DRAFT

SPACE ENVIRONMENT SENSOR SUITE (SESS)

Sensor Requirements Document (SRD)

for

NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS) SPACECRAFT AND SENSORS

Prepared by

Associate Directorate for Acquisition
NPOESS Integrated Program Office

Version One 19 JAN 99 [DRAFT]
revised 10 June 99

NOTICE

This draft SESS SRD is for evaluation purposes only. Contractors are advised that the list of SESS Primary EDRs and the EDR parameters are those proposed by the NPOESS Space Environment Steering Group (SESG). This list has not yet been officially recognized by the NPOESS. Only the SESS unique sections of the SRD are included herein. Please reference the common section of the SRD available from the Contractor's Library.

Integrated Program Office
Silver Spring MD 20910

TABLE OF CONTENTS

Table of Contents for SESS SRD Common Section

The following paragraphs of the SESS SRD can be found in the SRD "Common Section". The following SRD Common Section Table of Contents is for reference only. Page numbers have been intentionally omitted.

LIST OF FIGURES

LIST OF TABLES

APPENDICES

DRAFT

1. SCOPE

1.1 IDENTIFICATION

This Sensor Requirements Document (SRD) sets forth the requirements for the Space Environmental Sensor Suite (SESS) of the National Polar-orbiting Operational Environmental Satellite System (NPOESS). The SESS is alternatively referred to as the Sensor Suite. The sensor vendor responsible for the development of the SESS is referred to as the Contractor. The cognizant government Purchasing Contracting Officer is referred to as the Government.

1.2 SENSOR SUITE OVERVIEW

The SESS is the complement of sensors and algorithms used to provide the Space Environmental Parameters as specified in the NPOESS Integrated Operational Requirements Document (IORD-I). These data provide information about the space environment necessary *to ensure* reliable operations of current space-based and ground-based systems, *to facilitate* the analysis of system anomalies that are the result of space environmental effects, and *to guide* the design and efficient operations of future systems that may be affected by the space environment. General aspects of the space environment known to be important to these activities include; 1) thermospheric densities, temperatures, and composition, 2) ionospheric densities, temperatures, and ion composition and electron-ion bulk motions, 3) energetic charged particle fluxes extending from suprathermal to high energies, and 4) solar and magnetospheric energy inputs that couple to the thermosphere and ionosphere. Within the context of this SRD the processed Space Environmental Parameters are referred to as the space Environmental Data Records (EDRs) and the unprocessed sensor data are referred to as the Raw Data Records (RDRs).

The SESS consists of both the space sensor(s) used to acquire the RDRs and the algorithms needed to process the EDRs in the Interface Data Processor Segment (IDPS). The IDPS refers to the data processing elements within Centrals and Field Terminals that are needed to receive and process the RDRs into the EDRs. It is the responsibility of the Contractor to optimize the SESS architecture for providing the assigned set of space EDRs by *developing* specific space-environmental sensors, *leveraging* other NPOESS sensor data products, and *utilizing* ancillary space environmental data as available within the IDPS and the Government's Space Environmental Support System. The space environment should be viewed, where practical, as a coupled system and the successful determination of the individual space EDRs should fully exploit this fact.

1.3 DOCUMENT OVERVIEW

This document contains all performance requirements for the SESS. This document also defines all SESS-to-spacecraft interfaces. The Contractor should use this document as the basis of the Sensor Suite specification. Throughout this document, the following definitions apply:

- ***TBD*** (To Be Determined) applied to a missing requirement means that the Contractor should determine the missing requirement in coordination with the Government

- ***TBS*** (To Be Specified) means that the Government will specify the missing information in the course of the contract
- ***TBR*** (To Be Resolved) means that the requirement is subject to review for appropriateness by the Contractor or the Government. The Government may change "[*TBR*]" requirements in the course of the contract

The document is structured as follows; Section 1 provides some general background and definitions applicable to the specification, Section 2 provides the set of Applicable Documents, Section 3 are a set of unique requirements applicable to the SESS and common requirements applicable to all NPOESS sensors, Section 4 discusses Quality Assurance, and Section 5 discusses the requirements for delivery of the Sensor Suite. Appendix A contains a definition of the terms used throughout the document. Appendix B, NPOESS survivability requirements, is classified and, if applicable, will be made available after contract award. Appendix C is a Sensor Data Record Characteristics section, presently *TBS*. Appendix D is not used. Appendix E contains the RDRs and EDRs required for each Central and Field Terminal (TBR). Appendix F defines the acronyms and abbreviations used throughout the document. Appendix G describes Potential Pre-planned Product Improvements. Appendix H is the Verification Cross Reference Matrix [*TBD*].

1.3.1 Conflicts

SRDX1.3.1-1
The Contractor shall use the contents of this specification as the superseding set of requirements in the event of conflict between the referenced documents and the contents of this specification.

SRDX1.3.1-2
The Contractor shall comply with the Government's order of precedence [*TBS*] in the event of a conflict involving the external interface requirements or in the event of any other unresolved conflict.

1.3.2 Requirement Weighting Factors

The requirements stated in this specification are not of equal importance or weight. The following three paragraphs define the weighting factors incorporated in this specification:

- ***Shall*** designates the most important weighting level; that is, mandatory. A *shall* designates a contractually-mandated requirement. Any deviation from a mandatory requirement requires the approval of the Government.
- ***Should*** designates requirements requested by the Government that are not mandatory. Unless required by other contract provisions, noncompliance with a *should* requirement does not require approval of the Government.
- ***Will*** designates the lowest weighting level. These *will* requirements designate the <u>intent</u> of the Government and are often stated as examples of acceptable designs, items, and practices. Unless required by other contract provisions, noncompliance with a *will* requirement does not require approval of the Government.

1.4 SYSTEM CLASSIFICATIONS N/A

2. APPLICABLE DOCUMENTS

The documentation listed in this section follows an approach of minimum specifications and standards. The Contractor may add to or revise the documents listed in this section in coordination with the Government.

2.1 GOVERNMENT DOCUMENTS

The following documents of the exact issue shown form a part of this SRD to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1. Tailoring of documents in this section is *TBR*.

SPECIFICATIONS:

Military

DOD-E-83578A May 96	General Specification for Explosive Ordnance for Space Vehicles
Mil-A-83577B Feb 88	Moving Mechanical Assemblies for Space Launch Vehicles
MIL-C-24308 Apr 97	General Specification for Connectors, Electric, Rectangular, Non-Environmental, Miniature, Polarized Shell, Rack, and Panel
MIL-C-38999 Dec 97	Connectors, Receptacle, Electrical, Circular, Breakaway Wall Mounting Flange, Removable Crimp Contacts, Sockets, Series III, Shell Size 25, Metric

STANDARDS:

Federal

FED-STD-209E Sep 92	Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones

Military

MIL-STD-461D Jan 93	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462D Jan 93	Measurement of Electromagnetic Interference Characteristics
MIL-STD-975 Aug 94	NASA Standard Electrical, Electronic, and Electro-mechanical (EEE) Parts List, Revision M, 5 May 1998

MIL-STD-1540C Sep 94	Test Requirements for Launch, Upper Stage, and Space Vehicles
MIL-STD-1541A Dec 87	Electromagnetic Compatibility Requirements for Space Systems
MIL-STD-1553B Jan 96	Digital Time Division Command/Response Multiplex Data Bus

Department of Commerce/NOAA None (TBR)

OTHER PUBLICATIONS:

Regulations

AFM 91-201 7 Oct 94	Explosive Safety Standards
EWR 127-1 31 Mar 95	Eastern and Western Range Safety Requirements

Handbooks None (TBR)

Bulletins None (TBR)

Other

GPS ICD 200, REV C 19 January 1995	“NAVSTAR GPS Space Segment/Navigation User Interface”(U)
GPS ICD 203, REV B 22 Dec 1993	“NAVSTAR GPS SA/AS Requirements” (U) SECRET

Note: Contractors requiring copies of specifications, standards, handbooks, drawings, and publications in connection with specified acquisition functions should obtain them from the contracting activity or as directed by the Government.

2.2 NON-GOVERNMENT DOCUMENTS

The following documents of the exact issue shown form a part of this SRD to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1.

STANDARDS:

Military

CCSDS 203.0-B-1 Jan 87	CCSDS Recommendations for Space Data System Standards. Telecommand, Part 3: Data Management

	Service, Architectural Definition, Issue 1
CCSDS 701.0-B-2 Nov 92	CCSDS Recommendations for Advanced Orbiting Systems, Networks and Data Links, Architectural Specification
ISO/TC 209 (ISO/DIS 14644-1) Jan 97	Cleanrooms and Associated Controlled Environments
National Aerospace Standard (NAS) 411 Rev 2, 29 Apr 94	Hazardous Materials Management Program
SAE AS1773 May 88	Fiber Optics Mechanization of an Aircraft Internal Time Division Command/Response Multiplex Data Bus

2.3 REFERENCE DOCUMENTS

The following documents are for reference only and do not form a part of this specification. They are listed here because various parts of the SRD refer to them.

STANDARDS:

ANSI/ISO 9899-1990	Programming Language—C
DOD 5200.28-STD Mar 88	Department of Defense Trusted Computer System Evaluation Criteria
EIA/IEEE J-STD-016 30 Sep 95	Standard for Information Technology, Software Life Cycle Processes, Software Development, Acquirer-Supplier Agreement
MIL-STD-129M 1 Jun 93	Marking for Shipment and Storage Notice 1, 15 Sep 89
MIL-STD 961D Aug 95	DoD Standard Practice for Defense Specifications, w/ Notice 1
MIL-STD-882c Jan 93	System Safety Program Requirements

MIL-STD-1246C Apr 94	Military Standard Product Cleanliness Levels and Contamination Control Program
MIL-STD-1522A May 84	Standard General Requirements for Safe Design and Operation of Pressurized Missile and Space Systems, Notice 2: 20 Nov 86; Notice 3: 4 Sep 92
MIL-STD-1542B Nov 91	Electromagnetic Compatibility (EMC) and Grounding Requirements for Space Systems Facilities
MIL-STD-1543B Oct 88	Reliability Program Requirements for Space and Launch Vehicles
MIL-STD-1547A Dec 92	Parts and Materials Program for Space and Launch Vehicles
MIL-STD-1809 Feb 91	(USAF) Space Environments for USAF Space Vehicles
MIL-STD-1815A	ADA Programming Language
TM-86-01	Technical Manual Contract Requirements

Department of Commerce

DOC Sep 95 Edition Sep 95	National Telecommunications and Information Administration, Manual of Regulations for Federal Radio Frequency Management

NOAA

S24.801 Nov 72	Preparation of Operations and Maintenance Manuals, Revised Apr 97
S24.806 Jan 86	Software Development, Maintenance, and User Documentation, Revised Apr 94
S24.809 Dec 89	Grounding Standards

NASA

PPL-21 March 1995	Preferred Parts List, Goddard Space Flight Center (Updated May 1996)
SP-R-0 022A (JSC) 9 Sep 74	General Specification, Vacuum Stability Requirements of Polymeric Material for Spacecraft Application

NASA Tech Memo 100471	Orbital Debris Environments for Spacecraft Designed to Operate in Low Earth Orbit
SP 8031 1969	NASA Space Vehicle Design Criteria/Structures

OTHER PUBLICATIONS:

Regulations None (TBR)

Handbooks

DOD-HDBK-263B (date)	Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies, Equipment
MIL-HDBK-340 1 Jul 85	Application Guidelines for MIL-STD-1540B
DOD-W-83575 Jun 96	Gen Spec for Wiring Harness, Space Vehicle, Design and Testing
MIL-I-46058	Insulating Compound, Electrical (for Coating Printed Circuit Assemblies)
1985	Handbook of Geophysics and Space Environments
AFM 15-111 1 Sep 96	Surface Weather Observations

Other

TRD for NPOESS (current version)	Technical Requirements Document (TRD) for National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Spacecraft Payloads
IRD for NPOESS (current version)	Interface Requirements Document (IRD) for National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Spacecraft
IORD for NPOESS 28 Mar 96	Integrated Operational Requirements Document (IORD) for National Polar Orbiting Operational Environmental Satellite System (NPOESS) Spacecraft Payloads
ASTME-595-93 (current version)	Standard Test method for Total Mass Loss and Collected Volatile Condensable Materials for Outgassing in a Vacuum Environment

DRAFT

Attachment C S-480-80 Revised December 1994	AMSU-A Instrument Performance and Operation Specification (for the EOS/METSAT Integrated Programs); NASA GSFC
SYS/AMS/J0105/ BAE 03 Feb 1993	AMSU-B Instrument System Specification (British Aerospace)

Note: Technical society and technical association specifications and standards are generally available from reference libraries. They are also available in technical groups and using federal agencies. Contact the Government regarding any referenced document not readily available from other sources.

3. SENSOR REQUIREMENTS

3.1 DEFINITION

3.1.1 Sensor Suite Description

The SESS is one of several sensors under development by the Integrated Program Office (IPO) for utilization on POES and DMSP spacecraft and on NPOESS-era satellite constellations. The NPOESS-era satellites on which the SESS are to be deployed include the NPOESS and the METOP.

3.1.1.1 General Sensor Characteristics

The SESS consists of the space hardware needed to *measure* the SESS-assigned RDRs and the associated algorithms needed to *process* the SESS-assigned EDRs. The focus in the development of the SESS is to optimize the production of the SESS-assigned EDRs within the NPOESS IDPS. General sensor characteristics are purposely left vague thereby providing the Contractor with the maximum flexibility to design a cost-effective Sensor Suite that can be accommodated on the NPOESS and METOP spacecraft. Where possible and appropriate, the SESS should use other environmental sensors to maximize the EDR performance.

SRDS3.1.1.1-1
The SESS shall be capable of producing the SESS-assigned set of EDRs and RDRs.

SRDS3.1.1.1-2
The SESS shall consist of one or more sensors and other discrete components the sum of which comply with the overall constraints of this SRD.

SRDS3.1.1.1-3
The Contractor shall determine the overall SESS characteristics and performance parameters needed to satisfy the assigned set of EDRs.

SRDS3.1.1.1-4
The Contractor shall determine the most cost-effective functional architecture and specifications for the SESS; that is type, number, and characteristics for each functional component.

3.1.2 Specification Tree

Figure 3.1.3 shows a partial specification tree for the NPOESS System. This tree shows the flowdown in tractability of specification from the NPOESS TRD to the spacecraft IRD to the various sensor specifications. This SRD is used as the basis for producing the sensor specification for the SESS.

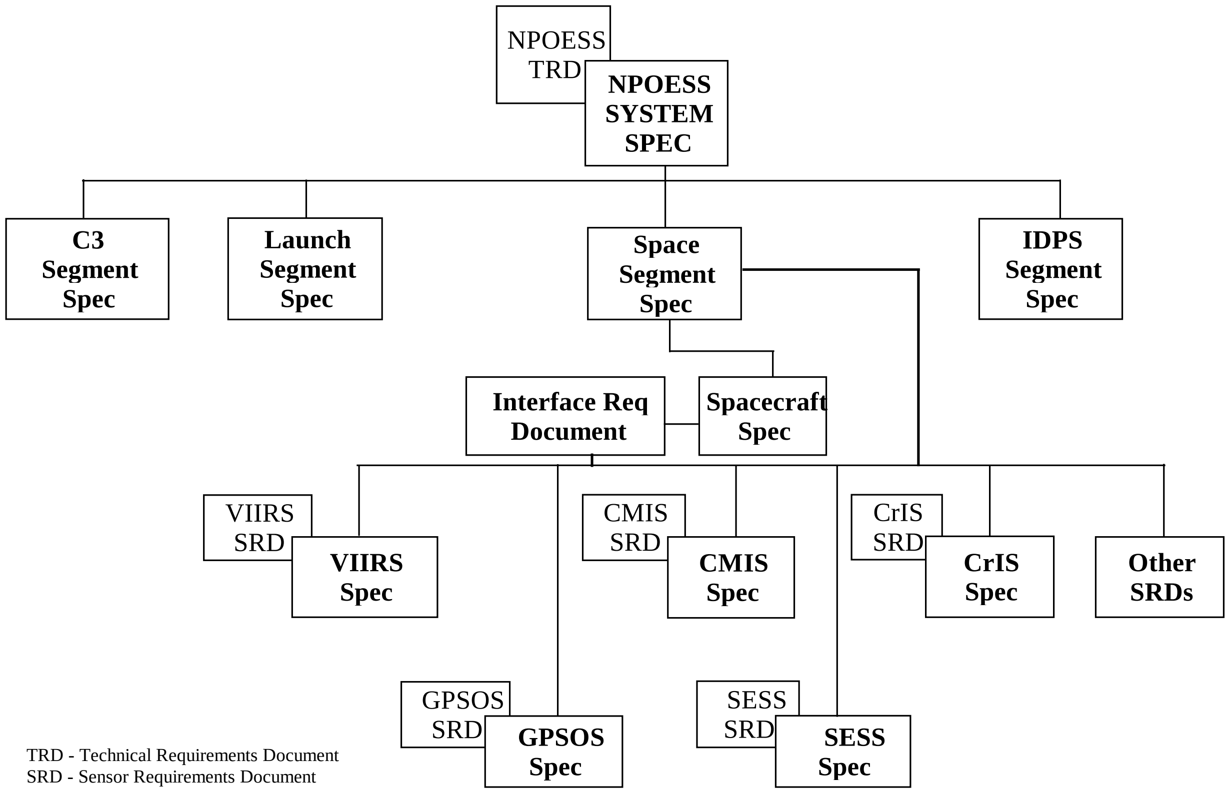

Figure 3.1.2 Partial Specification Tree for the NPOESS System

3.1.3 Top-Level Sensor Suite Functions

The SESS has the following top-level functions:

- *Measure* the space environmental EDRs
- *Assess* the Sensor Suite health and status
- *Format* the space environmental RDRs and status data
- *Interface* with host spacecraft
- *Process* RDRs into EDRs

SRDS3.1.3-1
The SESS shall measure the space environment per the assigned EDRs.

SRDS3.1.3-2
The SESS shall assess Sensor Suite health and status.

SRDS3.1.3-3
The SESS shall format the space environmental RDRs and the Sensor Suite health and status data.

SRDS3.1.3-4
The SESS shall interface for the host spacecraft for all command, control, and communication (C^3) functions.

SRDS3.1.3-5
The SESS shall provide the algorithm methodology to process the RDRs into EDRs within the IDPS.

3.1.4 Sensor Suite Modes

The SESS command structure consists of Common Sensor Modes and sensor unique Other Sensor Modes and Sub-modes.

3.1.4.1 Common Sensor Modes

The following Common Sensor Modes are common to all NPOESS sensors:

- OFF Mode
- OPERATIONAL Mode
- SAFE-HOLD Mode
- AUTONOMOUS Mode
- DIAGNOSTICS Mode

3.1.4.1.1 OFF Mode

SRDS3.1.4.1.1-1
The SESS shall have an OFF mode. The spacecraft commands the sensor into the OFF mode. In the OFF mode, no power is provided to the SESS.

3.1.4.1.2 OPERATIONAL Mode

SRDS3.1.4.1.2-1
The SESS shall have an OPERATIONAL mode. In the OPERATIONAL mode only Sensor Power is provided to the SESS. See Section 3.2.4.3.3.2.3 for a description of Sensor Power.

SRDS3.1.4.1.2-2
The SESS shall collect and process RDRs and sensor Health and Status Telemetry Data in the OPERATIONAL Mode.

SRDS3.1.4.1.2-3
The SESS shall have full functionality while in the OPERATIONAL modes. Full functionality means that the Sensor Suite collects and processes RDR data of sufficient quality so that the SESS-assigned EDRs can be provided at the threshold level. The SESS may have one or more Operational Sub-Modes, which can exceed full functionality for the Sensor Suite. Specification of these Operational Sub-Modes is *TBD*.

3.1.4.1.3 SAFE-HOLD Mode

In the SAFE HOLD mode, health and status data are collected and transmitted. Mission and calibration data are not collected. In the Safe Hold mode, most components are turned off, with survival heaters activated.

SRDS3.1.4.1.3-1
The SESS shall have a SAFE-HOLD mode.

SRDS3.1.4.1.3-2
The SAFE HOLD mode is a power conservation mode. The sensor shall accept a command in the event the spacecraft enters an anomalous configuration or orientation as determined by the spacecraft computer. A power subsystem anomaly is such an event.

SRDS3.1.4.1.3-3
The spacecraft C&DH will issue power conservation re-configuration commands to the sensors, via the data bus, that will place the sensor in a safe configuration. The return from SAFE-HOLD to the OPERATIONAL mode shall require ground intervention.

SRDK3.1.4.1.3-4
In this mode most components shall be turned off, with only survival heaters activated. See Section 3.2.4.3.3.2.1 for a description of Survival Heater Power

3.1.4.1.4 AUTONOMOUS Mode

SRDS3.1.4.1.4-1
The SESS shall have an AUTONOMOUS mode. The SESS must operate continuously while in this mode with no commands from the ground. In the AUTONOMOUS mode only Sensor Power is provided to the SESS.

SRDS3.1.4.1.4-2
The SESS shall collect and process RDRs and sensor Health and Status Telemetry Data in the OPERATIONAL Mode. The functionality of the SESS while in AUTONOMOUS mode is *TBS*.

SRDS3.1.4.1.4-3
The SESS shall be capable of operating in the AUTONOMOUS mode for 21 days. As an objective, the SESS should be capable of operating in the AUTONOMOUS mode for a minimum of 60 days.

3.1.4.1.5 DIAGNOSTIC Mode

SRDS3.1.4.1.5-1
The SESS shall have a DIAGNOSTIC mode. The DIAGNOSTIC mode is used primarily for Sensor Suite trouble-shooting and to upload new flight software to the Sensor Suite.

SRDS3.1.4.1.5-2
The SESS shall collect and process RDRs and sensor Health and Status Telemetry Data in the DIAGNOSTIC Mode. The functionality of the SESS while in DIAGNOSTIC mode is *TBS*.

SRDS3.1.4.1.5-3
The SESS flight software shall be 100% [*TBR*] re-programmable by command from the ground while in the DIAGNOSTIC mode.

3.1.4.2 Other Sensor Modes

3.1.4.2.1 LAUNCH Mode

SRDS3.1.4.2.1-1
The SESS shall have a LAUNCH Mode.

3.1.4.2.2 EARLY-ORBIT CHECKOUT Mode

SRDS3.1.4.2.2-1
The SESS shall have an EARLY-ORBIT CHECKOUT Mode. This mode is used during early-orbit operations to transition from the LAUNCH Mode to the OPERATIONAL Mode. The specification and characteristics of the EARLY-ORBIT CHECKOUT Mode are *TBD*.

3.1.4.2.3 CALIBRATION Mode

SRDS3.1.4.2.3-1
The SESS shall have a CALIBRATION Mode. This mode is used to update or validate the Sensor Suite calibrations provided with the RDRs. The specification and characteristics of the CALIBRATION Mode are *TBD*.

SRDS3.1.4.2.3-2
The SESS shall collect and process selected [*TBD*] RDRs and sensor Health and Status Telemetry Data in the CALIBRATION Mode.

3.1.4.3 Sensor Suite Mode Documentation

SRDS3.1.4.3-1
The Contractor shall provide the specification of all SESS Common Sensor Modes and Other Sensor Modes. These specifications are to be included in the sensor-unique ICD.

SRDS3.1.4.3-2
The Contractor shall provide the specification of all SESS reconfiguration commands used within each Common Sensor Mode or Other Sensor Mode and for transitioning between modes. These specifications are to be included in the sensor-unique ICD.

3.1.5 Operational and Organizational Concept

3.1.5.1 Launch Operations Concept

3.1.5.1.1 Pre-Launch

Spacecraft integration is performed prior to shipment to the launch site. The satellite is transported directly to the launch site for final vehicle preparations and checkout. Final inter-segment and launch system verification tests are to be completed prior to launch.

3.1.5.1.2 Launch and Injection

During launch and injection to the operational orbit the various spacecraft subsystems may be powered on or turned off in order to protect the spacecraft from the launch and injection environments or to comply with other constraints. Spacecraft telemetry to monitor vehicle and status will be provided during launch and injection. Transmission of launch vehicle telemetry may satisfy this requirement during the launch phase. Spacecraft telemetry transmission to ground monitoring stations are to be used to the maximum extent practicable during the injection phase. After insertion into its operational orbit and separation from the launch vehicle, appropriate deployments will be initiated by memory command. Early orbit check-out is to be conducted at the NPOESS primary SOC in Suitland, MD.

3.1.5.2 On-orbit Operational Concept

3.1.5.2.1 Overview

The NPOESS satellite is to operate in a near circular, sun-synchronous orbit. The nominal orbit for the satellite is 833 km altitude, 98.7^o inclination. The NPOESS orbit is a "precise" orbit; that is, the altitude is maintained to ± 17 (TBR) km, ± 0.05 (TBR) degrees inclination, and the nodal crossing time is maintained to ±10 minutes throughout the mission lifetime, to minimize the orbital drift (precession). The METOP will have similar characteristics. The NPOESS satellites must be capable of flying at any equatorial nodal crossing time. The nominal configuration for the three-satellite “NPOESS plus METOP” constellation has equally spaced nodal crossings (ascending) with NPOESS at 1730 and 1330 local times and METOP at 2130 local time.
The satellite will only be flown in orbits that keep sunlight off of the cold space side of the spacecraft. Because of natural variations in the orbit, the 10 minute nodal crossing time constraint, and variations in the solar illumination of the satellite, this will preclude the spacecraft from flying in orbits within about 30 (TBR on satellite contractor) minutes of noon.

SRDS3.1.5.2.1-1
Specified EDR performance shall be obtained for any of the orbits described in paragraph 3.1.5.2.1, except for orbits within about 30 (TBR on satellite contractor) minutes of noon.

3.1.5.2.2 On-orbit Satellite Checkout and Payload Performance Verification

The initial on-orbit period is to be used for satellite checkout and payload performance verification, including calibration. Following the initial checkout period, if appropriate, the satellite will transition to the operational phase. Nominally, the satellite will remain in the operational phase until the failure of a key sensor. After failure of a key sensor, the satellite will transition into a non-operational phase although the satellite may continue to collect and process RDRs to be used to provide auxiliary data. Satellite checkout and payload performance verification testing may be performed during any phase of the mission.

SRDS3.1.5.2.2-1
The Contractor shall specify the SESS performance verification criteria to be used for On-orbit Checkout and Payload Performance Verification. The SESS performance verification criteria are to be included in the sensor-unique ICD.

3.1.5.2.3 On-Orbit Operations

The nominal operating mode for on-orbit operations of the SESS is the OPERATIONAL Mode. At both specified (pre-planned) intervals and at unscheduled times, the SESS may be commanded into any Common Sensor Mode or Other Sensor Mode or self-command itself into selected Common Sensor Modes or Other Sensor Modes. Pre-planned mode changes are typically used to re-calibrate or validate the sensor calibration and to optimize the Sensor Suite performance capabilities; for example, day versus night.

SRDS3.1.5.2.3-1
The SESS shall be capable of being commanded by the spacecraft into any Common Sensor Mode thereby overriding any pre-programmed modes or prior mode-switching commands.

SRDS3.1.5.2.3-2
The SESS shall be capable of self-commanding the Sensor Suite into selected [*TBD*] modes.

3.1.6 Sensor Mission

The mission of the SESS is to provide high-quality data on the space environment per the assigned set of EDRs to support worldwide DoD and civilian operations and other high-priority programs.

3.2 SENSOR SUITE CHARACTERISTICS

3.2.1 Performance Characteristics

The performance characteristics for the SESS are defined by the product-level requirements as specified by the attributes of the SESS EDRs.

SRDS3.2.1-1
The Contractor shall derive the performance characteristics based on a flowdown of EDR requirements to instrument performance requirements using the Contractor’s EDR algorithms.

3.2.1.1 EDR Requirements

EDR requirements are broken into two categories specified as Primary EDRs and Secondary EDRs. Primary EDRs refer to those EDRs for which a sensor has been assigned primary responsibility. Primary responsibility includes sensor development <u>and</u> algorithm specification. The approach defined by the Contractor may or may not require the use of ancillary data from other than the Sensor Suite. Ancillary data includes, but is not limited to, data provided by other NPOESS sensors. Secondary EDRs refer to those EDRs for which the Sensor Suite may provide ancillary data to an EDR algorithm that is assigned to another NPOESS sensor.

3.2.1.1.1 Requirements Format

EDR requirements are specified by a general description of the data record, the physical units for the reported data, and a set of EDR attributes or parameters. The general descriptions for the EDRs are in narrative format. The physical units vary by EDR. The parameters for the EDRs are divided into four basic categories describing the data content, data quality, reporting frequency, and timeliness of the product. The categories are further specified in terms of the following EDR parameters:

- Data Content
    - Measurement range
    - Horizontal cell size
    - Vertical cell size
    - Horizontal coverage
    - Vertical coverage
- Data Quality
    - Measurement uncertainty
    - Measurement accuracy
    - Measurement precision
- Reporting frequency
    - Horizontal reporting interval
    - Vertical reporting interval
    - Maximum local average revisit time
    - Maximum local refresh
- Timeliness
    - Timeliness

SRDS3.2.1.1-1
The Contractor shall identify any variations in the approved definitions for these parameters that may be required to specify particular EDRs. The Contractor is advised to consult Appendix A for the approved definitions of the EDR parameters.

3.2.1.1.2 Parameter Values

Values for the EDR parameters are specified at both the Threshold level and at the Objective level. The Objective level is always more stringent than or equal to the Threshold level. An Objective-level parameter is only indicated if a parameter value more stringent than the Threshold level is considered to be of value. An EDR is satisfied at the Threshold level if all EDR parameters can be met at the Threshold level. An EDR is satisfied at the Objective level if all EDR parameters can be met at the Objective level.

3.2.1.1.2.1 Parameter Values Expressed in Physical Units

SRDS3.2.1.1.2.1-1
The Contractor shall interpret a parameter value expressed in physical units to be the value for that parameter averaged over the sample region defined by the vertical and horizontal cell sizes, unless otherwise specified.

3.2.1.1.2.2 Parameter Values Expressed as Percentages

SRDS3.2.1.1.2.2-1
The Contractor shall interpret a parameter value expressed as a percentage to be the percentage of the true value of that parameter averaged over the sample region defined by the vertical and horizontal cell sizes, unless otherwise specified.

3.2.1.1.3 SESS Primary EDRs

The following Primary EDRs are assigned to the SESS:

- Auroral Boundary (Appendix D, Section 40.8.1)
- Auroral Energy Deposition (Appendix D, Section 40.8.2)
- Auroral Imagery (Appendix D, Section 40.8.3)
- Electric Field (Appendix D, Section 40.8.4)
- Electron Density Profile (Appendix D, Section 40.8.5)
- Geomagnetic Field (Appendix D, Section 40.8.6)
- In-situ Plasma Fluctuations (Appendix D, Section 40.8.9)
- In-situ Plasma Temperature (Appendix D, Section 40.8.10)
- Ionospheric Scintillation (Appendix D, Section 40.8.11)
- Neutral Density Profile (Appendix D, Section 40.8.12)
- Medium Energy Charged Particles (Appendix D, Section 40.8.13)
- Energetic Ions (Appendix D, Section 40.8.14)
- Supra-thermal to Auroral Energy Particles (Appendix D, Section 40.8.16)
- Neutral Winds [Objective EDR] (Appendix D, Section 40.8.18)

SRDS3.2.1.1.3-1
The SESS shall be capable of producing the SESS Primary EDRs at the Threshold level. The SESS should be capable of producing the Primary EDRs at the Objective level.

SRDS3.2.1.1.3-2
The SESS shall be capable of satisfying *derived* [*TBR*] EDR requirements for the Primary EDRs assigned to the SESS. Derived requirements for an EDR are those requirements associated with satisfaction of another SESS-assigned EDR [*TBD*] or non-SESS EDR [*TBS*]. Derived requirements may be more stringent than the set of explicit EDR requirements discussed in Section 3.2.1.1.1.

SRDS3.2.1.1.3-3
The SESS shall be capable of satisfying the most stringent requirement in the event that a derived EDR requirement conflicts with an explicit EDR requirement.

SRDS3.2.1.1.3-4
The Contractor shall specify the sensor RDR’s and other ancillary data required to produce the EDRs. The processing of the RDRs and other ancillary data into the EDRs at Data Centrals and within Field Terminals is the responsibility of the IDPS.

SRDS3.2.1.1.3-5
The Contractor shall specify the conditions under which the requirement to deliver an EDR at the Threshold level cannot be met. The Contractor should indicate the conditions under which an EDR at the Objective level can not be met.

SRDS3.2.1.1.3-6
The Contractor shall specify the conditions under which an EDR which is incomplete and/or of degraded quality is still of potential utility.

3.2.1.1.3.1 Auroral Boundary

The auroral boundaries are the loci of points representing the equatorward and poleward edges of the auroral zones. A more precise definition of these boundaries can only be formulated within the context of the measurement technique involved. The requirement is the specification of the *equatorward* auroral boundary presented as the set of geographic latitudes and longitudes for the boundary referenced to an altitude of 120 km. The specification of the *poleward* boundary of the auroral zone is left as an objective measurement.

Units: Degrees latitude and longitude at a reference altitude of 120 km

Para. No.		Thresholds	Objectives
40.8.1-1	a. Horizontal Reporting Interval	100 km	10 km
40.8.1-2	b. Horizontal Coverage	>40° Magnetic latitude, N/S	[TBD]
40.8.1-3	c. Measurement Range	>40° Magnetic latitude, N/S	[TBD]
40.8.1-4	d. Measurement Uncertainty	100 km	10 km
40.8.1-5	e. Reporting Frequency	Twice per orbit [*TBR*]	Four times per orbit

3.2.1.1.3.2 Auroral Energy Deposition

Auroral Energy Deposition refers to the energy flux into the ionosphere from precipitating auroral particles. These data are used to estimate the total auroral heat input into each hemisphere. The hemispheric power input can be determined from direct auroral particle measurements or auroral imagery. In-situ measurements of precipitating ion and electron fluxes may be combined with statistical models of auroral activity to provide an estimate of the hemispheric power input. The total heat input can also be derived from ultraviolet (UV) and/or X-ray auroral imagery. The requirement on the EDR is the set of measurements of the auroral heat flux along the satellite path in each hemisphere.

Units: watts/m^2

Para. No.	Parameter	Thresholds	Objectives
40.8.2-1	a. Measurement Range	10^{-4} - 1 W/m^2	5 x 10^{-5} - 1 W/m^2
40.8.2-2	b. Horizontal Spatial Resolution	100 km	10 km
40.8.2-3	c. Horizontal Coverage	>40° Magnetic latitude, N/S	[TBD]
40.8.2-4	d. Measurement Uncertainty	Greater of{10^{-4} W/m^2, 20%}	Greater of{5x10^{-5} W/m^2, 10%}
40.8.2-5	e. Mapping Uncertainty	10 km [*TBR*]	1 km [*TBR*]
40.8.2-6	f. Reporting Frequency	twice per orbit [*TBR*]	Twice per orbit

3.2.1.1.3.3 Auroral Imagery

Two-dimensional (horizontal) images of the Earth's auroral zones. The requirement is for auroral imagery under both sunlit and darkened conditions. Imagery can be obtained at a variety of wavelengths, including the near infrared (IR), visible (VIS), ultraviolet (UV), and X-ray, as appropriate. These data can also be used to satisfy other SESS EDRs.

Units:
DMSP auroral activity criteria

Para. No.		Thresholds	Objectives
40.8.3-1	a. Horizontal Cell Size	100 km	10 km
40.8.3-2	b. Horizontal Reporting Interval	Horizontal Cell Size	Horizontal Cell Size
40.8.3-3	c. Horizontal Coverage	>40^{o} Magnetic latitude, N/S	[TBD]
40.8.3-4	d. Measurement Range	Moderate to very active aurora [*TBR*]	Quiet to very active aurora [*TBR*]
40.8.3-5	e. Measurement Uncertainty	10% [*TBR*]	5%[*TBR*]
40.8.3-6	f. Mapping Uncertainty	10 km	1 km
40.8.3-7	g. Maximum Local Average Revisit Time	4 hours	4 hours

3.2.1.1.3.4 Electric Fields

This EDR provides an in-situ measure of the ambient electric field (quasi DC). Electric fields can be measured directly using electric field booms or inferred from associated measurements of convection. Electric fields in the ionosphere drive the transport of plasma (convection) and, at high latitudes, provide a "footprint" of the magnetosphere. The polar-cap potential, calculated as the integral of the electric fields within the polar cap, nominally dawn to dusk, is an indicator of geomagnetic activity. Electric fields are also to be used to estimate the Joule heat input in the auroral zones. At low latitudes the electric field can be used to forecast the onset of ionospheric scintillation. The requirement on the EDR is the set of measurements of the electric field vector along the satellite path in each hemisphere.

Units: mV/m (millivolts per meter)

Para. No.	EDR Parameter	Thresholds	Objectives
40.8.4-1	a. Measurement Range	0 to ±150 mV/m	0 to ±250 mV/m
40.8.4-2	b. Horizontal Cell Size	10 km [*TBR*]	1 km [*TBD*]
40.8.4-3	b. Horizontal Reporting Interval	Horizontal Cell Size	Horizontal Cell Size
40.8.4-4	c. Horizontal Coverage	Global	Global
40.8.4-5	d. Measurement Uncertainty	3.0 mV/m	0.1 mV/m
40.8.4-6	e. Measurement Precision	2.0 mV/m	0.1 mV/m
40.8.4-7	f. Reporting Frequency	Twice per orbit [*TBR*]	Twice per orbit

3.2.1.1.3.5 Electron Density Profile

This EDR provides a measure of the electron density profile (EDP) and the total electron content (TEC) of the ionosphere. The ionosphere extends from; 1) the lower D near 60 km, 2) up through the local E-region and F_2-region peaks closer to 100 km and 250 km, respectively, 3) into the topside ionosphere, and 4) stretching up to the inner edge of the plasmasphere near 3000 km. The density along the EDP typically reaches a maximum at the F_2 peak. The DoD and DOC require specifications of the ionosphere in terms of characteristic ionospheric features (Chapman layers) to support HF Communications and HAM radio operators. The requirement on this EDR is for the EDP within the primary range of interest; that is, between 90 and 800 km. The TEC is needed by the DoD to assess ionospheric effects on radiowave propagation, including GPS. Unless otherwise indicated, the vertical

TEC is associated with the ionospheric column content; that is, from the ground to 36,000 km altitude. EDPs are also necessary inputs to various operational ionospheric algorithms and other space weather models.

A variety of techniques exist for measuring the ionospheric EDP. Included are in-situ measurements of plasma parameters such as density and temperature (see EDR 40.8.10), optical remote sensing techniques such as auroral imagery (EDR 40.8.3) and atmospheric airglow, active and passive high-frequency remote sensing, and TEC measurements using GPS. Complementary data from the NPOESS GPS Occultation Sensor (GPSOS) may also be available to support this EDR. The following is a partial list of useful ionospheric features which may be measured or inferred:

Features	Units	Definition
n_mF_2	cm^{-3}	Density at the F_2 peak
h_mF_2	km	Altitude of the F_2 peak
n_mE	cm^{-3}	Density at the E peak
h_mE	km	Altitude of the E peak
λ_{scale}	km	Scale height for the topside ionosphere
h_{trans}	km	Transition height for dominance of OII to light ions
$n_{in\text{-}situ}$	cm^{-3}	Density measured at the NPOESS spacecraft
$TEC_{overhead}$	cm^{-2}	TEC above NPOESS

DRAFT

Units:
cm^{-3} (density)
km (height)
TECU (1 TECU=10^{16} m^2)

Para. No.		Thresholds	Objectives
	a. Measurement Range		
40.8.5-1	1. Density, n_e	$3x10^4$ - 10^7 cm^{-3}	10^4 - 10^7 cm^{-3}
40.8.5-2	2. TEC (vertical)	3 - 200 TEC units	1 – 200 TEC units
	3. Features		
40.8.5-3	n_mF_2	10^5 - 10^7 cm^{-3}	10^4 - 10^7 cm^{-3}
40.8.5-4	h_mF_2	150 - 700 km	150 - 800 km
40.8.5-5	n_mE	10^5 - 10^7 cm^{-3}	10^4 - 10^7 cm^{-3}
40.8.5-6	h_mE	N/A	90 – 150 km
40.8.5-7	λ_{scale}	N/A	[*TBD*]
40.8.5-8	h_{trans}	N/A	[*TBD*]
40.8.5-9	$n_{in-situ}$	N/A	[*TBD*]
40.8.5-10	$TEC_{overhead}$	N/A	[*TBD*]
40.8.5-11	Ion composition	N/A	[*TBD*]
40.8.5-12	b. Horizontal Coverage	Global	Global
40.8.5-13	c. Vertical Coverage	90-800 km	60-3000 km
	d. Horizontal Cell Size		
40.8.5-14	1. Latitudes: 0-30°	100 km	10 km
40.8.5-15	2. Latitudes: 30-50°	500 km	250 km
40.8.5-16	3. Latitudes: 50-90°	50 km	10 km
	e. Vertical Cell Size (EDP)		
40.8.5-17	1. 90 to 500 km	10 km	3 km
40.8.5-18	2. above 500 km	20 km	5 km
40.8.5-19	f. Horizontal Reporting Interval	Horizontal Cell Size	Horizontal Cell Size
40.8.5-20	g. Vertical Reporting Interval (EDP)	Vertical Cell Size	Vertical Cell Size
	h. Measurement Uncertainty		
40.8.5-21	1. Density, n_e	Greater of {10^5 cm^{-3}, 30%}	Greater of {10^4 cm^{-3}, 5%}
40.8.5-22	2. TEC (vertical)	Greater of{3 TEC, 30 %}	Greater of{1 TEC, 30 %}
	3. Features		
40.8.5-23	n_mF_2	20%	10%
40.8.5-24	h_mF_2	20 km	5km
40.8.5-25	n_mE	20%	5 %
40.8.5-26	h_mE	10 km	3 km
40.8.5-27	λ_{scale}	N/A	[*TBD*]
40.8.5-28	h_{trans}	N/A	[*TBD*]
40.8.5-29	$n_{in-situ}$	N/A	[*TBD*]
40.8.5-30	$TEC_{overhead}$	N/A	[*TBD*]
40.8.5-31	Ion composition	N/A	5% [*TBR*]

3.2.1.1.3.6 Geomagnetic Field

This EDR provides in-situ measurements of the geomagnetic field. The primary use of this data is to support the periodic (5-year) updates to the World Magnetic Model (WMM), Mil-W-89500. A secondary use of the data is to detect transients (spatial and temporal) in the earth's field due to magnetic field-aligned currents. Variations in the reference field can adversely affect satellite magnetic torquing devices (attitude control). Field-aligned current characterization is also useful for magnetospheric specification models. {Note: The needs of the WMM require a well calibrated vector magnetometer over the duration of the mission – this requirement may drive the need for a co-manifested precise scalar magnetometer (0.1 nT [*TBD*]) as a part of the SESS. Please quantify the "degree of difficulty" in meeting this requirement.}

Units: nanotesla (nT)

Para. No.	EDR Parameters	Thresholds	Objectives
40.8.6-1	a. Measurement Range (per axis)	0 to ±60,000 nT	[TBD]
40.8.6-2	b. Measurement Accuracy (per axis)	17 nT	[TBD]
40.8.6-3	c. Measurement Precision (per axis)	6 nT	2 nT
40.8.6-4	d. Measurement Uncertainty	18 nT	[TBD]
40.8.6-5	e. Horizontal Cell Size	100 m	[TBD]
40.8.6-6	f. Horizontal Coverage	Global	Global
40.8.6-7	g. Horizontal Reporting Interval	1 km	100 m
	h. Mapping Accuracy		
40.8.6-8	1. Sensor position	100 m	[TBD]
40.8.6-9	2. Sensor orientation	1.0 arc min	0.6 arc min

3.2.1.1.3.7 In-situ Ion Drift Velocity

Merged into Electric Field EDR (Paragraph 3.2.1.1.3.4).

3.2.1.1.3.8 In-situ Plasma Density

Merged into Electron Density Profile (Paragraph 3.2.1.1.3.5) and In-situ Plasma Fluctuations (Paragraph 3.2.1.1.3.9).

3.2.1.1.3.9 In-situ Plasma Fluctuations

This EDR provides an in-situ measurement of plasma density fluctuations. The desired products are; 1) the mean plasma density, 2) the scale-sizes for ionospheric density structures; 3) the RMS value of $\delta n/n$, and 4) the spectral index for the fluctuation spectrum. These parameters are used to estimate C_kL; that is, the height-integrated irregularity strength parameter, which is an input to ionospheric scintillation models (see EDR 40.8.11).

Units:
Mean Plasma Density: cm^{-3}
Fluctuation Scale Length: m
Spectral Index: Dimensionless
$\delta n/n$: Dimensionless

Para. No.		Thresholds	Objectives
40.8.9-1	a. Horizontal Reporting Interval	100 km	50 km (TBR)
40.8.9-2	b. Horizontal Coverage	Global	Global
	c. Measurement Range		
40.8.9-3	1. Mean Plasma Density	$5x10^3$ to $5x10^6$ cm^{-3}	10^2 to 10^7 cm^{-3}
40.8.9-4	2. Fluctuation Scale Length	5 to 10^4 m	[TBD]
40.8.9-5	3. Spectral Index	1 to 5	[TBD]
40.8.9-6	4. $\delta n/n$	10^{-2} to 1	[TBD]
	d. Measurement Uncertainty		
40.8.9-7	1. Mean Plasma Density	Greater of{20%, 10^4 cm^{-3}}	Greater of{5%, $2x10^2$ cm^{-3}}
40.8.9-8	2. Fluctuation Scale Length	[*TBS*]	[*TBS*]
	e. Measurement Precision		
40.8.9-9	1. Spectral Index	[*TBS*]	[*TBS*]
40.8.9-10	2. $\delta n/n$	[*TBS*]	[*TBS*]
40.8.9-8	f. Local Time Range	[*TBS*]	[*TBS*]

3.2.1.1.3.10 In-situ Plasma Temperature (T_e & T_i)

This EDR provides in-situ measurements of the electron and ion temperatures. In-situ plasma temperatures are used to estimate topside scale heights as inputs to future operational ionospheric specification models.

Units:
Temperature: ^oK

Para. No.		Thresholds	Objectives
40.8.10-1	a. Horizontal Reporting Interval	100 km	10 km
40.8.10-2	b. Horizontal Coverage	Global	Global
40.8.10-3	c. Measurement Range	500 - 10,000 ^oK	[TBD]
40.8.10-4	d. Measurement Uncertainty	10%	5%

3.2.1.1.3.11 Ionospheric Scintillation

Ionospheric scintillation, which manifests itself as increased noise on a radiowave signal intensity and phase, is caused by small-scale variations in the ionospheric electron density along a trans-ionospheric propagation path between a transmitter and a receiver. The magnitude of the effect depends on the ionospheric background (density and drift motions), the amplitude and spectral characteristics of ionospheric density fluctuations, and the frequency and relative motion of the radiowave transmitter and receiver. Maximum scintillation effects are expected 1) at low magnetic latitudes after sunset and

2) within the auroral zones and polar caps. The requirement is for direct measure of scintillation parameters in terms of amplitude and phase fluctuation indices S_4 and sigma-ø at VHF to L-band frequencies. These data will be used for a global specification of scintillation.

Units:
S_4: Dimensionless
sigma-ø: radians

Para. No.		Thresholds	Objectives
40.8.11-1	a. Horizontal Cell Size	100 km	50 km
40.8.11-2	b. Horizontal Coverage	[*TBS*]	[*TBS*]
	c. Measurement Range		
40.8.11-3	1. S_4	0.1 - 1.5	[*TBS*]
40.8.11-4	2. sigma-ø	0.1 - 20 radians	[*TBS*]
	d. Measurement Uncertainty		
40.8.11-5	1. S_4	0.1	[*TBS*]
40.8.11-6	2. sigma-ø	0.1 radian	[*TBS*]
40.8.11-7	e. Local Time Range	[*TBS*]	[*TBS*]

3.2.1.1.3.12 Neutral Density Profile

Measurement of neutral density profiles. Profiles are to be used, along with other geophysical quantities, as inputs to upper atmospheric density models.

Units:
Atmospheric density: g cm^3
Number Density: cm^{-3}

Para. No.	Parameter	Thresholds	Objectives
40.8.12-1	a. Horizontal Cell Size	500 km	250 km
40.8.12-2	b. Horizontal Reporting Interval	Horizontal Cell Size	Horizontal Cell Size
	c. Vertical Cell Size		
40.8.12-3	1. Up to 120 km	5 km	0.5 km
40.8.12-4	2. Above 120 km	5 km	3 km
40.8.12-5	d. Vertical Reporting Interval	Vertical Cell Size	Vertical Cell Size
40.8.12-6	e. Horizontal Coverage	Global	Global
40.8.12-7	f. Vertical Coverage	90 to 800 km	90 to 1600 km
	g. Measurement Range		
40.8.12-8	1. Atmospheric density	$2x10^{-19}$ to $5x10^{-9}$ g cm^{-3}	[TBD]
40.8.12-9	2. Number density	$9x10^4$ to $6x10^{13}$ cm^{-3}	[TBD]
40.8.12-10	3. Neutral composition	N/A	N_2, O_2, O, He, H
	h. Measurement Uncertainty (Density)		
40.8.12-11	1. 90 to 500 km	10%	5%
40.8.12-12	2. 500 to 700 km	15%	10%
40.8.12-13	3. 700 to 1600 km	20%	15%
40.8.12-14	i. Measurement Precision	5%	1%

3.2.1.1.3.13 Medium Energy Charged Particles

Measurements of particles in this energy range are required to serve as inputs to models of the auroral ionosphere, determine the boundaries and extent of the polar cap, and provide inputs to magnetospheric models. These data are also used in the analysis of satellite anomalies involving surface charging and, at the higher energies, deep-dielectric charging and radiation damage. The requirement is for the energy distribution of both ions and electrons within the specified energy ranges. Particle measurements are required over a range of pitch angles both inside and external to the local loss cone. {Note: Electron fluxes above 3-to-4 MeV may be below detection sensitivities. Please quantify the "degree of difficulty" and benefits, if any, for measuring electron fluxes above 3 or 4 MeV.}

DRAFT

Units:
Energy: keV or MeV
Flux: m^{-2} sec^{-1} $ster^{-1}$

Para. No.		Thresholds	Objectives
40.8.13-1	a. Horizontal Reporting Interval	25 km	10 km
	b. Measurement Range		
40.8.13-2	1. Energy	50 keV to 10 MeV	[TBD]
40.8.13-3	2. Total flux	10^6 to $5x10^{11}$ m^{-2} s^{-1} $ster^{-1}$	10^5 to $2x10^{12}$ m^{-2} s^{-1} $ster^{-1}$
40.8.13-4	3. Pitch angle	0^o and 90^o (two angles)	0^o to 90^o (multiple angles)
	c. Measurement Precision		
40.8.13-5	1. Low energy roll-off	40%	[TBD]
40.8.13-6	2. Total flux	Greater of{10^6 m^{-2} s^{-1} $ster^{-1}$, 5%}	Greater of{10^5 m^{-2} s^{-1} $ster^{-1}$, 1%}
40.8.13-7	3. Pitch angle	15^o	[TBD]
	d. Measurement Uncertainty		
40.8.13-8	1. Energy	10%	5%
40.8.13-9	2. Total flux	Greater of{10^6 m^{-2} s^{-1} $ster^{-1}$, 20%}	Greater of {10^5 m^{-2} s^{-1} $ster^{-1}$, 10%}
40.8.13-10	3. Pitch angle	15^o	[TBD]
	e. Total Dose		
40.8.13-11	1. Range	N/A	10^1 to 10^6 rads/yr
40.8.13-12	2. Shielding thickness	N/A	4, 100, 250, 500 mils Al

3.2.1.1.3.14 Energetic Ions

Definition:
Measurements of energetic ions within this energy range are required as input to models of the auroral ionosphere, especially D-region and to determine the polar-cap boundary. These data are also used in assessments of satellite anomalies, semiconductor and solar-cell radiation damage, and radiation hazard to astronauts and aircraft personnel. The requirement is a measurement of the ion characteristics, including the energy spectrum and particle pitch angle. The pitch angle is used to distinguish the particle trapping boundary as a possible signature of the polar-cap boundary.

Units:
Energy: MeV
Flux: $m^{-2}\ s^{-1}\ ster^{-1}$
Linear Energy Transfer (L.E.T.): MeV $cm^{-2}\ mg^{-1}$

Para. No.	Parameter	Thresholds	Objectives
40.8.14-1	a. Horizontal Reporting Interval	25 km	[TBD]
40.8.14-2	b. Horizontal Coverage	Latitudes >40^o N & S	[TBD]
	c. Measurement Range		
40.8.14-3	1. Energy	10 MeV to 300 MeV	10 MeV to 400 MeV
40.8.14-5	2. Flux – protons	$5x10^3$ - $2x10^9$ $m^{-2}\ s^{-1}\ ster^{-1}$	[TBD]
40.8.14-6	3. Flux – alphas	N/A	10^2 - 10^8 $m^{-2}\ s^{-1}\ ster^{-1}$
40.8.14-7	4. Pitch angle – protons	0^o and 90^o (two angles)	[TBD]
	d. Measurement Precision		
40.8.14-8	1. Energy (ΔE/E or roll-off)	40%	[TBD]
40.8.14-9	2. Flux – protons	5%	1%
40.8.14-10	3. Pitch angle	15%	[TBD]
	e. Measurement Accuracy		
40.8.14-11	1. Energy	20%	10%
40.8.14-12	2. Flux	20%	10%
40.8.14-13	3. Pitch angle	10%	5%
	f. Linear Energy Transfer – *Objective**		
	1. Range	1 – 50 MeV $cm^{-2}\ mg^{-1}$	.1 – 100 MeV $cm^{-2}\ mg^{-1}$

* L.E.T. is an Objective (not a numbered) requirement

3.2.1.1.3.15 Solar Extreme Ultra Violet (EUV) Flux

This requirement has been assigned to the GOES Mission.

3.2.1.1.3.16 Supra-Thermal through Auroral Particles

This EDR provides in-situ measurements of moderately energetic (< 50 keV) electrons and ions, primarily in the auroral regions. These measurements are input to space environment models and are useful to satellite anomaly assessments (surface charging). The requirement is for the energy distribution and pitch angle distribution of precipitating charged particles within the specified energy range. Pitch angle information must be from within and external to the local loss cone angle.

Units:
Energy: eV or keV
Flux: m^{-2} sec^{-1} $ster^{-1}$ keV^{-1}

Para. No.		Thresholds	Objectives
40.8.16-1	a. Horizontal Reporting Interval	10 km	5 km
40.8.16-2	b. Horizontal Coverage	Latitudes > 40^o	[TBD]
	c. Measurement Range (electrons and ions)		
40.8.16-3	1. Energy	30 eV - 50 keV	30 eV – 100 KeV
40.8.16-4	2. Flux	10^8 - 10^{15} m^{-2} s^{-1} $ster^{-1}$ kev^{-1}	[TBD]
40.8.16-5	3. Pitch angle	0^o & 90^o (2 angles)	0^o – 90^o (multiple angles)
	d. Measurement Precision		
40.8.16-6	1. Energy ($\delta E/E$)	20%	10%
40.8.16-7	2. Flux	5%	1%
40.8.16-8	3. Pitch angle	15^o	[TBD]
	e. Measurement Accuracy		
40.8.16-9	1. Energy	10%	5%
40.8.16-10	2. Flux	10%	5%
40.8.16-11	3. Pitch angle	10%	[TBD]

3.2.1.1.3.17 Neutral Winds (Objective EDR)*

The neutral wind plays a significant role in the dynamics of the upper thermosphere. At low latitudes the neutral wind is driven by solar heating of the thermosphere whereas, at high latitudes, auroral-particle heating and collisional coupling to ionospheric convection are the principal sources of the wind. Neutral winds have a significant effect on satellite drag and are a determining factor in the generation of equatorial scintillation in the ionosphere near dusk. Specification of neutral winds is also important to first-principles thermospheric models. The Requirement is for measurements of the zonal and meridional components of the neutral wind.
Units: m s-1

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size	200 km	10 km
	b. Horizontal Reporting Interval	Horizontal Cell Size	Horizontal Cell Size
	c. Vertical Cell Size	20 km	10 km
	d. Vertical Reporting Interval	Vertical Cell Size	[TBD]
	e. Horizontal Coverage	0 to $\pm 30^o$ Magnetic Latitude	Global
	f. Vertical Coverage	200 km to 400 km	[TBD]
	g. Measurement Range	0 to ±300 m/s	0 to ±1500 m/s
	h. Measurement Uncertainty	Greater of{10%, 20 m/s}	Greater of{5%, 5 m/s}

* Neutral Winds is an Objective (not a numbered) requirement

3.2.1.1.4 Secondary SESS EDRs

The EDR data products for Secondary SESS EDRs have been assigned as Primary EDRs to NPOESS sensors other than SESS. In some cases these other Primary EDRs may require SESS data to process the associated algorithms.

SRDS3.2.1.1.4-1
The SESS shall meet [*TBS*] data specifications for the generation of Secondary EDRs. The Contractor will be advised by the Government of SESS data requirements identified by other NPOESS sensors after award of contract, and after the other sensor vendors advise the Government of their requirements.

3.2.1.2 Operational SDR Requirements [*TBR*]

In processing RDRs into EDRs the IDPS is to generate intermediate-level satellite instrument data files, including Sensor Data Records (SDRs). SDRs are needed for retrospective processing and for data archival. SDRs are to be delivered to the same user destinations as the associated EDRs, as specified in the EDR/RDR matrix (Appendix E). The generation and delivery of operational SDRs will be the responsibility of the IDPS (TSPR) contractor, not the SESS Contractor.

3.2.1.3 Operational RDR Requirements [*TBR*]

Since RDRs are processed into EDRs, RDRs are considered to have met their requirements when they are of an appropriate format, completeness, and quality to be adequately processed into their associated EDRs.

SRDS3.2.1.3-1
The Contractor shall be responsible for generating operational RDRs.

3.2.1.4 Earth Location Requirements

SRDS3.2.1.4-1
The SESS shall be designed so that with Contractor's scientific geolocation algorithms the mapping uncertainty requirements of all Primary EDRs can be met. The Contractor may adopt, adapt, or develop the required scientific geolocation algorithms.

SRDS3.2.1.4-2
The Contractor shall specify sensor requirements necessary to meet the mapping uncertainty requirements of the Primary SESS EDRs.

3.2.1.5 Algorithms [*TBR*]

3.2.1.5.1 Scope

SRDS3.2.1.5.1-1
The Contractor shall adopt or adapt existing algorithms or develop new scientific algorithms for all primary EDRs. Adopting an algorithm means using an existing algorithm without change. Adapting

an algorithm means using an existing algorithm with some modification, such as different values of coefficients, inclusion of higher order corrections, fusion of additional data sources, etc.

SRDS3.2.1.5.1-2
The Contractor shall also identify use of any auxiliary data required to meet EDR requirements. The government's Space Environment Steering Group (SESG) may also recommend science algorithms. This team has contributed to the definition of the instrument requirements of Section 3. The SESG may also provide advisory information on SESS functional and calibration requirements.

SRDS3.2.1.5.1-3
The contractor shall also adopt or adapt existing algorithms or develop new scientific algorithms for all intermediate level data products used to generate the primary EDRs, such as SDRs and flags indicating data quality, clear versus cloudy, etc. Because the SESS contractor is not responsible for the content or format of operational SDRs, the SESS contractor may select the appropriate intermediate-level data products needed as inputs to his scientific EDR algorithms in satisfying this requirement. The description of operational SDRs in Section 3.2.1.2 is provided as guidance. Algorithms need not be provided for data products that are generated by other sensor suites and utilized as inputs to the algorithms for SESS primary EDRs.

SRDS3.2.1.5.1-4
The contractor shall develop sufficient materials for an Algorithm Theoretical Basis Document (ATBD) for the assigned set of primary EDRs. ATBDs provide the physical theory and assumptions behind the EDRs, as well as the mathematical procedures required to produce the RDRs, convert the RDRs into SDRs, and convert the SDRs into the EDRs. The ATBD should discuss limitations on the approach, accuracy considerations, additional information required for measurement processing (mandatory and desirable), and alternative processing approaches required under alternative measurement situations (e.g., daytime and nighttime observations).

SRDS3.2.1.5.1-5
The contractor shall develop sufficient research grade source code for implementing the algorithm(s) described in the ATBD that address the primary EDRs. The research grade code should include all processes, other than input/output, needed to: convert RDRs into SDRs; convert SDRs into EDRs; use all mandatory outside data; use any optional outside data, if available; select alternative processing algorithms based on the data available; provide continuing calibration validation; and any other similar processing tasks required to satisfy allocated EDR quality and availability requirements. The scientific algorithms developed by the contractor may be adopted or adapted from existing algorithms, or developed, as needed.

3.2.1.5.2 Performance

3.2.1.5.2-1
The performance of the scientific EDR algorithms delivered by the SESS Contractor shall meet EDR thresholds and be no worse than the performance of algorithms utilized for current [*TBR*] operational data products for these EDRs, if such operational products exist.

3.2.1.5.2-2
The Contractor shall quantify any EDR algorithm performance degradation resulting from the lack of availability of any database or other auxiliary data.

3.2.1.5.3 Convertibility to Operational Code

The Government considers the SDR and EDR algorithms adopted, adapted, or developed by the SESS Contractor to be scientific, rather than operational, algorithms. The SESS Contractor is not responsible for identifying or developing *operational* SDR and EDR algorithms for the SESS. (Any operational algorithms necessary for the generation of RDRs will ultimately be the responsibility of the SESS Contractor, and the operational code implementing these algorithms will be part of the required flight software. This statement applies to the post-downselect phase of the SESS program.)

SRDS3.2.1.5.3-1
The scientific SDR and EDR algorithms delivered by the SESS Contractor shall be convertible into operational code that is compatible with a 20 minute maximum processing time at either the DoD Centrals or DoD field terminals for the conversion of all pertinent RDRs into all required EDRs for the site or terminal, including those based wholly or in part on data from other sensor suites. The intent of this requirement is to preclude algorithms that are so computationally intensive that any foreseeable implementation would stress or exceed the time available for delivery of EDRs in an operational environment.

SRDS3.2.1.5.3-2
The means by which the contractor shall validate the requirement that scientific algorithms be convertible to operational code subject to the constraint specified in SRDS 3.2.1.5.3-1 is (TBR).

SRDS3.2.1.5.3-3
The availability of any inputs required from databases or other ancillary sources to generate data products shall also be adequate to allow EDRs to be generated at the DoD Centrals and DoD field terminals within the time constraint specified in SRDS3.2.1.5.3-1.

3.2.1.6 Sensor Calibration

SRDS3.2.1.6-1
The SESS shall be capable of performing periodic autonomous or ground controlled mission sensor calibration, as required.

3.2.1.7 Real-time Data Downlink Data

SRDS3.2.1.7-1
The SESS shall provide to the spacecraft selected [*TBR*] real-time sensor data packets for real-time ground transmission.

3.2.1.8 Stored Data Downlink Data

SRDS3.2.1.8-1
The SESS shall provide to the spacecraft selected [*TBR*] stored-data sensor data packets containing the SESS mission data. The Contractor should consider that these data will be stored on-board the spacecraft for subsequent transmission to the ground.

3.2.1.9 Data Formatting and Compression

SRDS3.2.1.9-1

The data packets generated by the SESS shall conform to the Consultative Committee for Space Data Systems (CCSDS) packetization per the real-time and stored data specifications referenced in SRD Sections 3.2.4.8.2 and 3.2.4.9.4.

SRDS3.2.1.9-2
If data compression techniques are utilized by the SESS in generating data packets for storage on-orbit, the compression shall be lossless.

3.2.2 Interface Requirements

The NPOESS system interfaces relevant to the NPOESS sensors are depicted in Figure 3.2.2-1 below.

The NPOESS system interfaces relevant to the NPOESS sensors are depicted in Figure 3.2.2-1 below.

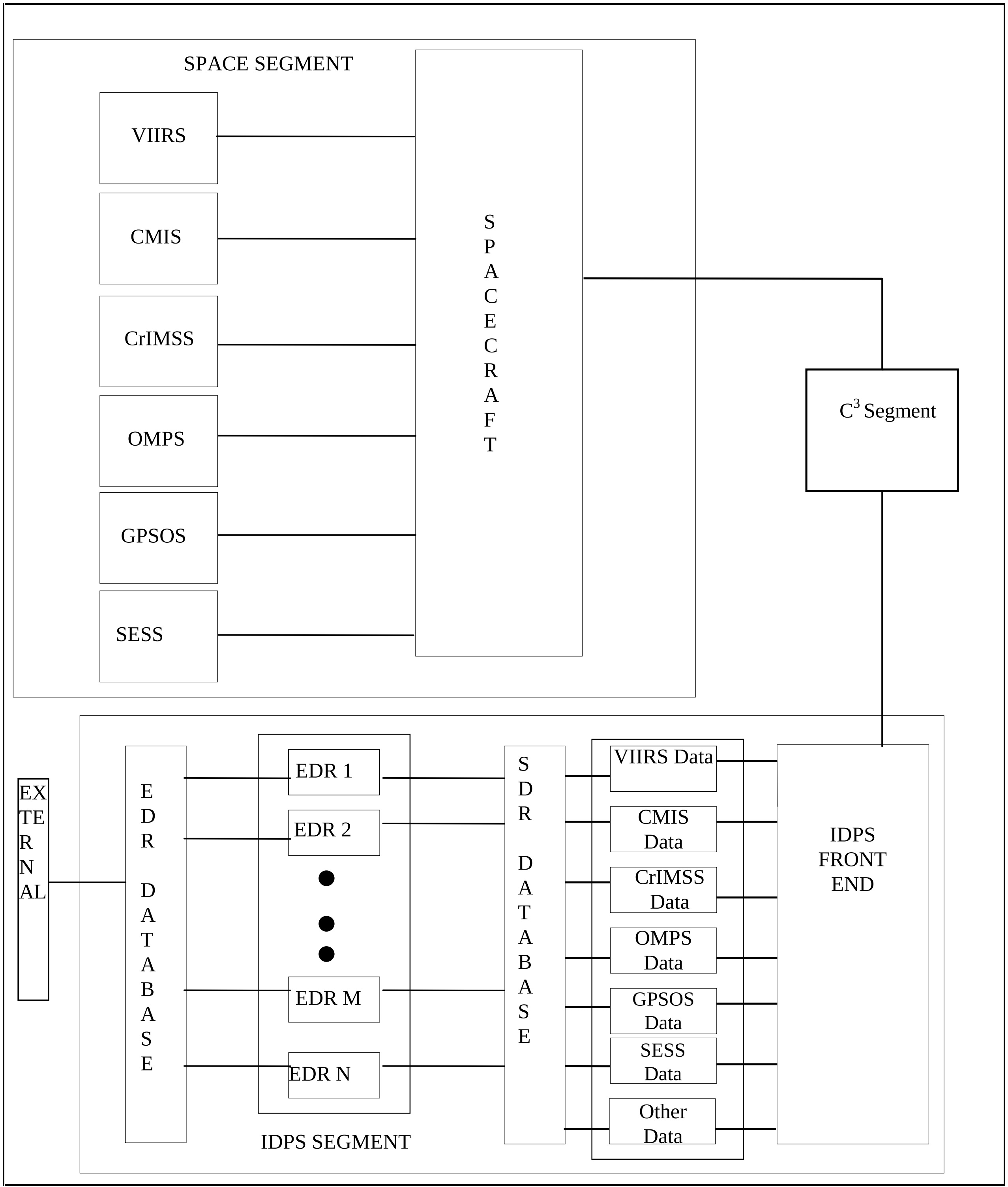

FIGURE 3.2.2-1 PARTIAL SYSTEM INTERNAL INTERFACES

SRDS3.2.2-1
The SESS shall be compatible with and interface to the NPOESS spacecraft [*TBS*].

3.2.4 Physical and Interface Characteristics

Mass, power, volume and data rates described herein are nominal values (with contingency) which were developed during initial studies at the Integrated Program Office. All values are defined *TBR*, indicating that specific allocations are negotiable. It is presently planned that definitive allocations will be defined by the IPO, in consultation with the other NPOESS sensor contractors, by the time of the SRR. In the interim, the Contractors should keep in mind that relaxation from nominal allocations will only be possible if changes are consistent with the requirement to accommodate the full NPOESS payload suite of instruments on a spacecraft which can be placed into a nominal 833 km orbit by an EELV class launch vehicle. The spacecraft-to-sensor interface requirements are broken down into four primary groups: mechanical, power, data, and thermal. A notional diagram of the top-level functional interfaces for any sensor is shown in Figure 3.2.4. In addition, environmental, software, testing, contamination, launch environment, and safety requirements are defined.

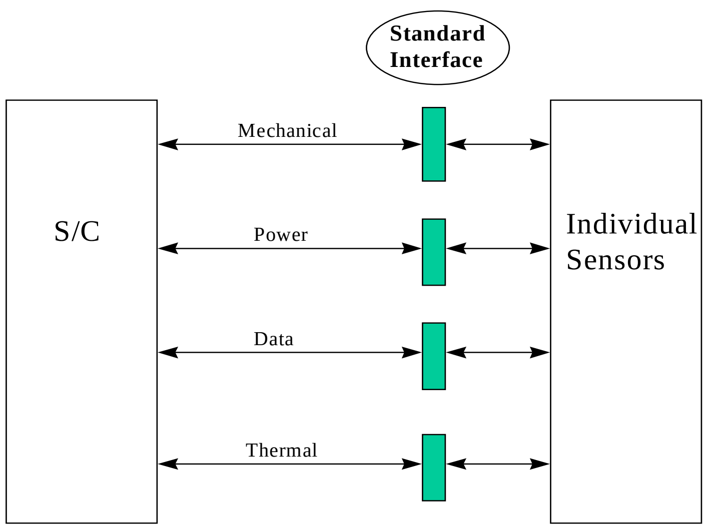

Figure 3.2.4. Notional Spacecraft-To-Sensor Functional Interfaces.

The following constraints are based on initial allocations from the NPOESS notional baseline. These constraints are expected to be further refined during the initial contract efforts. The following numbers include all margins assigned to the SESS.

SRDS3.2.4-1
The SESS mass shall be less than or equal to 100 kg [*TBR*].

SRDS3.2.4-2
The SESS power (maximum) shall be less than or equal to 62 watts [*TBR*].

DRAFT

SRDS3.2.4-3
The SESS total volume shall be less than or equal to 1.6×10^5 cm^3 [*TBR*].

SRDS3.2.4-4
The stowed dimensions of the SESS sensor shall be less than or equal to the following limits:

a) Velocity direction: [TBS]
b) Nadir direction: [TBS]
c) Anti-Solar direction: [TBS]

SRDS3.2.4-5
The SESS data rate to the spacecraft shall be less than or equal to 10 kbps [*TBR*].

See Common Section-Version Two, Revision a, 8 March 1999