launch/Acquisition, Checkout and Operational phases.

7.4.3 Format

The format of this report is an EXCEL spreadsheet as shown in the sample report given below.

The file will contain the following information:

a. Post maneuver actual state vector
b. Post maneuver predicted state vector
c. Thrust scale factor
d. Fuel remaining estimate

A sample report is given below.

EOS AM-1 Postmaneuver Report

Maneuver Type:	Groundtrack
Thruster Set Used:	Odd

	Planned	Observed	Delta (O-P)
Maneuver Date	19981022	19981022	
Maneuver Start (GMT)	11:10:31.604	11:10:31.604	0
Maneuver End (GMT)	11:10:50.327	11:10:50.303	-0.024
Duration (seconds)	18.723	18.699	-0.024

	Predicted Spacecraft State			Reconstructed Spacecraft State			Calibrated State	
Key Parameters	**Premaneuver Orbit**	**Postmaneuver Orbit**	**Change in Parameter**	**Premaneuver Orbit**	**Postmaneuver Orbit**	**Change in Parameter**	**Postmaneuver Orbit**	**Change in Parameter**
Osculating Elements (MJ2000):								
Epoch	11:10:31.604	11:10:50.327		11:10:31.604	11:10:50.303		11:10:50.303	
SMA (km)	7086.759930	7087.260230		7086.759930	7087.259610		7087.260230	
ECC	0.001324	0.001328		0.001324	0.001328		0.001328	
INC (deg)	98.303172	98.303143		98.303172	98.303143		98.303143	
RAAN (deg)	5.929990	5.929990		5.929990	5.929990		5.929990	
AOP (deg)	108.411380	111.659820		108.411380	111.655820		111.659820	
MA (deg)	67.453490	65.343220		67.453490	65.345790		65.343220	
Brouwer Mean Elements:								
Epoch	11:10:31.604	11:10:50.327		11:10:31.604	11:10:50.303		11:10:50.303	
SMA (km)	7077.708460	7078.165320	0.45686	7077.708460	7078.164750	0.45629	7078.165320	0.456860
ECC	0.001165	0.001169	4.1E-06	0.001165	0.001169	4.1E-06	0.001169	0.000004
INC (deg)	98.308521	98.308517	-4E-06	98.308521	98.308517	-4E-06	98.308517	-0.000004
RAAN (deg)	5.929190	5.929410		5.929190	5.929410		5.929410	
AOP (deg)	88.812200	91.970310		88.812200	91.966380		91.970310	
MA (deg)	87.060420	85.038320		87.060420	85.040830		85.038320	
Delta-V:								
Total Delta-V (m/sec)		0.300000			0.290000		0.280000	
Propulsion System State:								
Tank Pressure (PSIA)	360.000000	354.000000	-6	360.000000	354.000000	-6	354.000000	-6.000000
Tank Temp (deg C)	21.000000			21.000000			21.000000	
Fuel Mass(kg)	252.0000	248.0000	-4.0000	252.000000	248.500000	-3.500000	248.600000	-3.400000
S/C Mass (kg)	4444.00	4440.00	-4.0000	4444.000000	4440.500000	-3.500000	4440.600000	-3.400000
Mnvr Modeling Parameters:								
Thrust Scale Factor	1.000000			1.000000			1.000000	
DutyCycles 5lb #1	1.000000			1.000000			1.000000	
5lb #2	1.000000			1.000000			1.000000	
1lb #1	0.050000			0.040000			0.040000	
1lb #2	0.050000			0.040000			0.040000	
1lb #3	0.050000			0.040000			0.040000	
1lb #4	0.050000			0.040000			0.040000	
1lb #5	0.050000			0.040000			0.040000	
1lb #6	0.050000			0.040000			0.040000	
Attitude Parameters:								
X Rate Bias (deg)	0.000000	0.000000		0.000000	0.000000		0.000000	
Y Rate Bias (deg)	0.000000	0.000000		0.000000	0.000000		0.000000	
Z Rate Bias (deg)	0.000000	0.000000		0.000000	0.000000		0.000000	
Roll (deg)	0.000000	0.000000		0.000000	0.000000		0.000000	
Pitch (deg)	0.000000	0.000000		0.000000	0.000000		0.000000	
Yaw (deg)	0.000000	0.000000		0.000000	0.000000		0.000000	
Slew Angle (deg)	0.000000	0.000000		0.000000	0.000000		0.000000	
Slew Rate (deg)	0.000000	0.000000		0.000000	0.000000		0.000000	

Calibration Results:

Thrust Scale Factor (TSF) Planned: 1 Solved For: 0.98 Percent Error: -2

Comments:

This is only a sample

7.4.4 Accuracy

The accuracy associated with this product is best effort.

7.4.5 Delivery Schedule

This product is delivered after each EOS Terra orbit maneuver.

7.4.6 Timespan

There is no timespan associated with this product.

7.4.7 Transmission Medium

7.4.7.1 Prime Medium

This product is transferred to the FOT via SFTP.

7.4.7.2 Backup Medium

This product is transferred to the FOT via FAX.

7.4.8 Volume Estimate

There is no volume estimate for this product.

7.5 SCC Attitude Determination Validation

7.5.1 Description

The FDS validates the SCC attitude determination process and verifies that it meets the requirements as outlined in the EOS AM-1 DMR, Section 7140-1.

7.5.2 Mission Phase

This product is delivered during the Launch/Acquisition, Checkout and Operational phases.

7.5.3 Format

The product is a report of the validation process. The report contains SCC-determined attitude, ground-determined attitude, and attitude residuals (i.e., difference between the preceding two). A sample report is given below.

OBC Fine Attitude RPY Residuals Table

Time (YYYYDDD.HHMMSSmmm)	OBC Attitude (arc-sec)			Ground Attitude (arc-sec)			Attitude Residuals (arc-sec)		
	Roll	Pitch	Yaw	Roll	Pitch	Yaw	Roll	Pitch	Yaw
1997302.000000000	25.00	-15.00	20.00	15.00	-20.00	25.00	10.00	5.00	-5.00
1997302.000100002	25.10	-15.20	19.90	15.20	-19.90	25.10	9.90	4.70	-5.20
1997302.000200000	25.20	-15.40	19.80	15.40	-19.80	25.20	9.80	4.40	-5.40
1997302.000300001	25.30	-15.60	19.70	15.60	-19.70	25.30	9.70	4.10	-5.60
1997302.000399999	25.40	-15.80	19.60	15.80	-19.60	25.40	9.60	3.80	-5.80
1997302.000500001	25.50	-16.00	19.50	16.00	-19.50	25.50	9.50	3.50	-6.00
1997302.000600003	25.60	-16.20	19.40	16.20	-19.40	25.60	9.40	3.20	-6.20
1997302.000700001	25.70	-16.40	19.30	16.40	-19.30	25.70	9.30	2.90	-6.40

7.5.4 Accuracy

There is no accuracy associated with this product.

7.5.5 Delivery Schedule

This product is delivered once during the checkout phase prior to the attitude sensor calibration efforts, once during the checkout phase after the attitude sensor calibration efforts are complete, and as needed thereafter.

7.5.6 Timespan

There is no timespan associated with this product.

7.5.7 Transmission Medium

7.5.7.1 Prime Medium

This product is transferred to the EOC via SFTP.

7.5.7.2 Backup Medium

This product is transferred via a FAX or hardcopy.

7.5.8 Volume Estimate

There is no volume estimate for this product.

7.6 EOS Terra Pre-Maneuver Report

7.6.1 Description

Before each EOS Terra orbit maneuver, the FDS will provide the EOC with a report containing the predicted maneuver data of the spacecraft.

7.6.2 Mission Phase

This product is delivered during the Launch/Acquisition, Checkout and Operational phases.

7.6.3 Format

The file will contain the following information:

a. Pre-maneuver maneuver predicted state vector
b. Post maneuver predicted state vector
c. Thrust scale factor
d. Fuel remaining estimate

A sample report is given below.

EOS AM-1 Orbit Maneuver Plan

[X] Preliminary Plan

[ ] Final Plan

Maneuver Date	19981022
Maneuver Start (UTC)	11:10:31.604
Maneuver End (UTC)	11:10:50.327
Duration (seconds)	18.7230
Maneuver Type	Groundtrack
Thruster Set Used	Odd

	Predicted Spacecraft State		
Key Parameters	**Premaneuver Orbit**	**Postmaneuver Orbit**	**Change in Parameter**
Osculating Elements (MJ2000):			
Epoch	11:10:31.604	11:10:50.327	
SMA (km)	7086.759930	7087.260230	
ECC	0.001324	0.001328	
INC (deg)	98.303172	98.303143	
RAAN (deg)	5.929990	5.929990	
AOP (deg)	108.411380	111.659820	
MA (deg)	67.453490	65.343220	
Brouwer Mean Elements:			
Epoch	11:10:31.604	11:10:50.327	
SMA (km)	7077.708460	7078.165320	0.45686
ECC	0.001165	0.001169	4.1E-06
INC (deg)	98.308521	98.308517	-4E-06
RAAN (deg)	5.929190	5.929410	
AOP (deg)	88.812200	91.970310	
MA (deg)	87.060420	85.038320	
Delta-V			
Total Delta-V (m/sec)		0.300000	
Mnvr Modeling Parameters:			
Thrust Scale Factor	1.000000		
Duty Cycles 5lb #1	1.000000		
5lb #2	1.000000		
1lb #1	0.050000		
1lb #2	0.050000		
1lb #3	0.050000		
1lb #4	0.050000		
1lb #5	0.050000		
1lb #6	0.050000		
Attitude Parameters:			
X Rate Bias (deg)	0.000000	0.000000	
Y Rate Bias (deg)	0.000000	0.000000	
Z Rate Bias (deg)	0.000000	0.000000	
Roll (deg)	0.000000	0.000000	
Pitch (deg)	0.000000	0.000000	
Yaw (deg)	0.000000	0.000000	
Slew Angle (deg)	0.000000	0.000000	
Slew Rate (deg)	0.000000	0.000000	
Propulsion System State:			
Tank Pressure (psi)	360.000000	354.000000	-6.000000
Tank Temp (deg C)	21.000000		
Fuel Mass(kg)	252.0000	248.0000	-4.0000
S/C Mass (kg)	10161.30	10160.19	-1.1108

Comments:

This is only a sample.

7.6.4 Accuracy

The accuracy associated with this product is best effort.

7.6.5 Delivery Schedule

This product is delivered 24 hours and 48 hours before each EOS Terra maneuver.

7.6.6 Timespan

There is no timespan associated with this product.

7.6.7 Transmission Medium

7.6.7.1 Prime Medium

This product is transferred to the EOC via SFTP.

7.6.7.2 Backup Medium

This product is transferred to the EOC via FAX.

7.6.8 Volume Estimate

There is no volume estimate for this product.

7.7 Solar Eclipse Shadow Prediction Report

7.7.1 Description

The FDS provides the FOT with Solar Eclipse Shadow Prediction Reports which contain the times of the entrance into Moon/Sun eclipse along with the percent of shadow as seen by the Spacecraft. Also, the report contains the percent shadow at the maximum shadow time.

7.7.2 Mission Phase

This product is delivered during the Checkout and Operational phases.

7.7.3 Format

A sample report is given below.

Satellite – AM-1

Time (UTCG)	Shadow Type	Event	Condition	Duration	Percent Shadow
9 Mar 1997 00:56:26.97	Penumbra	Entrance		N/A	0.000000
9 Mar 1997 00:57:00.00	Penumbra			N/A	1.664378
9 Mar 1997 00:57:30.00	Penumbra			N/A	4.432019
9 Mar 1997 00:58:00.00	Penumbra			N/A	7.995428
9 Mar 1997 00:58:30.00	Penumbra			N/A	12.215781
.					
.					
.					
9 Mar 1997 01:04:30.00	Penumbra			N/A	91.535116
9 Mar 1997 01:05:00.00	Penumbra		Max Shadow	N/A	94.470832
9 Mar 1997 01:06:30.00	Penumbra			N/A	91.202781
9 Mar 1997 01:06:00.00	Penumbra			N/A	84.461073
.					
.					
.					
9 Mar 1997 01:11:30.00	Penumbra			N/A	4.597523
9 Mar 1997 01:12:00.00	Penumbra			N/A	1.048784
9 Mar 1997 01:12:17.63	Penumbra	Exit	Duration	15.844	0.000000

7.7.4 Accuracy

There is no accuracy requirement associated with this product.

7.7.5 Delivery Schedule

This product is delivered as part of the weekly (7-week) products.

7.7.6 Timespans

This product is to span the duration of the eclipse.

7.7.7 Transmission Medium

7.7.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

7.7.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

7.7.8 Volume Estimate

For an eclipse with predicted duration of 15 minutes, the data volume is about 2800 bytes (≈ 80 bytes/line x 35 lines).

7.8 Star Catalog Update Report

7.8.1 Description

The FDS will provide the EOC with a report when a new mission star catalog is produced for upload to the spacecraft. This report will include the following information:

a. The number of stars in the new catalog
b. A description of why a new mission catalog is required
c. The major differences between the new and existing catalogs
d. The criteria used to generate the new catalog, including:
    1. instrumental magnitude range
    2. variable amplitude magnitude
    3. position knowledge error
    4. predicted magnitude knowledge error
    5. proper motion
    6. multiple star selection
    7. near-neighbor selection

7.8.2 Mission Phase

The report is generated during the prelaunch, checkout, and operational phases.

7.8.3 Format

The format for each of these reports is in a Microsoft Word (or similar) document format. A sample report is given below.

EOS Terra Star Catalog Update Report

April 25, 1997

The Flight Dynamics Analysis Branch created the mission star catalog for EOS Terra.

The star catalog contains a total of 700 valid stars.

This star catalog was created to allow testing of the EOS Terra flight software by Lockheed-Martin during the prelaunch phase. The star catalog is used onboard the Terra spacecraft during all mission phases.

The following selection criteria was used:

a. the instrumental magnitude range is limited to be 2.0 through 5.7
b. the variable amplitude range is < 0.1 magnitude
c. for a component of a multiple star, the nearest star is not less than 5 magnitudes fainter, or is less than 5 arcseconds away
d. the position knowledge error is < 0.25 arcseconds
e. the predicted magnitude knowledge error is < 0.25 magnitudes
f. a near neighbor star within 0.2 degrees must be fainter by at least 5 magnitudes
g. a near neighbor star within 0.6 degrees must have a magnitude difference of at least 0.75 magnitudes
h. the total proper motion is 0.7 arcseconds/year

7.8.4 Accuracy

There is no accuracy requirement for this report.

7.8.5 Delivery Schedule

This report is delivered to the EOC on an as-needed basis. The delivery will coincide with the delivery the “EOS Terra Mission Star Catalog” product described in Section 3.5.

7.8.6 Timespan

There is no timespan associated with this report. The report is considered valid until a successive report is delivered.

7.8.7 Transmission Medium

7.8.7.1 Prime Medium

The report is delivered to the EOC via electronic mail.

7.8.7.2 Backup Medium

The reports is faxed to the EOC areas if necessary.

7.8.8 Volume Estimate

The volume estimate for each of these reports is 1 page (approximately 20 Kbytes).

7.9 (Deleted)

7.10 (Moved to Section 3.3)

7.11 (Deleted)

7.12 Daily Report

7.12.1 Description

The FDS delivers a daily report containing the maximum position and velocity differences from the TDRS tables compare for TD1, TD2, TD3, and TD4.

7.12.2 Mission Phase

This product is delivered during the Operational phases.

7.12.3 Format

Following a header that includes the spacecraft name, Terra, and the product generation date and time (YYYYDDD.HHMMSS), the product contains the position and velocity comparison data for the TD1, TD2, TD3, and TD4 TDRS on-board table slots in meters and meters per second, respectively.

Description	Format	Units
Header Line with Spacecraft name and Product generation time	Terra YYYYDOY.HHMMSS	n/a
TD1 Position Compare	xxxx.xxxxxxxxx	meters
TD1 Velocity Compare	xxxx.xxxxxxxxx	meters per second
TD2 Position Compare	xxxx.xxxxxxxxx	meters
TD2 Velocity Compare	xxxx.xxxxxxxxx	meters per second
TD3 Position Compare	xxxx.xxxxxxxxx	meters
TD3 Velocity Compare	xxxx.xxxxxxxxx	meters per second
TD4 Position Compare	xxxx.xxxxxxxxx	meters
TD4 Velocity Compare	xxxx.xxxxxxxxx	meters per second

A sample report is given below.

Terra 2020050.143245
94.732261600
0.004673741
13.219721041
0.000787813
64.628043545
0.004590868
5.850748399
0.000292679

7.12.4 Accuracy

The on-board accuracy requirement for position is 600 meters; for velocity it is 0.05 meters per second.

7.12.5 Delivery Schedule

This product is delivered daily.

7.12.6 Timespans

This product has no time span.

7.12.7 Transmission Medium

7.12.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

7.12.7.2 Backup Medium

The backup medium for this product is iron key.

7.12.8 Volume Estimate

The data volume is about 150 bytes.

7.13 Solar RFI Report

7.13.1 Description

The FDS provides the FOT with a Solar Radio Frequency Interference (RFI) Report that contains the contacts where solar RFI is expected. A 1-degree half angle is used. It provides data for the Norway sites SG1, SG2, and SG3.

7.13.2 Mission Phase

This product is delivered during the Operational phases.

7.13.3 Format

A sample report is given below.

```
Solar RFI Analysis Report
Mission:                Terra
Report Generation Time: Feb 17 2020 17:22:16.649 UTC
Analysis Start Epoch:   Feb 17 2020 00:00:00.000 UTC
Analysis End Epoch:     Apr 06 2020 00:00:00.000 UTC
Input Ephemeris File:   AM1_EOSEPHM7_048_2020_01.ephem
Ground Stations Used:   SG1 SG2 SG3
RFI Half-Angle:         1.00000 deg
```

Station	Entry Epoch (UTC)	Exit Epoch (UTC)	Duration (sec)	Min. Angular Sep. (deg)	Epoch at Minimum (UTC)
SG2	Mar 02 2020 08:15:58.688	Mar 02 2020 08:16:03.648	4.960	0.80419	Mar 02 2020 08:16:03.648
SG1	Mar 02 2020 08:15:58.688	Mar 02 2020 08:16:05.611	6.923	0.62214	Mar 02 2020 08:16:05.608
SG3	Mar 02 2020 08:15:58.688	Mar 02 2020 08:16:10.024	11.336	0.29220	Mar 02 2020 08:16:09.328
SG3	Mar 05 2020 08:46:29.083	Mar 05 2020 08:46:38.989	9.906	1.13888	Mar 05 2020 08:46:33.993
SG2	Mar 05 2020 08:46:29.083	Mar 05 2020 08:46:39.053	9.970	1.13661	Mar 05 2020 08:46:34.013
SG1	Mar 05 2020 08:46:29.083	Mar 05 2020 08:46:39.106	10.023	1.13467	Mar 05 2020 08:46:34.033
SG2	Mar 07 2020 08:34:08.509	Mar 07 2020 08:34:25.079	16.570	0.83030	Mar 07 2020 08:34:16.699
SG1	Mar 07 2020 08:34:08.509	Mar 07 2020 08:34:25.086	16.577	0.83198	Mar 07 2020 08:34:16.709
SG3	Mar 07 2020 08:34:08.509	Mar 07 2020 08:34:25.070	16.561	0.82831	Mar 07 2020 08:34:16.669
SG2	Mar 10 2020 09:04:34.189	Mar 10 2020 09:04:48.384	14.195	0.90115	Mar 10 2020 09:04:41.189
SG1	Mar 10 2020 09:04:34.189	Mar 10 2020 09:04:48.422	14.233	0.89874	Mar 10 2020 09:04:41.209
SG3	Mar 10 2020 09:04:34.189	Mar 10 2020 09:04:48.336	14.147	0.90394	Mar 10 2020 09:04:41.169
SG2	Mar 12 2020 08:52:21.585	Mar 12 2020 08:52:27.250	5.665	1.22432	Mar 12 2020 08:52:24.445
SG1	Mar 12 2020 08:52:21.585	Mar 12 2020 08:52:27.206	5.621	1.22644	Mar 12 2020 08:52:24.465
SG3	Mar 12 2020 08:52:21.585	Mar 12 2020 08:52:27.296	5.711	1.22185	Mar 12 2020 08:52:24.425
SG2	Mar 15 2020 09:22:42.110	Mar 15 2020 09:22:55.608	13.498	0.86547	Mar 15 2020 09:22:48.760
SG1	Mar 15 2020 09:22:42.110	Mar 15 2020 09:22:55.648	13.538	0.86252	Mar 15 2020 09:22:48.780
SG3	Mar 15 2020 09:22:42.110	Mar 15 2020 09:22:55.559	13.449	0.86886	Mar 15 2020 09:22:48.740
SG2	Mar 20 2020 09:40:52.386	Mar 20 2020 09:41:01.422	9.036	1.07997	Mar 20 2020 09:40:56.846
SG1	Mar 20 2020 09:40:52.386	Mar 20 2020 09:41:01.481	9.095	1.07640	Mar 20 2020 09:40:56.866
SG3	Mar 20 2020 09:40:52.386	Mar 20 2020 09:41:01.350	8.964	1.08405	Mar 20 2020 09:40:56.816
SG2	Mar 27 2020 09:46:45.067	Mar 27 2020 09:46:53.903	8.836	1.05757	Mar 27 2020 09:46:49.467
SG1	Mar 27 2020 09:46:45.067	Mar 27 2020 09:46:53.888	8.821	1.06144	Mar 27 2020 09:46:49.487
SG3	Mar 27 2020 09:46:45.067	Mar 27 2020 09:46:53.917	8.850	1.05316	Mar 27 2020 09:46:49.447
SG2	Apr 01 2020 10:04:52.107	Apr 01 2020 10:05:05.137	13.030	0.36658	Apr 01 2020 10:04:58.517
SG1	Apr 01 2020 10:04:52.107	Apr 01 2020 10:05:05.155	13.048	0.37121	Apr 01 2020 10:04:58.547
SG3	Apr 01 2020 10:04:52.107	Apr 01 2020 10:05:05.114	13.007	0.36133	Apr 01 2020 10:04:58.497

7.13.4 Accuracy

The accuracy for this product is best available.

7.13.5 Delivery Schedule

This product is delivered weekly on Mondays.

7.13.6 Timespans

This product is 49 days.

7.13.7 Transmission Medium

7.13.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

7.13.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

7.13.8 Volume Estimate

The data volume is typically about 4000 bytes for a 1 month period.

7.14 Low Elevation Contact Report

7.14.1 Description

The FDS provides the FOT with a report that provides the time periods where a ground station contact is above a 10-deg elevation. For each ground station contact, it provides the AOS and LOS times when the elevation is above 10 degrees along with the maximum elevation. This, paired with the nominal ground station contact report, helps the FOT diagnose issues with a contact. If an issue occurs at a time outside the contact span in this report, the spacecraft was below 10-deg in elevation and was in the ground stations “best effort” region.

7.14.2 Mission Phase

This product is delivered during the Operational phases.

7.14.3 Format

A sample report (partial duration) is given below.

```
        Report    LowElevContact

         Start   Feb 19 2020 00:00:00.000
           End   Feb 26 2020 00:00:00.000

--------------

         GS --> SC                  10 deg AOS Epoch               10 deg LOS Epoch                          Max Elev.
------------------          ------------------------    ------------------------          ------------
TR2S --> LowElev_SC         Feb 19 2020 00:16:39.951      Feb 19 2020 00:26:24.607        78.977402316
SG1S --> LowElev_SC         Feb 19 2020 01:04:25.325      Feb 19 2020 01:04:58.291        10.040145829
SG3S --> LowElev_SC         Feb 19 2020 01:04:26.373      Feb 19 2020 01:04:57.327        10.035525814
SG4S --> LowElev_SC         Feb 19 2020 01:04:26.917      Feb 19 2020 01:04:56.754        10.033004239
KLMS --> LowElev_SC         Feb 19 2020 01:04:25.806      Feb 19 2020 01:04:57.847        10.037918488
U4AS --> LowElev_SC         Feb 19 2020 01:06:42.557      Feb 19 2020 01:10:55.822        12.912741132
U5AS --> LowElev_SC         Feb 19 2020 01:06:42.598      Feb 19 2020 01:10:55.746        12.909712109
GLCS --> LowElev_SC         Feb 19 2020 01:06:36.688      Feb 19 2020 01:10:59.975        13.183020727
GLAS --> LowElev_SC         Feb 19 2020 01:06:36.668      Feb 19 2020 01:11:00.097        13.186750534
GLBS --> LowElev_SC         Feb 19 2020 01:06:36.675      Feb 19 2020 01:11:00.037        13.184999207
ASFS --> LowElev_SC         Feb 19 2020 01:06:41.493      Feb 19 2020 01:11:01.021        13.079262145
AS3S --> LowElev_SC         Feb 19 2020 01:06:41.480      Feb 19 2020 01:11:00.986        13.078660449
AS2S --> LowElev_SC         Feb 19 2020 01:06:41.460      Feb 19 2020 01:11:00.943        13.078132477
TR2S --> LowElev_SC         Feb 19 2020 01:54:28.236      Feb 19 2020 02:03:30.966        39.812807718
WAPS --> LowElev_SC         Feb 19 2020 02:27:31.827      Feb 19 2020 02:36:21.050        39.083069256
U4AS --> LowElev_SC         Feb 19 2020 02:43:28.268      Feb 19 2020 02:46:15.434        11.182606031
```

7.14.4 Accuracy

There is no accuracy requirement associated with this product. The ephemerides that this product uses are to produce an accuracy of 60 seconds absolute UTC at the end of a 3 week prediction.

7.14.5 Delivery Schedule

This product is to be delivered once per week for the 7-week product and once per day for the 7-day product.

7.14.6 Timespans

This product span is 7 weeks or 7 days.

7.14.7 Transmission Medium

7.14.7.1 Prime Medium

The product is transferred to the EOC via SFTP.

7.14.7.2 Backup Medium

The backup medium for this product is a 40GB Native DLTtape IV.

7.14.8 Volume Estimate

The data volume is typically about 4000 bytes for a 1 month period.

Section 8. CRMS to FDS Products

8.1 Terra OPM_Maneuver_Data

Description

The Orbit Parameter Message (OPM) maneuver file generated by CRMS will provide FDS a data file containing input to the automated RMM planning.

In support of automated conjunction assessment and risk mitigation for the Terra spacecraft the CRMS shall deliver CCSDS Orbit Parameter Messages (OPMs) to the FDS team. The FDS will ingest and process these OPMs to generate and deliver viable maneuver options for screening.

1. The file naming convention for these OPMs shall be as follows (the convention is also described in Appendix C.4):

Terra	Terra_OPM_[YYYY]-[MM]-[DD]_[HHMMSS].opm

   * The date and time correspond to the generation time of the OPM
2. Each OPM can contain up to 8 maneuver options. These are usually divided between two defined constraint window groups.
   a. A "constraint window group" is defined as a range of "Constraint_window_duration" values that will be grouped together for analysis and post-processing by the FDS
3. Except in special cases, two constraint window groups are expected for processing by the FDS
   a. Constraint window group #1 shall be defined as "Constraint_window_duration" values from 0.4 hours to 8 hours (inclusive)
   b. Constraint window group #2 shall be defined as "Constraint_window_duration" values greater than 8 hours
4. Except in special cases, two (2) "unconstrained" maneuver options will be included in the OPM for each constraint window group.
   a. An "unconstrained" maneuver option is a targeted burn size that mitigates a conjunction within a given "constraint window duration" and is not constrained by the mission delta-v buffer values provided by the FDS
   b. A "delta-v buffer" is defined as the maximum delta-v available to still remain within a mission orbit control box constraint

5. Up to three (3) additional maneuver options (based on the mission's delta-v buffer values provided by the FDS) per constraint window group may be included in the OPM
    a. The FDS shall provide a daily text report for each mission containing 3 delta-v buffer values to inform the creation of OPM maneuver options
6. There are occasions when there are no maneuver options found for a given event. This is a consequence of CRMS employing a delta-v cap that is lower than the required mitigating burn size. In these cases, CRMS will deliver an OPM that contains no maneuver options.
    a. For these cases the OPM shall contain the header record and a partial data record. The data record shall contain only the fields through and including "Comment State Covariance". It shall contain no data in the **Comment and Maneuver Parameters** section (See Data Record and Sample Data Record – No Options below).

Each unique maneuver option has two sections as dictated by the CCSDS OPM format: a comment section containing metadata related to the maneuver option, and a burn definition section detailing the maneuver parameters themselves.

A single maneuver option begins with the maneuver plan number comment line and ends with the cross-track delta-v parameter. There shall be exactly one of each required OPM line (defined in the Data Record table below) and up to one of each optional OPM line for each unique maneuver option.

Details on what constitutes valid values for each comment and maneuver parameter in the definition can be found in the **Comment and Maneuver Parameters** area in the Data Record section below. A sample OPM maneuver option definition can be found below as well (See Sample Data Record).

Format

NOTE:
With the exception of the comment statements under the Maneuver Parameters section, the Header Record table and Data Record table field name descriptions below were taken from the CCSDS 502.0-B-2 Orbit Data Messages, Blue Book, 11/2009. Also note the "Not used" description is placed beside the field names that are not currently used by EMOS.

Header Record

Field Name	Maximum Field Width	Description
CCSDS_OPM_VERS	18	CCSDS_OPM_VERS=2.0. Format version in the form of 'x.y', where 'y' is incremented for corrections and minor changes, and 'x' is incremented for major changes.
CREATION_DATE	24	File creation date and time in UTC.
ORIGINATOR	24	Creating agency or operator.

Sample Header Record

CCSDS_OPM_VERS = 2.0
CREATION_DATE = 2018-07-06T15:54:47.428
ORIGINATOR = SPACENAV

Data Record

Field Name	Max Field Width	Description
OBJECT_NAME	24	Spacecraft name for which the orbit state is provided.
OBJECT_ID	8	Object identifier of the object for which the orbit state is provided.
CENTER_NAME	24	Origin of reference frame, which may be a natural solar system body (planets, asteroids, comets, and natural satellites), including any planet barycenter or the solar system barycenter, or another spacecraft.
REF_FRAME	18	Name of the reference frame in which the ephemeris data are given.
REF_FRAME_EPOCH	18	Epoch of reference frame, if not intrinsic to the definition of the reference frame.
TIME_SYSTEM	8	Time system used for metadata, ephemeris data,

		and covariance data. TIME_SYSTEM=UTC		
COMMENT State Vector		Not used		
COMMENT Spacecraft Parameters		Not used		
COMMENT State Covariance		Not used		
Comment and Maneuver Parameters (Repeat for each maneuver)				
Parameter	Re-quired	Value Type	Valid Values	Description/Notes
COMMENT Maneuver_plan	Yes	Integer	1 through n	
COMMENT Constraint_name	Yes	String	• Unconstrained • Delta_V_Buffer_to_Center • Delta_V_Buffer_to_Const_Lim • Delta_V_Buffer_to_Sci_Req	n/a
COMMENT Constraint_file_name	Yes	String	• [filename] • N/A	Filename typically corresponds to FDS delta-v buffer report product (“Unconstrained” options shall have the value “N/A”)
COMMENT Constraint_value	Yes	String	• 0 – [x.xx]e-[xx] (positive) • N/A	Based on the delta-v buffer value associated with the Constraint_name (“Unconstrained” options shall have the value “N/A”)

COMMENT Constraint_window_times	No	String	[DD Mmm YYYY HH:MM:SS.sss] – [DD Mmm YYYY HH:MM:SS.sss]	Defines the constraint window span
COMMENT Constraint_window_duration	Yes	Float	[x.xx] (≥ 0.40 hours)	Based on Constraint_window_times
COMMENT TCA*_of_1st_event_in_man_plan	No	String	[DD Mmm YYYY HH:MM:SS.sss]	
COMMENT Trigger_event_object_name_ID	Yes	String	[Object name] [Object ID]	
COMMENT Trigger_event_TCA	Yes	String	[DD Mmm YYYY HH:MM:SS.sss]	
COMMENT Trigger_event_Pc**	Yes	Exponential	[x.xx]e-[xx] (positive)	
COMMENT Resultant_Aggregate_Pc	No	Exponential	[x.xx]e-[xx] (positive)	
MAN_EPOCH_IGNITION	Yes	String	[YYYY-MM-DD]T[HH:MM:SS]	Burn time
MAN_DURATION	Yes	Integer	0	
+MAN_DELTA_MASS	n/a	n/a	n/a	Not used.
MAN_REF_FRAME	Yes	String	RIC	
MAN_DV_1	Yes	Integer	0	1st component of the velocity increment (km/s)
MAN_DV_2	Yes	Exponential	[x.xxxx]e-[xx] (positive, non-zero)	2nd component of the velocity increment (km/s)
MAN_DV_3	Yes	Integer	0	3rd component of the velocity increment (km/s)

*TCA (Time of closest approach)

**Pc (Probability of collision)

+ MAN_DELTA_MASS (Not used – omitted from data file)

Sample Data Record – All Options

```
OBJECT_NAME = TERRA
OBJECT_ID = 25994
CENTER_NAME = EARTH
REF_FRAME = EME2000
TIME_SYSTEM = UTC

COMMENT State Vector
COMMENT Ephemeris_filename
MEME_25994_terra_1030000_SPEC_Terra-2019103-NOBURN-
S00_unclassified.txt
EPOCH = 2018-07-07T00:00:00.000
X = 1979.2259 [km]
Y = -904.3928 [km]
Z = 6729.81 [km]
X_DOT = 4.2796 [km/s]
Y_DOT = -5.8205 [km/s]
Z_DOT = -2.0347 [km/s]

COMMENT Spacecraft Parameters
COMMENT Force_model_file Database
MASS = 4456.2202 [kg]
SOLAR_RAD_AREA = 54.5 [m**2]
SOLAR_RAD_COEFF = 1.5
DRAG_AREA = 40.5 [m**2]
DRAG_COEFF = 2.2

COMMENT State Covariance
CX_X = 9.2797e-05 [km**2]
CY_X = -0.00011296 [km**2]
CY_Y = 0.00016373 [km**2]
CZ_X = -4.3604e-05 [km**2]
CZ_Y = 5.7461e-05 [km**2]
CZ_Z = 2.4334e-05 [km**2]
CX_DOT_X = -4.3941e-08 [km**2/s]
CX_DOT_Y = 6.0191e-08 [km**2/s]
CX_DOT_Z = 2.0223e-08 [km**2/s]
CX_DOT_X_DOT = 2.9996e-11 [km**2/s**2]
CY_DOT_X = 2.0674e-08 [km**2/s]
CY_DOT_Y = -2.6855e-08 [km**2/s]
```

```
CY_DOT_Z = -7.7331e-09 [km**2/s]
CY_DOT_X_DOT = -6.2854e-12 [km**2/s**2]
CY_DOT_Y_DOT = 1.0574e-11 [km**2/s**2]
CZ_DOT_X = -1.5133e-07 [km**2/s]
CZ_DOT_Y = 2.0565e-07 [km**2/s]
CZ_DOT_Z = 7.644e-08 [km**2/s]
CZ_DOT_X_DOT = 7.5847e-11 [km**2/s**2]
CZ_DOT_Y_DOT = -3.5192e-11 [km**2/s**2]
CZ_DOT_Z_DOT = 2.6816e-10 [km**2/s**2]

COMMENT Maneuver_plan 1
COMMENT Constraint_name Unconstrained
COMMENT Constraint_file_name N/A
COMMENT Constraint_value N/A
COMMENT Constraint_window_times 08 Jul 2018 07:45:26.591 - 09 Jul
2018 07:45:26.591
COMMENT Constraint_window_duration 24.00 [hrs]
COMMENT TCA_of_1st_event_in_man_plan 08 Jul 2018 08:40:14.607
COMMENT Trigger_event_object_name_ID WORLDVIEW 2 DEB 41738
COMMENT Trigger_event_TCA 09 Jul 2018 07:45:26.591
COMMENT Trigger_event_Pc 2.40e-05
COMMENT Resultant_Aggregate_Pc 9.77e-08
MAN_EPOCH_IGNITION = 2018-07-09T06:56:29
MAN_DURATION = 0
MAN_REF_FRAME = RIC
MAN_DV_1 = 0 [km/s]
MAN_DV_2 = 9.0591e-05 [km/s]
MAN_DV_3 = 0 [km/s]

COMMENT Maneuver_plan 2
COMMENT Constraint_name Delta_V_Buffer_to_Center
COMMENT Constraint_file_name AM_DELVBUF1_188_2018_01.report
COMMENT Constraint_value 0 - 2.02e-05 [km/s]
COMMENT Constraint_window_times 08 Jul 2018 07:45:26.591 - 09 Jul
2018 07:45:26.591
COMMENT Constraint_window_duration 24.00 [hrs]
COMMENT TCA_of_1st_event_in_man_plan 08 Jul 2018 08:40:14.607
COMMENT Trigger_event_object_name_ID WORLDVIEW 2 DEB 41738
COMMENT Trigger_event_TCA 09 Jul 2018 07:45:26.591
COMMENT Trigger_event_Pc 2.40e-05
COMMENT Resultant_Aggregate_Pc 2.34e-05
MAN_EPOCH_IGNITION = 2018-07-09T07:45:21
MAN_DURATION = 0
```

```
MAN_REF_FRAME = RIC
MAN_DV_1 = 0 [km/s]
MAN_DV_2 = 1.4391e-05 [km/s]
MAN_DV_3 = 0 [km/s]

COMMENT Maneuver_plan 3
COMMENT Constraint_name Delta_V_Buffer_to_Const_Lim
COMMENT Constraint_file_name AM_DELVBUF1_188_2018_01.report
COMMENT Constraint_value 0 - 3.13e-05 [km/s]
COMMENT Constraint_window_times 08 Jul 2018 07:45:26.591 - 09 Jul
2018 07:45:26.591
COMMENT Constraint_window_duration 24.00 [hrs]
COMMENT TCA_of_1st_event_in_man_plan 08 Jul 2018 08:40:14.607
COMMENT Trigger_event_object_name_ID WORLDVIEW 2 DEB 41738
COMMENT Trigger_event_TCA 09 Jul 2018 07:45:26.591
COMMENT Trigger_event_Pc 2.40e-05
COMMENT Resultant_Aggregate_Pc 2.35e-05
MAN_EPOCH_IGNITION = 2018-07-09T07:44:26
MAN_DURATION = 0
MAN_REF_FRAME = RIC
MAN_DV_1 = 0 [km/s]
MAN_DV_2 = 5.1181e-06 [km/s]
MAN_DV_3 = 0 [km/s]

COMMENT Maneuver_plan 4
COMMENT Constraint_name Delta_V_Buffer_to_Sci_Req
COMMENT Constraint_file_name AM_DELVBUF1_188_2018_01.report
COMMENT Constraint_value 0 - 3.98e-05 [km/s]
COMMENT Constraint_window_times 08 Jul 2018 07:45:26.591 - 09 Jul
2018 07:45:26.591
COMMENT Constraint_window_duration 24.00 [hrs]
COMMENT TCA_of_1st_event_in_man_plan 08 Jul 2018 08:40:14.607
COMMENT Trigger_event_object_name_ID WORLDVIEW 2 DEB 41738
COMMENT Trigger_event_TCA 09 Jul 2018 07:45:26.591
COMMENT Trigger_event_Pc 2.40e-05
COMMENT Resultant_Aggregate_Pc 2.35e-05
MAN_EPOCH_IGNITION = 2018-07-09T07:45:26
MAN_DURATION = 0
MAN_REF_FRAME = RIC
MAN_DV_1 = 0 [km/s]
MAN_DV_2 = 3e-05 [km/s]
MAN_DV_3 = 0 [km/s]
```

```
COMMENT Maneuver_plan 5
COMMENT Constraint_name Unconstrained
COMMENT Constraint_file_name N/A
COMMENT Constraint_value N/A
COMMENT Constraint_window_times 09 Jul 2018 03:38:32.386 - 09 Jul
2018 07:45:26.591
COMMENT Constraint_window_duration 4.12 [hrs]
COMMENT TCA_of_1st_event_in_man_plan 08 Jul 2018 08:40:14.607
COMMENT Trigger_event_object_name_ID WORLDVIEW 2 DEB 41738
COMMENT Trigger_event_TCA 09 Jul 2018 07:45:26.591
COMMENT Trigger_event_Pc 2.40e-05
COMMENT Resultant_Aggregate_Pc 9.77e-08
MAN_EPOCH_IGNITION = 2018-07-09T06:56:29
MAN_DURATION = 0
MAN_REF_FRAME = RIC
MAN_DV_1 = 0 [km/s]
MAN_DV_2 = 9.0591e-05 [km/s]
MAN_DV_3 = 0 [km/s]

COMMENT Maneuver_plan 6
COMMENT Constraint_name Delta_V_Buffer_to_Center
COMMENT Constraint_file_name AM_DELVBUF1_188_2018_01.report
COMMENT Constraint_value 0 - 2.02e-05 [km/s]
COMMENT Constraint_window_times 09 Jul 2018 03:38:32.386 - 09 Jul
2018 07:45:26.591
COMMENT Constraint_window_duration 4.12 [hrs]
COMMENT TCA_of_1st_event_in_man_plan 08 Jul 2018 08:40:14.607
COMMENT Trigger_event_object_name_ID WORLDVIEW 2 DEB 41738
COMMENT Trigger_event_TCA 09 Jul 2018 07:45:26.591
COMMENT Trigger_event_Pc 2.40e-05
COMMENT Resultant_Aggregate_Pc 2.34e-05
MAN_EPOCH_IGNITION = 2018-07-09T07:45:21
MAN_DURATION = 0
MAN_REF_FRAME = RIC
MAN_DV_1 = 0 [km/s]
MAN_DV_2 = 1.4391e-05 [km/s]
MAN_DV_3 = 0 [km/s]

COMMENT Maneuver_plan 7
COMMENT Constraint_name Delta_V_Buffer_to_Const_Lim
COMMENT Constraint_file_name AM_DELVBUF1_188_2018_01.report
COMMENT Constraint_value 0 - 3.13e-05 [km/s]
```

```
COMMENT Constraint_window_times 09 Jul 2018 03:38:32.386 - 09 Jul
2018 07:45:26.591
COMMENT Constraint_window_duration 4.12 [hrs]
COMMENT TCA_of_1st_event_in_man_plan 08 Jul 2018 08:40:14.607
COMMENT Trigger_event_object_name_ID WORLDVIEW 2 DEB 41738
COMMENT Trigger_event_TCA 09 Jul 2018 07:45:26.591
COMMENT Trigger_event_Pc 2.40e-05
COMMENT Resultant_Aggregate_Pc 2.35e-05
MAN_EPOCH_IGNITION = 2018-07-09T07:44:26
MAN_DURATION = 0
MAN_REF_FRAME = RIC
MAN_DV_1 = 0 [km/s]
MAN_DV_2 = 5.1181e-06 [km/s]
MAN_DV_3 = 0 [km/s]

COMMENT Maneuver_plan 8
COMMENT Constraint_name Delta_V_Buffer_to_Sci_Req
COMMENT Constraint_file_name AM_DELVBUF1_188_2018_01.report
COMMENT Constraint_value 0 - 3.98e-05 [km/s]
COMMENT Constraint_window_times 09 Jul 2018 03:38:32.386 - 09 Jul
2018 07:45:26.591
COMMENT Constraint_window_duration 4.12 [hrs]
COMMENT TCA_of_1st_event_in_man_plan 08 Jul 2018 08:40:14.607
COMMENT Trigger_event_object_name_ID WORLDVIEW 2 DEB 41738
COMMENT Trigger_event_TCA 09 Jul 2018 07:45:26.591
COMMENT Trigger_event_Pc 2.40e-05
COMMENT Resultant_Aggregate_Pc 2.35e-05
MAN_EPOCH_IGNITION = 2018-07-09T07:45:26
MAN_DURATION = 0
MAN_REF_FRAME = RIC
MAN_DV_1 = 0 [km/s]
MAN_DV_2 = 3e-05 [km/s]
MAN_DV_3 = 0 [km/s]
```

Note: Under rare circumstances it is possible for the MAN_DV_2 (in-track delta-v) value for a lower delta-v buffer option to be slightly larger than the MAN_DV_2 for a higher delta-v buffer option. This can occur in cases where the Probability of Collision (Pc) values at the maximum boundary of the delta-v buffers are increasing in size, and is due to the convergence tolerance process the CRMS software utilizes for maneuver option seed selection.

Sample Data Record – No Options

```
OBJECT_NAME = TERRA
OBJECT_ID = 25994
CENTER_NAME = EARTH
REF_FRAME = EME2000
TIME_SYSTEM = UTC

COMMENT State Vector
COMMENT Ephemeris_filename
      MEME_25994_terra_1030000_SPEC_Terra-2019103-NOBURN-
S00_unclassified.txt
EPOCH = 2018-07-07T00:00:00.000
X = 1979.2259 [km]
Y = -904.3928 [km]
Z = 6729.81 [km]
X_DOT = 4.2796 [km/s]
Y_DOT = -5.8205 [km/s]
Z_DOT = -2.0347 [km/s]

COMMENT Spacecraft Parameters
COMMENT Force_model_file Database
MASS = 4456.2202 [kg]
SOLAR_RAD_AREA = 54.5 [m**2]
SOLAR_RAD_COEFF = 1.5
DRAG_AREA = 40.5 [m**2]
DRAG_COEFF = 2.2

COMMENT State Covariance
CX_X = 9.2797e-05 [km**2]
CY_X = -0.00011296 [km**2]
CY_Y = 0.00016373 [km**2]
CZ_X = -4.3604e-05 [km**2]
CZ_Y = 5.7461e-05 [km**2]
CZ_Z = 2.4334e-05 [km**2]
CX_DOT_X = -4.3941e-08 [km**2/s]
CX_DOT_Y = 6.0191e-08 [km**2/s]
CX_DOT_Z = 2.0223e-08 [km**2/s]
CX_DOT_X_DOT = 2.9996e-11 [km**2/s**2]
CY_DOT_X = 2.0674e-08 [km**2/s]
CY_DOT_Y = -2.6855e-08 [km**2/s]
CY_DOT_Z = -7.7331e-09 [km**2/s]
CY_DOT_X_DOT = -6.2854e-12 [km**2/s**2]
CY_DOT_Y_DOT = 1.0574e-11 [km**2/s**2]
```

CZ_DOT_X = -1.5133e-07 [km**2/s]
CZ_DOT_Y = 2.0565e-07 [km**2/s]
CZ_DOT_Z = 7.644e-08 [km**2/s]
CZ_DOT_X_DOT = 7.5847e-11 [km**2/s**2]
CZ_DOT_Y_DOT = -3.5192e-11 [km**2/s**2]
CZ_DOT_Z_DOT = 2.6816e-10 [km**2/s**2]

Delivery

This product will be delivered during all phases of the mission.

Accuracy

The accuracy of this product is the best available.

End Users

This product is needed by Terra , FOT, FDS and spacecraft engineers.

Appendix A Operations Concepts

This appendix contains the high level operations concepts as agreed to by all affected signing parties.

A.1 EOS Operations Center (EOC)

A.1.1 FDS Workstations in EOC

a. Utilize primary and backup FDS SUN/Solaris workstations for TGSS support.
b. Utilize primary and backup FDS PC workstations for the following:
   1. Maneuver support
   2. Predicted orbit generation
c. Both workstations are dedicated to EOS Terra operations. Future EOS mission development work is restricted during the operational phase.
d. The prime FDS workstations is connected to a separate LAN from the backup workstations.
e. After the early mission, maintenance of the FDS workstations is assumed by the ESMO Project.
f. All non-real-time products transferred (via SFTP) to and from the FDS is handled via the FDS product workstations. All real-time information is handled via an Eclipse stream to the FDS Windows workstations.

A.1.2 EOC Workstation for FDS Operators

a. ESMO will provide an EOC FDS Workstation for use by FDS operators:
   1. Used to get real-time displays
   2. Is dedicated for use by FDS operators when access to real-time displays is needed in the control center
   3. In the event that this workstation fails, another workstation is provided as close as possible to the prime FDS workstations.

A.1.3 FDAB Personnel in EOC

a. All FDAB mission analysts were in the EOC during the early mission.
b. Other FDAB contractors can access FDS workstations in the EOC via the EBnet remote interface.

c. Support for attitude and orbit in EOC was 24 hours a day until checkout was complete.

A.1.4 FDS Training

a. The FDS Team in the EOC are trained to operate the FDS software.
b. FDT will continue to do calibration, analysis, and anomaly investigation throughout the mission, and with support from FDAB, as negotiated.
c. FDT will be on call at all times during normal working hours to assist in problem investigation.

A.2 Data Transfer to FDS

The data transfer interface is described in Appendices B and G for real-time telemetry and carryout files, respectively.

A.3 FDS Generated Products

A.3.1 Real-Time Attitude Determination System (RTADS)

a. Is a stand-alone system executing on the FDS Windows Workstations and available to the EOC.
b. RTADS can generate a tabular display of data.
c. FDAB and/or FDS provides training to the FDS FOT on how to run RTADS.
d. RTADS needs an ephemeris to execute.
e. FDAB is responsible for maintaining RTADS.

A.3.2 Planning Aids

a. All planning aids to be generated on the FDS Windows Workstations in the EOC.
b. FDAB provided training to the FDS FOT on how to generate the planning aids.
c. After early mission support, the FDS FOT is responsible for generation of planning aids.
d. External data for planning aids (if any) are from non-real-time telemetry source (standing order requests generated by FOT).

e. All planning aids are transferred from the Windows Workstations workstation to the EOC via SFTP.
f. A naming convention (such as date and time in file name) is implemented to distinguish same products for different timespans and days.
g. Since the FDS FOT is responsible for generating these products after early mission there is no need for a notification process for planning aid deliveries.

a. FDS FOT to use an archiving procedure after the transfer of files to ensure disk volume will not be exceeded.
b. Formats for planning aids are formatted data files as shown in this ICD.
c. NASA Code 580 is responsible for maintaining any FDAB-unique software.
d. Updates to new versions of COTS products, if needed, (such as STK) are the responsibility of ESMO to determine the need for and to work details. FDAB will provide contact names for negotiating support. Any Code 580-written code will need to be coordinated with and updated by Code 580, if needed, in conjunction with COTS update. Normal mission COTS updates are only anticipated when new EOS missions are added or when the manufacturer no longer supports the current version resident on the FDS.
e. FDAB will provide necessary documentation (e.g., users' guides).

A.3.3 Calibration of Attitude Sensors

a. FDAB is responsible for all calibration activities during the early mission.
b. Calibration functions execute on the FDS Windows Workstations in the EOC.
c. FDAB provided the FDS FOT training on the Attitude Sensor Calibration software resident on the FDS workstations.
d. Output products and reports are delivered to the EOC.
e. FDT to deliver attitude maneuver plans to the FOT for approval.
f. Data needed for calibration are via standing order requests generated by the FDS FOT.

A.3.4 Maneuver Planning and Support

a. FDT is responsible for planning all orbit raising and inclination adjust maneuvers during the early mission

b. FDT provides the FDS FOT training on the routine orbit raising maneuver planning software resident on the FDS PC workstations in the EOC.

c. FDT is available during normal working hours for orbit maneuver planning consultation.

d. FDT is responsible for planning all calibration related maneuvers throughout the mission in conjunction with FDS FOT

e. FDS delivers maneuver plans to the FOT for approval according to ICD delivery schedule

A.3.5 TONS Ground Support System (TGSS)

a. The TGSS software operates on the FDS SUN/Solaris workstations in the EOC.

b. FDAB provided training to the FDS FOT in executing the TGSS and generating reports.

c. The FDT operates the TGSS in the EOC.

d. The TDRSS ephemerides is provided by FDS.

A.3.6 Data Archiving

a. FDT personnel are responsible for offloading archived datasets from the FDS workstations so as not to accumulate datasets and exceed the storage capacity.

Appendix A EMOS Real-Time Telemetry Interface

B.1 Design and Data Flow Overview

This section documents the real-time interface between EMOS and FDS. The EMOS interface is implemented using Eclipse.

Eclipse will have the following features:

a. Eclipse is able to send FDS at least 300 mnemonics without significant performance impact.
b. Eclipse is able to support multiple connections, but only one connection per process.
c. Eclipse to provide the actual mnemonic time (time of the data within the packet) for each mnemonic, not the packet time.
d. Eclipse to provide times in UTC and will specify whether the time is absolute or relative to a specified epoch.
e. Eclipse to accept requests for mnemonics by name (as well as by number).
f. Eclipse to accept requests for both raw and converted (engineering units) mnemonic values.
g. Eclipse to provide a method of getting all real numbers in IEEE floating point format.
h. Eclipse to provide the capability to use callback functions (mnemonic updated to user only when value changes) as well as request functions (mnemonic sampled at user-defined frequency, regardless of update status, may be sampled when unchanged).

In addition, EMOS personnel to provide the following:

a. Eclipse libraries to FDS that are suitable for a PC platform in either C, C++, or Java.
b. Documentation that specifies all applicable function calls.
c. A technical point of contact for flight dynamics personnel to ask questions about Eclipse.
d. Any commercial off the shelf (COTS) licenses necessary (e.g. PVWave).

Appendix A File Naming Convention

C.1 Files from FDS to EMOS

Files delivered by the FDS to the EMOS follow the following convention with field names delimited by underscores:

AM1_<filename>N_ddd_yyyy_vv.FDD,

where

<filename> = the string given in the table below for each of the products.

N = 1 or 7, used to distinguish the type of product:

- 1 for 1 week product (delivered daily)
- 7 for 7 week product (delivered weekly)

For other products which are neither 1-week nor 7-week products, the value 1 is used as the default.

ddd = the 3-digit day of year corresponding to the start time of the file (not the creation date of the file).

yyyy = the year corresponding to the start year of the file (not the creation year of the file).

vv = a two digit version number indicator. Version is 01 unless a product must be present.

Product 3.92 was requested by the FOT for automation. It is also delivered to EMOS (MMS) but has the following non-standard naming convention:

Terra_CHECKLIST_ ddd _yyyy_hhmmss.pdf

Where

ddd = the 3-digit day of year corresponding to the creation date of the file.

yyyy = the year corresponding to the creation date of the file.

Hhmmss = the hours, minutes, and seconds of the creation time of the file

The extension is .pdf

There is nominally only one delivery. If products are generated in the morning and an RMM is executed, a new checklist may be generated and delivered if new products are generated.
The delivery locations is /mms/<system>/am1/external/fdf/

Where <system> is ops1, ops2, or sup1

FDS Product	<filename>	ICD Section
FSS Transformation Table	FSSTRANS	3.3.3.1
FSS Calibration Table	FSSCALIB	3.3.3.2
SSST Transformation Table	SSSTTRANS	3.3.3.3
SSST Parameters Table	SSSTPARAM	3.3.3.4
IRU Transformation Table	IRUTRANS	3.3.3.5
IRU Scaling Table	IRUSCAL	3.3.3.6
IRU Biases Table	IRUBIASES	3.3.3.7
Attitude Slew Table	ATTSLEW	3.4
EOS Mission Star Catalog	STARCATALOG	3.5
Star Density Profile	STAR1DENPROF STAR2DENPROF	3.6
SSST Star Interference	STAR1INTERFER STAR2INTERFER	3.7
ESA Sun/Moon Interference	ESAINTERFER	3.8
FSS Visibility Predict	FSSVISPREDICT	3.9
TDRS State Vectors	TDRS1STATE, TDRS2STATE, TDRS3STATE, TDRS4STATE	3.11
EOS Brouwer-Lyddane Elements	EOSBLELEM	3.12
TDRS Brouwer-Lyddane Elements	TDRS1BLELEM, TDRS2BLELEM, TDRS3BLELEM, TDRS4BLELEM	3.13
Simulated Terra Spacecraft	SIMSCEPHM	3.15
Filter Tuning Parameters	TUNINGPARAM	3.16
Nadir OMNI-to-TDRS Viewing	OMNINTDRS	3.17
HGA-to-TDRS Line of Sight	HGATDRS	3.18
OMNI-to-Ground Station Viewing	OMNIGRND	3.19
HGA Gimbal Angles	HGAGIMBAL	3.20
Predicted EOS-Terra Ephemeris	EOSEPHM	3.21
Predicted TDRS Ephemeris	TDRS1EPHM TDRS2EPHM TDRS3EPHM TDRS4EPHM	3.22
Orbit Adjust Maneuver Request	ORBITMANREQ	3.24
Delta-V Parameters Table	DELTAVPARM	3.25

Mass and Center of Mass Location	MASSLOCATION	3.26
Predicted EOS-Terra Ranging Data	FDFRANGE	3.27

FDS Product	<filename>	ICD Section
Attitude Predictions	ATTITUDE	3.28
Predicted Orbital Events	ORBEVENT	3.29
Planned Orbit Maneuver Dataset	MNVRTIME	3.30
Solar/Lunar Azimuth and Elevation Angle	CERSUNAZEL CERMOONAZEL MODSUNAZEL MODMOONAZEL	3.31
Solar Beta Angles	SOLBETA	3.32
Predicted Local Sun Time	LOCALSUN	3.33
Lunar Beta Angles	LUNBETA	3.34
MODIS Sun and Moon FOV Events	MODSUNMNFOV	3.35
MODIS Planets/Stars FOV Events	PLSTFOVEVNT	3.36
Predicted Sub-Satellite Point	GRNDTRCK	3.37
Predicted Spacecraft Altitude	ALTITUDE	3.38
Predicted Spacecraft Day/Night	DAYNIGHT	3.39
Terra State Error Covariance	STATEERRCOV	3.40
Local Oscillator Frequency Report	OSCFREQREP	3.48
X-band Interference Times	XBANDDSN	3.50
Predicted Orbit Number and Start	ORBITNUM	3.53
UTC to UT1 Timing Difference	TIMINGDIFF	3.54
Predicted Instrument Orbit Events	INSTORBEVENT	3.55
Predicted EOS Terra State Vector	EOSSTATEVECT	3.56
Simulated TDRS State Vectors	SIMTDRS1STAVEC, SIMTDRS2STAVEC, SIMTDRS3STAVEC, SIMTDRS4STAVEC	3.57
Simulated EOS Terra Brouwer-Lyddane Elements	SIMEOSBLELEM	3.58
Simulated TDRS Brouwer-Lyddane Elements	SIMTDRS1BLELEM, SIMTDRS2BLELEM, SIMTDRS3BLELE	3.59

	M, SIMTDRS4BLELEM,	
Simulated EOS Terra State Vectors	SIMSTAVEC	3.60
Ground Station Contact Times	GRNDCONTACT	3.61
MODIS FOV Target View Period	MODISFOV	3.62
Earth Gravity Model Spherical Harmonic Coefficient	HARMONICCOEFF	3.63
Earth Gravity Model Degree Variance	DEGREEVAR	3.64

FDS Product	<filename>	ICD Section
Harris-Priester Atm. Density Model Data	MAXDENSMODEL MINDENSMODEL	3.65
Solar Ephemeris Modification Data	SOLEPHMMOD	3.66
EOS Terra Modeling Data	EOSMODELING	3.67
TDRS Modeling Data	TDRSMODELING	3.68
Ground Antenna Modeling Data	GRNDANT1MODEL, GRNDANT2MODEL, GRNDANT3MODEL, GRNDANT4MODEL,	3.69
State Tolerance Data	STATETOLER	3.70
Doppler Measurement Tolerance Data	MEASTOLER	3.71
Covariance Tolerance Data	COVTOLER	3.72
Navigation Time Step Data	NAVTIMESTEP	3.73
Phys. and Math. Constants	PHYSCONST	3.74
Atmospheric Drag Data	ATMOSDRAG	3.77
TDRS Measurement Bias Data	TDRSMEASBIAS	3.78
Simulated UTC to UT1 Timing Difference	SIMTIMINGDIFF	3.79
Navigation Thruster Table	NAVTHRUSTER	3.80
HGA to TDRSS S-Band Viewing Times	HGASTDRS	3.81

HGA to TDRSS TONS-Based Viewing Times	HGATTDRS	3.82
Zenith OMNI-to-TDRS Viewing	OMNIZTDRS	3.83
TAM FDIR Predict Table	TAMPREDICTS	3.84
Thruster Control Parameters Table	THRUSTERPARM	3.85
CERES FOV Moon Intrusion Times	CERMOONENTRY	3.86
TDRS Minimum Ray Path Height	MINRAYPATH	3.87
FDS Checklist	CHECKLIST	3.92
Inclination (Yaw) Data	INCDATA	3.93
Sensor Calibration Trend Report	SENCALTRDREP	7.1
Onboard Navigation EVAL./Quality Assurance	NAVEVALQUAL	7.2
EOS-Terra Post Maneuver Report	POSTMANREP	7.3
SCC Attitude Determination Validation	SCCATTVALID	7.4
EOS-Terra Pre-Maneuver report	PREMANEUV	7.5
Solar Eclipse Shadow Prediction Report	ECLSHADOW	7.6
Star Catalog Update Report	STCATUPDRPT	7.7

C.2 Files from EMOS to FDS

Reports delivered by the EMOS to the FDS have the following names:

"TDRSMAP.RPT" for TDRS Naming Convention Map (Section 4.12)

Carryout files delivered by the EMOS to the FDS follow the following convention with field names delimited by underscores:

AM1_<filename>_hhmmss_ddd_yyyy_HHMMSS_DDD_YYYY_vv.EMOS,

where

<filename> = one of the following four character strings:

a. "ATTITUDECO" for attitude telemetry
b. "MANEUVERCO" for propulsion telemetry
c. "ORBITCO" for TONS telemetry
d. "TONSSTATECO" for TONS state vectors

hhmmss_ddd_yyyy = the hours:minutes:seconds, day of year, and the year corresponding to the start time of the file (not the creation time of the file)

HHMMSS_DDD_YYYY = the hours:minutes:seconds, day of year, and the year corresponding to the end time of the file (the last data point in the file).

vv = a two digit version number indicator. Version is 01 unless a product must be resent.

The TONS State with Covariance Data File is delivered to FDS from the FOT. The file is in the form of an ASCII formatted comma separated report. This file has the following convention with field names delimited by underscores:

DyP_AM1_TONSTATECOVAR_YYYYDOY_hhmmss_YYYYDOY_hhmmss_vvv.csv

where

The first set of YYYYDOY_hhmmss is the year, day of year, hour, minute, and second at the start of the file,

and

The second set is the year, day of year, hour, minute, and second at the end of the file.

C.3 Files from FDS to DAACs

Files delivered by the FDS to the DAACs follow the following convention with field names delimited by underscores:

AM1_<filename>_hhmmss_ddd_yyyy_vv.FDD,

where

<filename> = the string given in the table below for each of the products:

a. DEFATT for definitive attitude files
b. DEFORB for definitive orbit files

hhmmss = the hours:minutes:seconds corresponding to the start time of the file (not the creation time of the file)

ddd = the 3-digit day of year corresponding to the start day of the file (not the creation date of the file).

Yyyy = the start year of the file (not the creation year of the file).

Vv = a two digit version number indicator. Version is 01 unless a product must be resent.

C.4 Files from CRMS to FDS

The Orbit Parameter Message (OPM) Maneuver File generated by CRMS and delivered to FDS has the following naming convention:

<sat_name>_OPM_<yyyy-mm-dd_hhmmss>.ext,

where...

- <sat-name> = Name of satellite (i.e. Terra)
- yyyy = the creation year of the file
- mm = the creation month of the file
- dd = the creation day of the file
- hhmmss = the creation time of the file (in hours, minutes and seconds)
- ext = opm

CRMS Product	Type	<filename>
OPM Maneuver File	opm	Terra_OPM_2016-03-21_054646

C.5 Files from FDS to CRMS

The **Force Model Data and Maneuver Report Files** delivered by the FDS to the CRMS have the following naming convention:

AM1_<filename>N_ddd_yyyy_vv.ext,

where...

<filename> = the string given in the table below for each of the products.

N = 1 or 7, used to distinguish the type of product:

a. 1 for 1 week product (delivered daily)
b. 7 for 7 week product (delivered weekly)
c. For other products which are neither 1-week nor 7-week products, the value 1 is used as the default.

Ddd = the 3-digit day of year corresponding to the start time of the file (not the creation date of the file).

Yyyy = the year corresponding to the start year of the file (not the creation year of the file).

Vv = a two digit version number indicator. Version will be 01 unless a product must be present.

Ext = “Report”

FDS Product	Type	<filename>
Force Model Data	Report file	SCDATA
Predicted Maneuver Reports	Report file	PREDMAN
Historical Maneuver Performance Data	Report file	MANPERFDATA
Maneuver Constraint Information	Report file	DELTAVBUF

The **Earth Orientation Parameters (EOP) Data Files** that FDS delivers to CRMS have a timestamp which is the file type embedded in the filename that makes the files unique. See table below.

<filename>

UT1UTC.dat.YYYYDOY_HHMMSS File
UTCTAI.dat.YYYYDOY_HHMMSS File

Where YYYY=creation year
DOY=creation day
HHMMSS=hour, minutes, and seconds the file was created.

FDS Product	<filename>	Type
EOP Data	UT1UTC.DAT	YYYYDOY_HHMMSS
Leap Second Correction Data	UTCTAI.DAT	YYYYDOY_HHMMSS

The Orbit Ephemeris Message (OEM) Files delivered by the FDS to the CRMS have the following naming conventions with the fields separated by underscores and dashes. The product description and sample file names are provided in the table below.

The daily nominal and no burn ephemeris files:

MEME_25994_terra_DOYHHMM_OPS_Terra-YYYYDOY-NOMINAL-SVV_unclassified.txt
MEME_25994_terra_DOYHHMM_SPEC_Terra-YYYYDOY-NOBURN-SVV_unclassified.txt

Where...

- DOYHHMM is the start day of the ephemeris data
- YYYYDOY is the file generation epoch
- SVV is the version

The risk mitigation maneuver (RMM) special screening ephemeris files:

MEME_25994_terra_DOYHHMM_SPEC_DOYHHMMSS-NNN-YYYYMMDDHHMMSS-SPMANV_unclassified.txt

Where...

- DOYHHMM is the start day of the ephemeris data
- DOYHHMMSS is the file generation epoch
- NNN is the burn delta-v with units of cm/sec (assumed decimal is one place from the right (i.e. NN.N))
- YYYYMMDDHHMMSS is the burn epoch

FDS Product Description	<filename>
NOMINAL Daily Predicted Ephemeris and Covariance Data	MEME_25994_terra_2960000_OPS_Terra_2019296_NOMINAL_S00_unclassified.txt
NO-BURN Daily Predicted Ephemeris and Covariance Data	MEME_25994_terra_2960000_SPEC_Terra_2019296_NOBURN_S00_unclassified.txt
RMM Predicted Ephemeris and Covariance Data	MEME_25994_terra_2960530_SPEC_296143805-011-20191023200000-

	SPMANV_unclassified.txt

Appendix A (Deleted)

Appendix A Orbit Interpolation Algorithm

This appendix contains documentation on the orbit interpolation algorithm and a sample algorithm implementation.

E.1 Orbit Interpolation Algorithm Limitations

In general, the routine should be implemented as follows:

a. The maximum acceptable gap length which may be filled using this routine is 60 seconds. In the event of a larger gap, FDS should be notified and requested to provide an ephemeris file to fill the gap.

b. Five points are required on either side of the gap to use in the interpolation scheme. These telemetry points must be fed into the routine via the POSARR and VELARR arrays such that array components 1-5 contain the points prior to the gap (point 5 would be the one at the edge of the gap and 1 would be the point earliest prior to the gap) and array components 6-10 contain the points following the gap (point 6 would be the one at the edge of the gap and 10 would be the point latest after the gap).

c. Data points used in filling the gap must be distinct, original data points, which meet all limit and spike checks imposed in DPREP, i.e. which are considered valid points. These data points must be from the original (TONS) data set, and must be comprised of 5 points on either side of the gap, i.e. five before and five after. The first valid data point must not be more than four AM1 packet intervals (normally 1.024 seconds, although small variations may exist) before the gap and the last valid data point must not be more than four such intervals after the gap.

Appendix A Spacecraft Table Load Parameters

F.1 Terra Tables Supported by FDS

F.1.1 List of Tables and Table Numbers

Table Name	ICD Section	Table Number
STAR_CATALOG_TBL	3.5 (EOS AM-1 Mission Star Catalog)	179
FSS_XFORM_TABLE	3.3 (Sensor Calibration Table)	125
SSST_EULER_PARAMS_TBL	3.3	178
IRU_XFORM_TBL	3.3	72
FSS_CAL_TBL	3.3	63
SSST_PARAMS_TBL	3.3	65
IRU_SCALING_TBL	3.3	70
IRU_BIASES_TBL	3.3	73
ATTITUDE_SLEW_TBL	3.4 (Attitude Slew Table)	126
DV_PARAMETERS_TBL	3.25 (Delta-V Parameters Table)	106
TDRS1_STATE_TABLE	3.11 (TDRS State Vectors)	272
TDRS2_STATE_TABLE	3.11	273
TDRS3_STATE_TABLE	3.11	274
TDRS4_STATE_TABLE	3.11	275
EOS_OE_TABLE	3.12 (EOS AM-1 Brouwer-Lyddane Elts)	201
TDRS1_OE_TABLE	3.13 (TDRS Brouwer-Lyddane Elts)	202
TDRS2_OE_TABLE	3.13	203
TDRS3_OE_TABLE	3.13	204
TDRS4_OE_TABLE	3.13	205
TUNING_PARAM_TABLE	3.16 (Filter Tuning Parameters)	261
STATE_ERROR_COV_TABLE	3.40 (AM-1 State Error Cov Matrix)	279
UT1_TABLE	3.54 (UTC to UT1 Timing Difference)	251
EOS_STATE_TABLE	3.56 (Predicted EOS AM-1 State Vector)	276
TDRS1_STATE_TABLE	3.57 (Simulated TDRS State Vectors)	272
TDRS2_STATE_TABLE	3.57	273
TDRS3_STATE_TABLE	3.57	274

TDRS4_STATE_TABLE	3.57	275
EOS_OE_TABLE	3.58 (Simulated EOS AM-1 Brouwer-Lyddane Elts)	201
TDRS1_OE_TABLE	3.59 (Simulated TDRS Brouwer-Lyddane Elts)	202

Table Name	ICD Section	Table Number
TDRS2_OE_TABLE	3.59	203
TDRS3_OE_TABLE	3.59	204
TDRS4_OE_TABLE	3.59	205
EOS_STATE_TABLE	3.60 (Simulated EOS AM-1 State Vector)	276
HARMONIC_COEFFICIENTS_TABLE	3.63 (EGM Spherical Harmonics Coeff)	254
DEGREE_VARIANCE_TABLE	3.64 (EGM Degree Variance)	280
MIN_DENSITY_COEFFS_TABLE	3.65 (Harris-Priester Atm. Density Model)	255
MAX_DENSITY_COEFFS_TABLE	3.65	256
SOLAR_EPHEM_MOD_TABLE	3.66 (Solar Ephem Modification Data)	253
EOS_MODEL_TABLE	3.67 (EOS AM-1 Modeling Data)	263
TDRS_MODEL_TABLE	3.68 (TDRS Modeling Data)	264
TDRS1_GRD_STN_TABLE	3.69 (Ground Antenna Modeling Data)	265
TDRS2_GRD_STN_TABLE	3.69	266
TDRS3_GRD_STN_TABLE	3.69	267
TDRS4_GRD_STN_TABLE	3.69	268
STATE_TOLER_TABLE	3.70 (State Tolerance Data)	269
MEAS_TOLER_TABLE	3.71 (Doppler Meas. Tolerance Data)	270
COV_TOLER_TABLE	3.72 (Covariance Tolerance Data)	271
TIME_STEP_TABLE	3.73 (Navigation Time Step data)	259
PHYS_CONST_TABLE	3.74 (Phys. And Math. Constants)	260
ATMOS_DRAG_TABLE	3.77 (Atm. Drag Data)	258
TDRS_MEAS_BIAS_TABLE	3.78 (TDRS Meas. Bias Data)	278
UT1_TABLE	3.79 (Simulated UTC to UT1 Timing Difference)	251
THRUSTER_TABLE	3.80 (Navigation Thruster Table)	257
FDIR_TAM_PREDICTS_TBL	3.84 (TAM FDIR Predict Table)	152
THRUSTER_CONTROL_PARS_TBL	3.85 (Thruster Control Parameters Table)	105

F.2 Table Load File Format

Header Record: 137 bytes.

Field Name	Maximum Field Width	Description
Satellite Id	8	The satellite id of the Terra spacecraft (“AM1”).
File Type	14	This field indicates the type of file. The only valid value is “TABLELOAD”.
File Creation Time	14	Time when the file was created in the form YYYYDDD.HHMMSS
Table Name	30	The table name as defined in the EMOS PDB.
Table Number	4	The unique number identifying this table in the EMOS PDB.
Destination	2	RT ID = 5 refers to SCC1, RT ID = 6 refers to SCC2.
Uplink Window Start	14	Start time of the valid uplink window in the form YYYYDDD.HHMMSS. This field contains 0.0 if the table can be uplinked at any time.
Uplink Window Stop	14	Stop time of the valid uplink window in the form YYYYDDD.HHMMSS. This field contains 0.0 if the table can be uplinked at any time.
Operations Window Start	14	Start time of the valid operations window of the table in the form YYYYDDD.HHMMSS. This field contains 0.0 if the table data is valid for all times.
Operations Window Stop	14	Stop time of the valid operations window in the form YYYYDDD.HHMMSS. This field contains 0.0 if the table data is valid for all times.

Data Records: 27 bytes.

Field Name	Maximum Field Width	Description

Table Field Number	4	Unique number which identifies a parameter within a table in the EMOS PDB.
Value	22	The new value to be loaded for this parameter.

Notes:

1. Partial table loads are supported by the EOC. However, the data records within a single table load file must be contiguous. For example, a partial load of table number 179, field numbers 13 through 16 may be supplied in a single table load file. A partial load of table number 179, field numbers 13-16 and 37-40 must be split into two different files before delivery to the EOC.
2. The Data Records within the Table Load file must appear in ascending Table Field Number order.
3. The parameter values appearing in the data records are classified into four data types:
   a. FL – Floating point data type (32 bit)
   b. IT – Integer data type (16 bit)
   c. LF – Long floating point data type (64 bit)
   d. LI – Long integer data type (32 bit)

The ASCII data format for each data type is specified as follows:

Data Type	**ASCII Format**	**Example**
FL	SX.XXXXXEsXX. (6 significant digits) S = "–" if negative. S = "+" if the exponent is positive, "–" if negative.	–123.4 -> "–1.23400E+02"
IT	SXXXXX. (up to 5 significant digits) S = "–" if negative.	123 -> "123"
LF	SX.XXXXXXXXXXEsXX. (11 significant digits) S = "–" if negative.	123.4 -> "1.2340000000E+02"

	S = “+” if the exponent is positive, “–” if negative.	
LI	SXXXXXXXXXX. (up to 10 significant digits) S = “–” if negative.	123 -> “123”

F.3 Table Load File Naming Convention

Reference Appendix C.

Appendix A Carryout File Description

G.1 Carry-Out File Data

A Carry-Out File is a standard output file created in response to an FOT request. The standard carry-out file format provides the means to represent different parameter data in a consistent manner. Created carry-out files are protected and available as “read-only”.

Carry-out files can be generated to contain the following data:

a. Terra spacecraft housekeeping data
b. Terra spacecraft health and safety data
c. Terra diagnostic telemetry data
d. Network Control Center (NCC) User Performance Data (UPD) message data
   [also known as operator data message (ODM) data]
e. EDOS Customer Operations and Data Accounting (CODA) message data

Carry-out files are transferred on an as-needed basis. Carry-out file size for electronic data transfer may not exceed the 2 GB UNIX file size limit. Physical media for the backup transfer mode permits a single 2 GB file to be written onto a single media volume.

G.2 Carry-Out File Format and Contents

The general format and contents of an EMOS carry-out file are shown in Table G-1. Carry-out file data is provided in the American Standard Code for Information Interchange (ASCII) format to the FDS Workstation. Each record in a carry-out file terminates with an ASCII new-line character. Fields within in a record are separated by the vertical bar “|” delimiter. Fields may vary in length up to the maximum size indicated. Data records in a file are ordered by the time associated with each data record.

Carry-out file contents vary depending on mission start and stop times and set of parameters specified in each FOT file generation request. Valid Parameter Mnemonics and Parameter IDs are found in the EOC Project

Database (PDB), the operational point of control for AM-1 spacecraft definition files, which are provided and validated through the collective effort of the FOT, the AM-1 spacecraft vendor, and other designated sources.

Each carry-out file includes one File Header, at least one Header Record, and one or more Data Records. A single Header Record is included for each spacecraft parameter addressed in a carry-out file. There may be one or more Data Records associated with each Header Record. Data Records map to the corresponding Header Record through the Parameter ID (PID). Data Records include converted data values and may also include raw data and decoded data. Converted data is presented in the form of engineering unit (EU) converted values or discrete state converted values. A sample carry-out file follows Table G-1.

Table G-1. Carry-Out File Data Format

Item No.	Data Item	Data Type	Max Size (in Bytes)	Values
- -	***File Header***	- -	- -	- -
H1	Time of First Parameter in string format, YYYY/DDD HH:MM:SS.MMM	String	ASCII 21B	Valid mission times
H2	Total Number of Header Records	16 Bit Integer	ASCII 5B	0 to 65535
- -	***Start Header Record***	- -	- -	- -
H3	Parameter Mnemonic	String	ASCII 20B	Valid Parameter Mnemonic per PDB
H4	EMOS Parameter ID	16 Bit Integer	ASCII 6B	Valid Parameter ID per EOC Data Base
H5	Terra PDB Parameter ID	16 Bit Integer	ASCII 5B	Valid Parameter ID per Terra PDB
H6	Data Type defined by: R = Real I = Integer S = String (e.g. Discrete State String)	Character	ASCII 1B	R, I or S
H7		N/A	0B	N/A
- -	***End Header Record*** *[Repeat Header Record for each Parameter]* - -			
- -	***Start Data Record***	- -	- -	- -

D1	Time of Parameter, stated as offset time from Item H1 the start time of the first parameter. The offset is calculated from the onboard sample time.	Real 8 Byte Floating Point Number	ASCII 16B	Offset Time in Seconds
D2	EMOS Parameter ID	16 Bit Integer	ASCII 6B	Valid Parameter ID per EOC Data Base
D3	Terra PDB Parameter ID	16 Bit Integer	ASCII 5B	Valid Parameter ID per Terra PDB
D4	Raw value [1] (Raw values are not reported for ground telemetry.)	Integer	ASCII 10B	All
D5	Converted value	Variable per Item H6	ASCII 20B	Real number in exponential format
D6	Decoded value [1]	32 Bit Integer	ASCII 10B	All

Note 1: Field is unfilled when value does not exist for the parameter identified. See sample record.

Table G-1. Carry-Out File Data Format (Continued)

Item No.	Data Item	Data Type	Max Size (in Bytes)	Values
D7	Status Word, containing data for status flags arranged as bits in a 32 Bit Integer where Bit 0 is the Least Significant Bit. Bit 0 RedHi Bit 1 RedLow Bit 2 YellowHi Bit 3 YellowLow Bit 4 Delta Limit Bit 5 Rail Limit Bit 6 Bad Quality Bit 7 Conversion Error Bits 8-31 Reserved for Future Use Note: bits 0-3 are mutually exclusive	32 Bit Integer	ASCII 10B	1 = true, 0 = false for bits 0-7
- -	***End Data Record (End Line)*** *[Repeat D1 – D7 until End of File]*			- -

Sample Carry-Out File Record

Sample Record	Sample Record Data Description
1999/234 19:23:43.024	time of first parameter
3	total number of header records
MPSEMISA1|123|23IR||	first header record
MPSEMISA2|124|24IR||	second header record
MPSEPMONOUT2|13456I3456|I||	last header record. Rest of file is data.
0.0|123|23I029|23.5676||0	data record for EMOS Parameter ID 123, no decoded value
0.001|124|24I099|83.5676||4	data record for EMOS Parameter ID 124, no decoded value
0.052|123|23I029|23.5676||0	data record for EMOS Parameter ID 123, no decoded value
0.055|124|24I089|80.5676||4	data record for EMOS Parameter ID 124, no decoded value
1.000|13456|3456I4294967295||-1|0	data record for EMOS Parameter ID 13456, no converted value

.....etc.....

For each mnemonic in the PDB, its data type is determined based on the following algorithm:

If PDB field “State Text” is defined (state mnemonic) Then
Item H6 will have the value “S” (string)
Else If PDB field “Data Rep” is “FL” (floating point) Then
Item H6 will have the value “R” (real)
Else If PDB field “Scale Factor” is not empty OR
PDB field “C zero” is not empty OR
PDB field “C one” is not empty OR
PDB field “C two” is not empty OR
PDB field “C three” is not empty OR
PDB field “C four” is not empty OR
PDB field “C five” is not empty Then
Item H6 will have the value “R” (real)
Else
Item H6 will have the value “I” (integer)

G.3 Carry-Out File Data Transfer Method

The EMOS accesses spacecraft data and formats an FOT operator-specified data set into a carry-out file. The carry-out file is delivered to the FDS Workstation using SFTP as described in Section 2.4.2. Files are transferred directly to a directory on the FDS Workstation. (Information on the directory names and locations can be found in Reference 9.) The FDS reads the transferred ASCII carry-out files in the directory and ingests the necessary spacecraft data for processing.

G.4 Carry-Out File Data Transfer Error Handling

Collocation of the EOC User Stations and the FDS Workstation within the EOC enables quick and easy operator correction of data transfer errors. Carry-out file data errors are operator corrected by regeneration of the carry-out file from the EMOS. For loss of communication interface between the EMOS and the FDS Workstation, operator intervention permits transfer of data using physical media. Interruption of SFTP requires FOT operator intervention to reinitialize SFTP transfer from the EOC User Station.

Appendix A Abbreviations, Acronyms, and Symbols

\	line continuation symbol
\n	new line symbol
ACS	Attitude Control System
AGS	Alaska Ground Station
ASCII	American Standard Code for Information Interchange
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
CCSDS	Consultative Committee for Space Data Systems
CCTV	Closed Circuit Television
CERES	Clouds and Earth's Radiant Energy System
CMS	Command Management System
cov	covariance
CSS	Coarse Sun Sensor
DAACs	Distributed Active Archive Centers
DAT	digital audio tape
DCE	distributed computing environment
deg	degree
deg/s	degrees per second
DMR	Detailed Mission Requirements
EBnet	EOSDIS Backbone Network
ECEF	Earth-Centered Earth-Fixed
ECI	Earth Centered Inertial
EDOS	EOS Data and Operations System
ELV	Expendable Launch Vehicle

EMOS	EOS Mission Operations System
EOC	EOS Operations Center
EOS	Earth Observing System
ESMO	Earth Sciences Mission Operations
ESA	Earth Sensor Assembly
ESE	Earth Science Enterprise
FDAB	Flight Dynamics Analysis Branch
FDE	Flight Dynamics Engineer
FDF	Flight Dynamics Facility
FDIR	fault detection isolation and recovery
FDS	Flight Dynamics System
FDT	Flight Dynamics Team
FL	floating point data type (32 bit)
FOT	Flight Operations Team
FOV	Field of View
FSS	Fine Sun Sensor
GHA	Greenwich hour angle
GSFC	Goddard Space Flight Center
GN&CS	Guidance, Navigation and Control Subsystem
HGA	High Gain Antenna
HTML	hyper-text markup language
Hz-S	S-band Hertz
ICD	Interface Control Document
IP	Internet Protocol
IRU	Inertial Reference Unit
IT	integer data type (16 bit)
kg	kilogram
km	kilometer
km/s	kilometers per second

LF	long floating point data type (64 bit)
LI	long integer data type (32 bit)
LOF	Local Oscillator Frequency
LVLH	local horizontal-local vertical
m	meter
m/s	meters per second
µs	microsecond
MISR	Multi-angle Imaging SpectroRadiometer
MOPITT	Measurements of Pollution in the Troposphere
ms	millisecond
MSR	Monthly Status Report
MTR	Magnetic Torquer Rod
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications
NCC	Network Control Center
NU	No unit (or unitless)
OE	Orbital Element
OEM	Orbit Ephemeris Message
OPM	Orbit Parameter Message
P_c	Probability of Collision
PI	Principal Investigator
PID	Parameter ID
RAAN	right ascension of ascending node
rad	radian
rad/s	radians per second
RMM	Risk Mitigation Maneuver
RSS	root sum square
RT	Remote Terminal
RTADS	Real-Time Attitude Determination System

s	second
SCC	Spacecraft Controls Computer
SDPS	Science Data Processing Segment
SFTP	Secure File Transfer Protocol
SGS	Svalbard Ground Station
SSIM	Spacecraft Simulator
SSST	Solid State Star Tracker
STGT	Second TDRSS Ground Terminal
TAM	Three-Axis Magnetometer
tar	tape archive retrieval
TBD	To Be Determined
TCA	time of closest approach
TDRS	Tracking and Data Relay Satellite
TDRSS	Tracking and Data Relay Satellite System
TGSS	TONS Ground Support System
TONS	TDRS Onboard Navigation System
WOTS	Wallops Orbital Tracking Station
WSGTU	White Sands Ground Terminal Upgrade
UTC	Universal Time Coordinated